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Substitute for form 1449/PTO SECOND INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Use as many sheets as necessary)			<i>Complete if Known</i>		
			<i>Application Number</i>	13/991,513	
			<i>Filing Date</i>	June 4, 2013	
			<i>First Named Inventor</i>	Henrik ÖJELUND et al.	
			<i>Art Unit</i>	Unassigned	
			<i>Examiner Name</i>	Unassigned	
Sheet	1	of	1	<i>Attorney Docket Number</i>	0079124-000070

U.S. PATENT DOCUMENTS					
Examiner Initials ¹	Cite No. ¹	Document Number	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		Number-Kind Code ² (if known)			
		US-			
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		US-			
		US-			

FOREIGN PATENT DOCUMENTS						
Examiner Initials ¹	Cite No. ¹	Foreign Patent Document	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T ⁶
		Country Code ³ Number ⁴ Kind Code ⁵ (if known)				

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials ¹	Cite No. ¹	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ²
		C. GRAETZEL et al., "A NON-CONTACT MOUSE FOR SURGEON-COMPUTER INTERACTION", Technology and Health Care, 12(3), 2004, pages 1-19.	
		SEBASTIAN VOGT et al., "AN AR SYSTEM WITH INTUITIVE USER INTERFACE FOR MANIPULATION AND VISUALIZATION OF 3D MEDICAL DATA", Stud. Health Technol. Inform., Medicine Meets Virtual Reality 12, 2004; vol. 98, pages 397-403.	

Examiner Signature		Date Considered	
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*EXAMINER: Initial if reference considered, whether or not citation is in conformance with M.P.E.P. § 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

Electronic Patent Application Fee Transmittal

Application Number:	13991513
Filing Date:	04-Jun-2013
Title of Invention:	SYSTEM WITH 3D USER INTERFACE INTEGRATION
First Named Inventor/Applicant Name:	Henrik Öjelund
Filer:	William C. Rowland/Albina Torres-Price
Attorney Docket Number:	00791.24-000070

Filed as Small Entity

U.S. National Stage under 35 USC 371 Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Natl Stage Search Fee - Report provided	2642	1	240	240
Natl Stage Exam Fee - all other cases	2633	1	360	360

Pages:

Claims:

Miscellaneous-Filing:

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Oath/Decl > 30 Mos From 371 commencement	2617	1	70	70

Petition:

Patent-Appeals-and-Interference:

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Extension - 1 month with \$0 paid	2251	1	100	100
Miscellaneous:				
Total in USD (\$)				770

Electronic Acknowledgement Receipt

EFS ID:	16891575
Application Number:	13991513
International Application Number:	
Confirmation Number:	9282
Title of Invention:	SYSTEM WITH 3D USER INTERFACE INTEGRATION
First Named Inventor/Applicant Name:	Henrik Öjelund
Customer Number:	21839
Filer:	William C. Rowland/Albina Torres-Price
Filer Authorized By:	William C. Rowland
Attorney Docket Number:	0079124-000070
Receipt Date:	19-SEP-2013
Filing Date:	04-JUN-2013
Time Stamp:	15:18:21
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	\$770
RAM confirmation Number	1979
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
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1	Applicant Response to Pre-Exam Formalities Notice	ResponseToMPS.pdf	190237 5b20a57701f87a1797ba0d30faa70179d2495b13	no	3
Warnings:					
Information:					
2	Authorization for Extension of Time all replies	GenAuthorization.pdf	33411 1b6c22b529812ebe6d16f76d634753deb34bc09b	no	1
Warnings:					
Information:					
3	Miscellaneous Incoming Letter	PetitionForEOT.pdf	34051 48d768a55ec582545e3b5425b6f6307c9b7bab51	no	1
Warnings:					
Information:					
4	Preliminary Amendment	PreliminaryAmendment.pdf	194375 0a9e9ec38080f3a81a7859148627011bea7d57fc	no	8
Warnings:					
Information:					
5	Oath or Declaration filed	Declaration.pdf	126512 16dda78d4bc54fd4886e04d9fb2be8d908b51e82	no	2
Warnings:					
Information:					
6	Transmittal Letter	IDS.pdf	28531 9237bd923f9265b5d575b6e17012176027d0fa9e	no	1
Warnings:					
Information:					
7	Information Disclosure Statement (IDS) Form (SB08)	1449.pdf	86095 3eec77aa82e9b81aa5b28c5ac451c2dd251ffb8	no	1
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
8	Non Patent Literature	NPL_BY_GRAETZEL.PDF	5241082 9172106a741fd7557ce477f3dcd178293494a2f9	no	19
Warnings:					
Information:					
9	Non Patent Literature	NPL_BY_VOGT.PDF	4459143 5367285da81ebce0495b4a6d0287f009f8881177	no	7

Warnings:					
Information:					
10	Fee Worksheet (SB06)	fee-info.pdf	37444	no	2
			6f4e0b3157ed00a31680059361e029ecce5a48ff		
Warnings:					
Information:					
Total Files Size (in bytes):				10430881	
<p>This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.</p> <p><u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.</p> <p><u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.</p> <p><u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.</p>					

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/991,513	Filing Date 06/04/2013	<input type="checkbox"/> To be Mailed
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ENTITY: LARGE SMALL MICRO

APPLICATION AS FILED – PART I

FOR	NUMBER FILED	NUMBER EXTRA	RATE (\$)	FEE (\$)
<input type="checkbox"/> BASIC FEE <small>(37 CFR 1.16(a), (b), or (c))</small>	N/A	N/A	N/A	
<input type="checkbox"/> SEARCH FEE <small>(37 CFR 1.16(k), (l), or (m))</small>	N/A	N/A	N/A	
<input type="checkbox"/> EXAMINATION FEE <small>(37 CFR 1.16(o), (p), or (q))</small>	N/A	N/A	N/A	
TOTAL CLAIMS <small>(37 CFR 1.16(i))</small>	minus 20 =	*	X \$ =	
INDEPENDENT CLAIMS <small>(37 CFR 1.16(h))</small>	minus 3 =	*	X \$ =	
<input type="checkbox"/> APPLICATION SIZE FEE <small>(37 CFR 1.16(s))</small>	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
<input type="checkbox"/> MULTIPLE DEPENDENT CLAIM PRESENT <small>(37 CFR 1.16(j))</small>				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

	(Column 1)	(Column 2)	(Column 3)	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)
AMENDMENT	09/19/2013	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR			
	Total <small>(37 CFR 1.16(i))</small>	* 20	Minus	** 20	= 0	X \$40 = 0
	Independent <small>(37 CFR 1.16(h))</small>	* 1	Minus	***3	= 0	X \$210 = 0
	<input type="checkbox"/> Application Size Fee <small>(37 CFR 1.16(s))</small>					
	<input type="checkbox"/> FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM <small>(37 CFR 1.16(j))</small>					
					TOTAL ADD'L FEE	0

	(Column 1)	(Column 2)	(Column 3)	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR			
	Total <small>(37 CFR 1.16(i))</small>	*	Minus	**	=	X \$ =
	Independent <small>(37 CFR 1.16(h))</small>	*	Minus	***	=	X \$ =
	<input type="checkbox"/> Application Size Fee <small>(37 CFR 1.16(s))</small>					
	<input type="checkbox"/> FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM <small>(37 CFR 1.16(j))</small>					
					TOTAL ADD'L FEE	

LIE
/ADRIENE SELLMAN/

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
 ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
 *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

Table with 3 columns: U.S. APPLICATION NUMBER NO. (13/991,513), FIRST NAMED APPLICANT (Henrik Öjelund), ATTY. DOCKET NO. (0079124-000070)

21839
BUCHANAN, INGERSOLL & ROONEY PC
POST OFFICE BOX 1404
ALEXANDRIA, VA 22313-1404

INTERNATIONAL APPLICATION NO.

PCT/DK2011/050461

Table with 2 columns: I.A. FILING DATE (12/05/2011), PRIORITY DATE (12/06/2010)

CONFIRMATION NO. 9282
371 FORMALITIES LETTER



Date Mailed: 06/28/2013

Notification of Insufficient Fees (DO/EO/US)

The following items have been submitted by the applicant or the IB to the United States Patent and Trademark Office as a Designated Office (37 CFR 1.494):

- Indication of Small Entity Status
• Priority Document
• Copy of the International Application filed on 06/04/2013
• Copy of the International Search Report filed on 06/04/2013
• Information Disclosure Statements filed on 06/04/2013
• Oath or Declaration filed on 06/04/2013
• U.S. Basic National Fees filed on 06/04/2013
• Assignee Statement for PGPUB filed on 06/04/2013
• Priority Documents filed on 06/04/2013

The following items MUST be furnished within the period set forth below in order to complete the requirements for acceptance under 35 U.S.C. 371:

- Additional claim fees of \$1280 as a small entity, including any required multiple dependent claim fee, are required. Applicant must submit the additional claim fees or cancel the additional claims for which fees are due.
• To avoid abandonment, a surcharge (for late submission of filing fee, search fee, examination fee or oath or declaration) as set forth in 37 CFR 1.492(h) of \$70 for a small entity in compliance with 37 CFR 1.27, must be submitted with the missing items identified in this letter.

SUMMARY OF FEES DUE:

Total additional fees required for this application is \$1950 for a Small Entity:

- \$70 Surcharge.
• The application search fee has not been paid. Applicant must submit \$240 to complete the search fee. Note a surcharge will be required if submitted later than commencement of the national stage (37 CFR 1.492(h)) and the basic national fee was not paid before July 1, 2005.
• The application examination fee has not been paid. Applicant must submit \$360 to complete the examination fee for a small entity in compliance with 37 CFR 1.27. Note a surcharge will be required if submitted later than commencement of the national stage (37 CFR 1.492(h)) and the basic national fee was not paid before July 1, 2005.

Total additional claim fee(s) for this application is \$1280

- \$1280 for 32 total claims over 20.

ALL OF THE ITEMS SET FORTH ABOVE MUST BE SUBMITTED WITHIN TWO (2) MONTHS FROM THE DATE OF THIS NOTICE OR BY 32 MONTHS FROM THE PRIORITY DATE FOR THE APPLICATION, WHICHEVER IS LATER. FAILURE TO PROPERLY RESPOND WILL RESULT IN ABANDONMENT.

The time period set above may be extended by filing a petition and fee for extension of time under the provisions of 37 CFR 1.136(a).

Applicant is reminded that any communications to the United States Patent and Trademark Office must be mailed to the address given in the heading and include the U.S. application no. shown above (37 CFR 1.5)

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web.
<https://portal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html>

For more information about EFS-Web please call the USPTO Electronic Business Center at **1-866-217-9197** or visit our website at <http://www.uspto.gov/ebc>.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

MARILYN J YOUNGER

Telephone: (571) 272-8183

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number
13/991,513

APPLICATION AS FILED - PART I

(Column 1) (Column 2)

FOR	NUMBER FILED	NUMBER EXTRA
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A
TOTAL CLAIMS (37 CFR 1.16(j))	52 minus 20 = *	32
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 = *	
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).	
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))		

SMALL ENTITY

RATE(\$)	FEE(\$)
N/A	140
N/A	240
N/A	360
x 40 =	1280
x 210 =	0.00
	0.00
TOTAL	2020

OR OTHER THAN SMALL ENTITY

RATE(\$)	FEE(\$)
N/A	
N/A	
N/A	
TOTAL	

* If the difference in column 1 is less than zero, enter "0" in column 2.

APPLICATION AS AMENDED - PART II

(Column 1) (Column 2) (Column 3)

AMENDMENT A		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA
	Total (37 CFR 1.16(i))	*	Minus	**	=
	Independent (37 CFR 1.16(h))	*	Minus	***	=
	Application Size Fee (37 CFR 1.16(s))				
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					

SMALL ENTITY

RATE(\$)	ADDITIONAL FEE(\$)
x =	
x =	
TOTAL ADD'L FEE	

OR OTHER THAN SMALL ENTITY

RATE(\$)	ADDITIONAL FEE(\$)
x =	
x =	
TOTAL ADD'L FEE	

(Column 1) (Column 2) (Column 3)

AMENDMENT B		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA
	Total (37 CFR 1.16(i))	*	Minus	**	=
	Independent (37 CFR 1.16(h))	*	Minus	***	=
	Application Size Fee (37 CFR 1.16(s))				
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					

RATE(\$)	ADDITIONAL FEE(\$)
x =	
x =	
TOTAL ADD'L FEE	

OR OTHER THAN SMALL ENTITY

RATE(\$)	ADDITIONAL FEE(\$)
x =	
x =	
TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Table with 6 columns: APPLICATION NUMBER, FILING or 371(c) DATE, GRP ART UNIT, FIL FEE REC'D, ATTY DOCKET NO, TOT CLAIMS, IND CLAIMS. Row 1: 13/991,513, 06/04/2013, 140, 0079124-000070, 52, 2

CONFIRMATION NO. 9282

21839
BUCHANAN, INGERSOLL & ROONEY PC
POST OFFICE BOX 1404
ALEXANDRIA, VA 22313-1404

FILING RECEIPT



Date Mailed: 06/28/2013

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections

Inventor(s)

Henrik Öjelund, Lyngby, DENMARK;
David Fischer, Stenlose, DENMARK;
Karl-Josef Hollenbeck, Kobenhavn O, DENMARK;

Applicant(s)

Henrik Öjelund, Lyngby, DENMARK;
David Fischer, Stenlose, DENMARK;
Karl-Josef Hollenbeck, Kobenhavn O, DENMARK;

Assignment For Published Patent Application

3Shape A/S, Copenhagen K, DENMARK

Power of Attorney: The patent practitioners associated with Customer Number 21839

Domestic Priority data as claimed by applicant

This application is a 371 of PCT/DK2011/050461 12/05/2011
which claims benefit of 61/420,138 12/06/2010

Foreign Applications (You may be eligible to benefit from the Patent Prosecution Highway program at the USPTO. Please see http://www.uspto.gov for more information.)

DENMARK PA 2010 01104 12/06/2010 No Access Code Provided

Request to Retrieve - This application either claims priority to one or more applications filed in an intellectual property Office that participates in the Priority Document Exchange (PDX) program or contains a proper Request to Retrieve Electronic Priority Application(s) (PTO/SB/38 or its equivalent). Consequently, the USPTO will attempt to electronically retrieve these priority documents.

If Required, Foreign Filing License Granted: 06/25/2013

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/991,513**

Projected Publication Date: 10/03/2013

Non-Publication Request: No

Early Publication Request: No

**** SMALL ENTITY ****

Title

SYSTEM WITH 3D USER INTERFACE INTEGRATION

Preliminary Class

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at <http://www.uspto.gov/web/offices/pac/doc/general/index.html>.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, <http://www.stopfakes.gov>. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

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Title 35, United States Code, Section 184
Title 37, Code of Federal Regulations, 5.11 & 5.15

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This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit <http://www.SelectUSA.gov> or call +1-202-482-6800.

**MULTIPLE DEPENDENT CLAIM
FEE CALCULATION SHEET**

Substitute for Form PTO-1360
(For use with Form PTO/SB/06)

Application Number

13991513

Filing Date

Applicant(s) **Henrik OJELUND**

* May be used for additional claims or amendments

CLAIMS	AS FILED		AFTER FIRST AMENDMENT		AFTER SECOND AMENDMENT			*		*		*	
	Indep	Depend	Indep	Depend	Indep	Depend		Indep	Depend	Indep	Depend	Indep	Depend
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Total Indep	2		0		0								
Total Depend	50	↙	0	↙	0	↙							
Total Claims	52		0		0								
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TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A SUBMISSION UNDER 35 U.S.C. 371		ATTORNEY'S DOCKET NO. 0079124-000070
		U.S. APPLICATION No. (If known) Unassigned
INTERNATIONAL APPLICATION NO. PCT/DK2011/050461	INTERNATIONAL FILING DATE December 5, 2011	PRIORITY DATE CLAIMED December 6, 2010
TITLE OF INVENTION SYSTEM WITH 3D USER INTERFACE INTEGRATION		
APPLICANT(S) FOR DO/EO/US ÖJELUND, Henrik FISCHER, David HOLLENBECK, Karl-Josef		
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information.		
1. <input type="checkbox"/> This is an express request to begin national examination procedures (35 U.S.C. 371(f)). NOTE: The express request under 35 U.S.C. 371(f) will not be effective unless the requirements under 35 U.S.C. 371(c)(1), (2), and (4) for payment of the basic national fee, copy of the International Application and English translation thereof (if required), and the oath or declaration of the inventor(s) have been received. 2. <input type="checkbox"/> A copy of the International Application (35 U.S.C. 371(c)(2)) is attached hereto (not required if the International Application was previously communicated by the International Bureau or was filed in the United States Receiving Office (RO/US)). 3. An English language translation of the International Application (35 U.S.C. 371(c)(2)) a. <input type="checkbox"/> is attached hereto. b. <input type="checkbox"/> has been previously submitted under 35 U.S.C. 154(d)(4). 4. An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)) a. <input type="checkbox"/> is attached. b. <input type="checkbox"/> was previously filed in the international phase under PCT Rule 4.17(iv).		
Items 5 to 8 below concern amendments made in the international phase.		
<u>PCT Article 19 and 34 amendments</u>		
5. <input type="checkbox"/> Amendments to the claims under PCT Article 19 are attached (not required if communicated by the International Bureau) (35 U.S.C. 371(c)(3)). 6. <input type="checkbox"/> English translation of the PCT Article 19 amendment is attached (35 U.S.C. 371(c)(3)). 7. <input type="checkbox"/> English translation of annexes (Article 19 and/or 34 amendments only) of the International Preliminary Examination Report is attached (35 U.S.C. 371(c)(5)).		
<u>Cancellation of amendments made in the international phase</u>		
8a. <input type="checkbox"/> Do not enter the amendment made in the international phase under PCT Article 19. 8b. <input type="checkbox"/> Do not enter the amendment made in the international phase under PCT Article 34.		
NOTE: A proper amendment made in English under Article 19 or 34 will be entered in the U.S. national phase application absent a clear instruction from applicant not to enter the amendment(s).		
The following items 9 to 17 concern a document(s) or information included.		
9. <input checked="" type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98. 10. <input type="checkbox"/> A preliminary amendment 11. <input checked="" type="checkbox"/> An Application Data Sheet under 37 CFR 1.76. 12. <input type="checkbox"/> A substitute specification. NOTE: A substitute specification cannot include claims. See 37 CFR 1.125(b). 13. <input type="checkbox"/> A power of attorney and/or change of address letter. 14. <input type="checkbox"/> A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.3 and 37 CFR 1.821-1.825. 15. <input checked="" type="checkbox"/> Assignment papers (cover sheet and document(s)). Name of Assignee : 3Shape A/S . 16. <input type="checkbox"/> 37 CFR 3.73(c) Statement (when there is an Assignee).		

U.S. APPLICATION NO. (If known) Unassigned	INTERNATIONAL APPLICATION NO. PCT/DK2011/050461	ATTORNEY'S DOCKET NO. 0079124-000070
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17. Other items or information:
 Form PCT/IB/301
 Form PCT/IB/304
 Form PCT/IB/306
 Form PCT/IB/308 (First Notice)
 Form PCT/IB/308 (Second Notice)
 Form PCT/IB/311
 Form PCT/ISA/210

The following fees have been submitted.				CALCULATIONS	PTO USE ONLY
18. <input checked="" type="checkbox"/>	Basic national fee (37 CFR 1.492(a))	(1631)	\$280	\$ 280	
19. <input type="checkbox"/>	Examination fee (37 CFR 1.492(c)) If the written opinion prepared by ISA/US or the International preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4)	(1643)	\$0	\$	
	All other situations	(1633)	\$720	\$	
20. <input type="checkbox"/>	Search fee (37 CFR 1.492(b)) If the written opinion prepared by ISA/US or the International preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4)	(1640)	\$0		
	Search fee (37 CFR 1.445(a)(2)) has been paid on the international application to the USPTO as an International Searching Authority	(1641)	\$120		
	International Search Report prepared by an ISA other than the US and provided to the Office or previously communicated to the US by the IB	(1642)	\$480		
	All other situations	(1632)	\$600	\$	
TOTAL OF 18, 19 and 20 =				\$ 280	
<input type="checkbox"/>	Additional fee for specification and drawings filed in paper over 100 sheets (excluding sequence listing in compliance with 37 CFR 1.821(c) or (e) in an electronic medium or computer program listing in an electronic medium) (37 CFR 1.492(j)). Fee for each additional 50 sheets of paper or fraction thereof	(1681)	\$400		
Total Sheets		Extra sheets	Number of each additional 50 or fraction thereof (round up to a whole number)	RATE	
- 100 =		/ 50 =		x \$400	\$
Surcharge of \$140.00 for furnishing any of the search fee, examination fee, or the oath or declaration after the date of commencement of the national stage (37 CFR 1.492(h)).				\$	
CLAIMS		NUMBER FILED	NUMBER EXTRA	RATE	
Total claims		- 20 =		x \$80 (1615)	\$
Independent Claims		- 3 =		x \$420 (1614)	\$
MULTIPLE DEPENDENT CLAIM(S) (if applicable)				+ \$780 (1616)	\$
TOTAL OF ABOVE CALCULATIONS =				\$ 280	
<input checked="" type="checkbox"/>	Applicant claims small entity status. See 37 CFR 1.27. Fees above are reduced by 1/2.			140	
SUBTOTAL =				\$ 140	
Processing fee of \$140.00 (1618) for furnishing the English translation later than 30 months from the earliest claimed priority date (37 CFR 1.492(l)).				\$	
TOTAL NATIONAL FEE =				\$ 140	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property				\$	
TOTAL FEES ENCLOSED =				\$	
				Amount to be refunded:	
				Amount to be charged:	140


- a. A check in the amount of \$__ to cover the above fees is enclosed.
 - b. Please charge my Deposit Account No. **02-4800** in the amount of \$__ to cover the above fees.
 - c. The Director is hereby authorized to charge additional fees which may be required, or credit any overpayment, to Deposit Account No. **02-4800** as follows:
 - i. any required fee
 - ii. any required fee except for excess claims fees required under 37 CFR 1.492(d) and (e) and multiple dependent claim fee required under 37 CFR 1.492(f).
 - d. Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038. The PTO-2038 should only be mailed or faxed to the USPTO. However, when paying the basic national fee, the PTO-2038 may NOT be faxed to the USPTO.
- ADVISORY:** If filing by EFS-Web, do NOT attach the PTO-2038 form as a PDF along with your EFS-Web submission. Please be advised that this is not recommended and by doing so your credit card information may be displayed via PAIR. To protect your information, it is recommended to pay fees online by using the electronic payment method.

NOTE: Where an appropriate time limit under 37 CFR 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the International Application to pending status.

Correspondence Address

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APPLICATION DATA SHEET

Application Information

Application Number::

Filing Date::

Application Type:: Nonprovisional

Subject Matter:: Utility

Suggested Classification::

Suggested Group Art Unit::

CD-ROM or CD-R?:: None

Number of CD Disks::

Number of Copies of CDs::

Sequence Submission?::

Computer Readable Form (CRF)?:: No

Number of Copies of CRF::

Title:: SYSTEM WITH 3D USER INTERFACE
INTEGRATION

Attorney Docket Number:: 0079124-000070

Request for Early Publication?:: No

Request for Non-Publication?:: No

Suggested Drawing Figure:: Fig. 2a

Total Drawing Sheets:: 5

Small Entity?:: Yes

Latin Name::

Variety Denomination Name::

Petition Included?:: No

Petition Type::

Licensed US Govt. Agency::

Contract or Grant Numbers::

Secrecy Order in Parent Appl.?:: No

Applicant Information

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Representative Information

Representative Customer Number:: 21839

Domestic Priority Information

Application::	Continuity Type::	Parent Application::	Parent Filing Date::
This Application	National Stage of	PCT/DK2011/050461	12/05/2011
PCT/DK2011/050461	Claiming the benefit under 35 USC 119(e)	61/420,138	12/06/2010

Foreign Priority Information

Country::	Application Number::	Filing Date::	Priority Claimed::
Denmark	PA 2010 01104	12/06/2010	Yes

Assignee Information

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Signature	<i>William C Rowland</i>	Date	June 4, 2013
Name	William C. Rowland	Registration No.	30888

System with 3D user interface integration

Field of the invention

- 5 This invention generally relates to a method and a system comprising a handheld device and at least one display.

Background of the invention

- 10 3D visualization is important in many fields of industry and medicine, where 3D information is becoming more and more predominant.

Displaying and inspecting 3D information is inherently difficult. To fully understand a 3D object or entire environment on a screen, the user should generally be able to rotate the object or scene, such that many or preferentially all surfaces are displayed. This is true even for 3D displays, e.g. stereoscopic or holographic, where from a given viewing position and with a given viewing angle, the user will only see some surfaces of an arbitrary 3D environment. Often, the user will also want to zoom into details or zoom out for an overview.

20 Various user interaction devices are in use for software that displays 3D data; these devices are: 3D mice, space balls, and touch screens. The operation of these current interaction devices requires physically touching them.

25 Physically touching a user-interaction device can be a disadvantage in medical applications due to risks of cross-contamination between patients or between patient and operator, or in industrial applications in dirty environments.

30

Several non-touch user interfaces for 3D data viewing in medical applications have been described in the literature. Vogt et al (2004) describe a touchless interactive system for in-situ visualization of 3D medical imaging data. The user interface is based on tracking of reflective markers, where a camera is mounted on the physician's head. Graetzel et al (2004) describe a touchless system that interprets hand gestures as mouse actions. It is based on stereo vision and intended for use in minimally invasive surgery.

It remains a problem to improve systems that require user interfaces for view control, which for example can be used for clinical purposes.

Summary

Disclosed is a system comprising a handheld device and at least one display, where the handheld device is adapted for performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment, and where the handheld device is adapted for remotely controlling the view with which said 3D environment is represented on the display.

The system may be adapted for switching between performing the at least one action in the physical 3D environment, and remotely controlling the view with which the 3D environment is represented on the display.

The system disclosed here performs the integration of 3D user interface functionality with any other handheld device with other operating functionality, such that the operator ideally only touches this latter device that is intended to be touched. A particular example of such a handheld device is one that records some 3D geometry, for example a handheld 3D scanner.

30

The handheld device is a multi-purpose device, such as a dual-purpose or two-purpose device, i.e. a device both for performing actions in the physical 3D environment, such as measuring and manipulating, and for remotely controlling the view of the 3D environment on the display.

5

Geometrically, a view is determined by the virtual observer's/camera's position and orientation relative to the 3D environment or its visual representation. If the display is two-dimensional, the view is also determined by the type of projection. A view may also be determined by a magnification factor.

10

The virtual observer's and the 3D environment's position and orientation are always relative to each other. In terms of user experience in software systems with 3D input devices, the user may feel that for example, he/she is moving the 3D environment while remaining stationary himself/herself, but there is always an equivalent movement of the virtual observer/camera that gives the same results on the display. Often, descriptions of 3D software systems use the expression "pan" to indicate an apparent translational movement of the 3D environment, "rotate" to indicate a rotational movement of the 3D environment, and "zoom" to indicate a change in magnification factor.

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Graphically, a view can represent a 3D environment by means of photographs or as some kind of virtual representation such as a computer graphic, or similar. A computer graphic can be rendered for example with texture and/or shading and/or virtual light sources and/or light models for surface properties. A computer graphic can also be a simplified representation of the 3D environment, for example a mesh, an outline, or an otherwise simplified representation. All or parts of the 3D environment can also be rendered with some degree of transparency. A view may represent the 3D environment in total or only parts thereof.

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All of the touch-less prior art systems are 3D user interface devices only. In many prior art applications, the operator using such user interface device will also hold and work with another device that really is the central device in the overall application, e.g. a medical instrument.

It is thus an advantage of the present system that the 3D user-interface functionality is integrated in the central device, which is used for performing some kind of action.

In some embodiments the handheld device is adapted for remotely controlling the magnification with which the 3D environment is represented on the display.

In some embodiments the handheld device is adapted for changing the rendering of the 3D environment on the display.

In some embodiments the view is defined as viewing angle and/or viewing position.

In some embodiments the at least one action comprises one or more of the actions of:

- measuring,
- recording,
- scanning,
- manipulating,
- modifying.

In some embodiments the 3D environment comprises one or more 3D objects.

In some embodiments the handheld device is adapted to be held in one hand by an operator.

5 In some embodiments the display is adapted to represent the 3D environment from multiple views.

In some embodiments the display is adapted to represent the 3D environment from different viewing angles and/or viewing positions.

10 In some embodiments the view of the 3D environment in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

15 In some embodiments the magnification represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

In some embodiments the handheld device is adapted to record the 3D geometry of the 3D environment.

20

Thus the handheld device may be an intraoral dental scanner, which records the 3D geometry of a patient's teeth. The operator may move the scanner along the teeth of the patient for capturing the 3D geometry of the relevant teeth, e.g. all teeth. The scanner may comprise motion sensors for taking the movement of the scanner into account while creating the 3D model of the scanned teeth.

25

The 3D model of the teeth may be shown on a display, and the display may for example be a PC screen and/or the like.

30

The user interface functionality may comprise incorporating motion sensors in the scanner to provide that the user can determine the view on the screen by moving the scanner. Pointing the scanner down can provide that the scanned teeth are shown given a downward viewing angle. Holding the scanner in a horizontal position can provide that the viewing angle is likewise horizontal.

In some embodiments the handheld device comprises at least one user-interface element. A user-interface element is an element which the user may manipulate in order to activate a function on the user interface of the software. Typically the use interface is graphically presented on the display of the system.

The handheld device may furthermore be provided with an actuator, which switches the handheld device between performing the at least one action and remotely controlling the view. By providing such a manual switching function that enables the operator to switch between performing the at least one action and remotely controlling the view, the operator may easily control what is performed.

Such an actuator can for example be in the form of a button, switch or contact. In other embodiments it could be a touch sensitive surface or element.

In another embodiment the actuator could be a motion sensor provided in the handheld device that function as the actuator when it registers a specific type of movement, for example if the operator shakes the handheld device. Examples of such motion sensors will be described herein with respect to the user-interface element, however, the person skilled in the art will based on the disclosure herein understand that such motion sensors may also be used as actuators as discussed.

For example, the handheld device can in one embodiment be an intra-oral 3D scanner used by a dentist. The scanner is set to be performing the action of scanning a dental area when the actuator is in one position. When the
5 actuator is switched into a second position the handheld is set to control the view with which the 3D environment is represented on the display. This could for example be that when the dentist have scanned a part of or the complete desired area of an dental arch he can activate the actuator which then allows the dentist to remotely control the view of the 3D representation of the
10 scanned area on the display by using the handheld device.

For example, the actuator could be a button. When the button is pressed quickly the handheld device is prepared for scanning, i.e. it is set for performing at least one action, the scanning procedure, in the physical 3D
15 environment. The scanning is stopped when the button is pressed quickly a second time.

While the scanning is performed a virtual 3D representation is visually built on the display.
20

The user can now press and hold the button. This will put the handheld in a controller mode, where the handheld device is adapted for remotely controlling the view with which the 3D environment, such as scanned teeth, is represented on the display. While holding the button pressed the system will
25 use signals from a motion sensor in the handheld device to determine how to present the view of the virtual 3D environment. Thus, if the user turns or otherwise moves the hand that holds the handheld device the view of the virtual 3D environment on the display will change accordingly.

30 Thus, the dentist may use the same handheld device for both scanning an area and subsequently verifying that the scan has been executed correctly

without having to move away from the patient or touching any other equipment than already present in his hands.

5 In one embodiment the user-interface element is the same as the actuator, or where several user-interface elements are present at least one also functions as an actuator.

The system may be equipped with a button as an additional element providing the user-interface functionality.

10 In an example the handheld device is a handheld intraoral scanner, and the display is a computer screen. The operator or user may be a dentist, an assistant and/or the like. The operation functionality of the device may be to record some intraoral 3D geometry, and the user interface functionality may be to rotate, pan, and zoom the scanned data on the computer screen.

15

In some embodiments the at least one user-interface element is at least one motion sensor.

20 Thus the integration of the user interface functionality in the device may be provided by motion sensors, which can be accelerometers inside the scanner, whose readings determine the orientation of the display on the screen of the 3D model of the teeth acquired by the scanner. Additional functionality, e.g. to start/stop scanning, may be provided by a button. The button may be located where the operator's or user's index finger can reach it
25 conveniently.

Prior art intraoral scanners use a touch screen, a trackball, or a mouse to determine the view in the display. These prior art user interface devices can be inconvenient, awkward and difficult to use, and they can be labor-
30 intensive, and thus costly to sterilize or disinfect. An intraoral scanner should always be disinfected between scanning different patients, because the

scanner is in and may come in contact with the mouth or other parts of the patient being scanned.

5 The operator or user, e.g. dentist, may use one hand or both hands to hold the intraoral scanner while scanning, and the scanner may be light enough and comfortable to be held with just one hand for a longer time while scanning.

10 The device can also be held with one or two hands, while using the device as remote control for e.g. changing the view in the display. It is an advantage of the touchless user interface functionality that in clinical situations, the operator can maintain both hands clean, disinfected, or even sterile.

15 An advantage of the system is that it allows an iterative process of working in a 3D environment without releasing the handheld device during said process. For the above intraoral scanning system example, the operator, e.g. dentist, can record some teeth surface geometry with a handheld device that is an intraoral scanner, inspect coverage of the surface recording by using that same handheld device to move, e.g. rotate, the recorded surface on the display, e.g. a computer screen, detect possible gaps or holes in the coverage of the scanned teeth, and then for example arrange the scanner in the region where the gaps were located and continue recording teeth surface geometry there. Over this entire iterative cycle, which can be repeated more than once, such as as many times as required for obtaining a desired scan coverage of the teeth, the dentist does not have to lay the handheld intraoral scanner out of his or her hands.

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30 In some embodiments, the 3D user interface functionality is exploited in a separate location than the operation functionality. For the above intraoral scanning system example, the scanning operation is performed in the oral cavity of the patient, while the user interface functionality is more flexibly

exploited when the scanner is outside the patient's mouth. The key characteristic and advantage of the system, again, is that the dentist can exploit the dual and integrated functionality, that is operation and user interface, of the scanner without laying it out of his or her hands.

5

The above intraoral scanning system is an example of an embodiment. Other examples for operation functionality or performing actions could be drilling, welding, grinding, cutting, soldering, photographing, filming, measuring, executing some surgical procedure etc..

10

The display of the system can be a 2D computer screen, a 3D display that projects stereoscopic image pairs, a volumetric display creating a 3D effect, such as a swept-volume display, a static volume display, a parallax barrier display, a holographic display etc.. Even with a 3D display, the operator has only one viewing position and viewing angle relative to the 3D environment at a time. The operator can move his/her head to assume another viewing position and/or viewing angle physically, but generally, it may be more convenient to use the handheld device with its built-in user interface functionality, e.g. the remote controlling, to change the viewing position and/or viewing angle represented in the display.

15

20

In some embodiments the system comprises multiple displays, or one or more displays that are divided into regions. For example, several sub-windows on a PC screen can represent different views of the 3D environment. The handheld device can be used to change the view in all of them, or only some of them.

25

In some embodiments the user interface functionality comprises the use of gestures.

Gestures made by e.g. the operator can be used to change, shift or toggle between sub-windows, and the user-interface functionality can be limited to an active sub-window or one of several displays.

- 5 In some embodiments the gestures are adapted to be detected by the at least one motion sensor. Gestures can alternatively and/or additionally be detected by range sensors or other sensors that record body motion.

10 The operator does not have to constantly watch the at least one display of the system. In many applications, the operator will shift between viewing and possible manipulating the display and performing another operation with the handheld device. Thus it is an advantage that the operator does not have to touch other user interface devices. However, in some cases it may not be possible for the operator to fully avoid touching other devices, and in these
15 cases it is an advantage that fewer touches are required compared to a system where a handheld device does not provide any user interface functionality at all.

20 In some embodiments the at least one display is arranged separate from the handheld device.

In some embodiments the at least one display is defined as a first display, and where the system further comprises a second display.

25 In some embodiments the second display is arranged on the handheld device.

30 In some embodiments the second display is arranged on the handheld device in a position such that the display is adapted to be viewed by the operator, while the operator is operating the handheld device.

In some embodiments the second display indicates where the handheld device is positioned relative to the 3D environment.

5 In some embodiments the first display and/or the second display provides instructions for the operator.

10 The display(s) can be arranged in multiple ways. For example, they can be mounted on a wall, placed on some sort of stand or a cart, placed on a rack or desk, or other.

15 In some embodiments at least one display is mounted on the device itself. It can be advantageous to have a display on the device itself because with such an arrangement, the operator's eyes need not focus alternately between different distances. In some cases, the operating functionality may require a close look at the device and the vicinity of the 3D environment it operates in, and this may be at a distance at most as far away as the operator's hand. Especially in crowded environments such as dentist's clinics, surgical operation theatres, or industrial workplaces, it may be difficult to place an external display closely to the device.

20 In some embodiments visual information is provided to the operator on one or more means other than the first display.

25 In some embodiments audible information to the operator is provided to the operator.

30 Thus in some embodiments, the system provides additional information to the operator. In some embodiments, the system includes other visual clues shown on means other than the display(s), such as LEDs on the device. In some embodiments, the system provides audible information to the operator, for example by different sounds and/or by speech.

Said information provided to the operator can comprise instructions for use, warnings, and the like.

5 The information can aid with improving the action performance or operation functionality of the device, for example by indicating how well an action or operation is being performed, and/or instructions to the operator aimed at improving the ease of the action or operation and/or the quality of the action or operation's results. For example, a LED can change in color and/or flashing frequency. In a scanner, the information can relate to how well the
10 scanned 3D environment is in focus and/or to scan quality and/or to scan coverage. The information can comprise instructions on how best to position the scanner such as to attain good scan quality and/or scan coverage. The instructions can be used for planning and/or performing bracket placement. The instructions can be in the form of a messenger system to the operator.

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In some embodiments, some 3D user interface functionality is provided by at least one motion sensor built into the device. Examples of motion sensors are accelerometers, gyros, and magnetometers and/or the like. These sensors can sense rotations, lateral motion, and/or combinations thereof.
20 Other motion sensors use infrared sensing. For example, at least one infrared sensor can be mounted on the device and at least one infrared emitter can be mounted in the surroundings of the device. Conversely, the at least one emitter can be mounted on the device, and the at least one sensors in the surroundings. Yet another possibility is to use infrared reflector(s) on
25 the device and both sensor(s) and emitter(s) on the surroundings, or again conversely. Thus motion can be sensed by a variety of principles.

Through proper signal processing, some sensors can recognize additional operator actions; for example gestures such as taps, waving, or shaking of
30 the handheld device. Thus, these gestures can also be exploited in the 3D user interface functionality.

5 In some embodiments the handheld device comprises at least two motion sensors providing sensor fusion. Sensor fusion can be used to achieve a better motion signal from for example raw gyro, accelerometer, and/or magnetometer data. Sensor fusion can be implemented in ICs such as the InvenSense MPU 3000.

10 In some embodiments the handheld device comprises at least one user-interface element other than the at least one motion sensor.

In some embodiments the at least one other user-interface element is a touch-sensitive element.

15 In some embodiments the at least one other user-interface element is a button.

In some embodiments the at least one other user-interface element is a scroll-wheel.

20 In some embodiments, user interface functionality is provided through additional elements on the device. Thus these additional elements can for example be buttons, scroll wheels, touch-sensitive fields, proximity sensors and/or the like.

25 The additional user interface elements can be exploited or utilized in a workflow suitable for the field of application of the device. The workflow may be implemented in some user software application that may also control the display and thus the view represented thereon. A given interface element can supply multiple user inputs to the software. For example, a button can
30 provide both a single click and a double click. For example, a double click can mean to advance to a subsequent step in a workflow. For the example of

intraoral scanning, three steps within the workflow can be to scan the lower mouth, the upper mouth, and the bite. A touch-sensitive field can provide strokes in multiple directions each with a different effect, etc. Providing multiple user inputs from a user interface elements is advantageous because the number of user interface elements on the device can be reduced relative to a situation where each user interface element only provides one user input.

The motion sensors can also be exploited in a workflow. For example, lifting the device, which can be sensed by an accelerometer, can represent some type of user input, for example to start some action. In a device that is a scanner, it may start scanning. Conversely, placing the device back in some sort of holder, which can be sensed by an accelerometer as no acceleration occur over some period of time, can stop said action.

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If the action performed by the device is some kind of recording, for example scanning, for example 3D scanning, the results of the recording can also be exploited as user inputs, possibly along with user inputs from other user interface elements. For example, with a 3D scanner with a limited depth of field, it may be possible to detect whether any objects within the 3D environments are present in the volume corresponding to this depth of field by detecting whether any 3D points are recorded. User inputs can depend on such detected presence. For example, a button click on an intraoral scanner can provide a different user input depending on whether the scanner is in the mouth, where teeth are detectable, or significantly away from and outside the mouth. Also the effect of motion sensor signals can be interpreted differently for either situation. For example, the scanner may only change the view represented on the display when it is outside the mouth.

In some embodiments the handheld device is adapted to change a viewing angle with which the 3D environment is represented on the at least one display.

- 5 In some embodiments the handheld device is adapted to change a magnification factor with which the 3D environment is represented on the at least one display.

- 10 In some embodiments the handheld device is adapted to change a viewing position with which the 3D environment is represented on the at least one display.

In some embodiments the view of the 3D environment comprises a viewing angle, a magnification factor, and/or a viewing position.

15

In some embodiments the view of the 3D environment comprises rendering of texture and/or shading.

- 20 In some embodiments the at least one display is divided into multiple regions, each showing the 3D environment with a different view.

- 25 Thus in some embodiments the user interface functionality comprises changing the view with which the 3D environment is displayed. Changes in view can comprise changes in viewing angle, viewing position, magnification and/or the like. A change in viewing angle can naturally be effected by rotating the device. Rotation is naturally sensed by the aid of gyros and/or relative to gravity sensed by an accelerometer. Zooming, i.e. a change in magnification, can for example be achieved by pushing the handheld device forward and backward, respectively. A translational change of the viewing
30 position, i.e., panning, can for example be achieved by pushing the handheld device up/down and/or sideways.

In some embodiments the user interface functionality comprises selecting or choosing items on a display or any other functionality provided by graphical user interfaces in computers known in the art. The operator may perform the selection. The Lava C.O.S scanner marketed by 3M ESPE has additional buttons on the handheld device, but it is not possible to manipulate the view by these. Their only purpose is to allow navigation through a menu system, and to start/stop scanning.

10 In some embodiments the user interface functionality comprises manipulating the 3D environment displayed on the screen. For example, the operator may effect deformations or change the position or orientation of objects in the 3D environment. Thus, in some embodiments the user interface functionality comprises virtual user interface functionality, which can be that the 3D data are manipulated, but the physical 3D environment in which the device operates may not be manipulated.

In some embodiments the handheld device is an intraoral scanner and/or an in-the-ear scanner. If the scanner comprises a tip, this tip may be exchanged whereby the scanner can become suitable for scanning in the mouth or in the ear. Since the ear is a smaller cavity than the mouth, the tip for fitting into an ear may be smaller than a tip for fitting in the mouth.

25 In some embodiments the handheld device is a surgical instrument. In some embodiments, the surgical instrument comprises at least one motion sensor, which is built-in in the instrument.

In some embodiments the handheld device is a mechanical tool. In some embodiments, the tool has at least one motion sensor built in. In other embodiments, other user-interface elements are built in as well, for example buttons, scroll wheels, touch-sensitive fields, or proximity sensors.

In some embodiment the 3D geometry of the 3D environment is known a-priori or a 3D representation of the environment is known a priori, i.e. before the actions (s) are performed. For example in surgery, a CT scan may have been taken before the surgical procedure. The handheld device in this example could be a surgical instrument that a physician needs to apply in the proper 3D position. To make sure this proper position is reached, it could be beneficial to view the 3D environment from multiple perspectives interactively, i.e. without having to release the surgical instrument.

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An advantage of the system, also in the above surgery example, is the ability of the handheld device to record the 3D environment at least partially, typically in a 3D field-of-view that is smaller than the volume represented in the a-priori data. The 3D data recorded by the handheld device can be registered in real time with the a-priori data, such that the position and orientation of the device can be detected.

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In some embodiments the 3D geometry comprises a 3D surface of the environment.

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In some embodiments the 3D geometry comprises a 3D volumetric representation of the environment.

Thus the 3D environment can be displayed as volumetric data, or as surface, or a combination thereof. Volumetric data are typically represented by voxels. Voxels can comprise multiple scalar values. Surface data are typically represented as meshed, such as triangulated meshes, or point clouds.

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The scanning may be performed by means of LED scanning, laser light scanning, white light scanning, X-ray scanning, and/or CT scanning.

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The present invention relates to different aspects including the system described above and in the following, and corresponding systems, methods, devices, uses, and/or product means, each yielding one or more of the benefits and advantages described in connection with the first mentioned aspect, and each having one or more embodiments corresponding to the
5 embodiments described in connection with the first mentioned aspect and/or disclosed in the appended claims.

In particular, disclosed herein is a method of interaction between a handheld
10 device and at least one display, where the method comprises the steps of:

- performing at least one action in a physical 3D environment by means of the handheld device;
- visually representing the physical 3D environment by the at least one display; and
- 15 - remotely controlling the view of the represented 3D environment on the display by means of the handheld device.

Furthermore, the invention relates to a computer program product comprising program code means for causing a data processing system to perform the
20 method according to any of the embodiments, when said program code means are executed on the data processing system, and a computer program product, comprising a computer-readable medium having stored there on the program code means.

25 According to another aspect, disclosed is a system comprising a handheld device for operating in a 3D environment and at least one display for visualizing said environment, where the display is adapted to represent said environment from multiple perspectives,
where said device is adapted to be held in one hand by an operator, and
30 where the perspective represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

According to another aspect, disclosed is a system comprising a handheld device for operating in a 3D environment and at least one display for visualizing said environment, where the display is adapted to represent said environment in multiple views,

where said device is adapted to be held in one hand by an operator, where the view represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device, and where the device has at least one touch-sensitive user interface element.

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The motion of the operator's hand is typically determined by a motion sensor arranged in the handheld device.

15 **Definitions**

3D geometry: A constellation of matter or its virtual representation in a three-dimensional space.

20 3D environment: A constellation of physical objects each having a 3D geometry in a three-dimensional space.

View: The way a 3D environment is represented on a display. Geometrically, a view is determined by the virtual observer's/camera's position and orientation. If the display is two-dimensional, the view is also determined by the type of projection. A view may also be determined by a magnification factor. Graphically, a view can show the 3D environment by means of photographs or as some kind of virtual representation such as a computer graphic, or similar. A computer graphic can be rendered for example with texture and/or shading and/or virtual light sources and/or light models for surface properties. A computer graphic can also be a simplified

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representation of the 3D environment, for example a mesh, an outline, or an otherwise simplified representation. All or parts of the 3D environment can also be rendered with some degree of transparency. A view may represent the 3D environment in total or only parts thereof.

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Functionality: A purpose or intended use.

Performing action(s) or operating functionality: Actions or functionality that includes some type of interaction with a 3D environment, such as measuring, 10 modifying, manipulating, recording, touching, sensing, scanning, moving, transforming, cutting, welding, chemically treating, cleaning, etc. The term “operating” is thus not directed to surgical procedures, but operating may comprise surgical procedures.

15 User Interface Functionality: Functionality for interaction between a human user and a machine with a display.

Handheld device: An object that has at least one functionality and that is held 20 by a human operator’s hand or both hands while performing this at least one functionality.

3D scanner: A device that analyzes a real-world object or 3D environment to collect data on its shape and possibly its appearance.

25 Coverage of scan: The degree to which a physical surface is represented by recorded data after a scanning operation.

Motion sensor: A sensor detecting motion. Motion can be detected by: sound 30 (acoustic sensors), opacity (optical and infrared sensors and video image processors), geomagnetism (magnetic sensors, magnetometers), reflection of transmitted energy (infrared laser radar, ultrasonic sensors, and

microwave radar sensors), electromagnetic induction (inductive-loop detectors), and vibration (triboelectric, seismic, and inertia-switch sensors). MEMS accelerometers, gyros, and magnetometers are examples of motions sensors.

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Workflow: a sequence of tasks implemented in software.

Brief description of the drawings

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The above and/or additional objects, features and advantages of the present invention, will be further elucidated by the following illustrative and non-limiting detailed description of embodiments of the present invention, with reference to the appended drawings, wherein:

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Fig. 1 shows an example of the system comprising a handheld device and a display.

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Fig. 2 shows an example of user interface functionality in the form of remote controlling using the handheld device.

Fig. 3 shows an example of the handheld device.

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Fig. 4 shows an example of a flow-chart of a method of interaction between a handheld device and a display.

Detailed description

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In the following description, reference is made to the accompanying figures, which show by way of illustration how the invention may be practiced.

Fig. 1 shows an example of the system comprising a handheld device and a display. The handheld device 100 is in this example an intraoral dental scanner, which records the 3D geometry of the patient's teeth. The operator
 5 102 moves the scanner along the teeth of the patient 104 for capturing the 3D geometry of the relevant teeth, e.g. all teeth. The scanner comprises motion sensors (not visible) for taken the movement of the scanner into account while creating the 3D model 105 of the scanned teeth. The display
 10 101 is in this example a PC screen displaying the data recorded by the scanner.

Fig. 2 shows an example of user interface functionality in the form of remote controlling using the handheld device. The motion sensors (not shown) in the handheld device 100, e.g. scanner, provide that the user 102 can determine
 15 the view shown on the display 101, e.g. screen, by moving the handheld device 100.

Fig. 2a) shows that pointing the device 100 down can provide that the 3D model 105 of the scanned teeth is shown from a downward viewing angle.

Fig. 2b) shows that holding the scanner in a horizontal position can provide
 20 that the viewing angle is likewise horizontally from the front, such that the 3D model 105 of the scanned teeth is shown from the front.

Fig. 3 shows an example of the handheld device.

The handheld device 100 is in this example an intraoral scanner with a pistol-
 25 grip. The scanner comprises a housing 106 comprising the pistol-grip part 107, and a tip 108 adapted for insertion in the mouth of the patient. In this example the scanner also is equipped with a button 103 which is an additional element providing user-interface functionality.

30 The example system as shown in fig. 1, fig. 2 and fig. 3 comprises a device 100 which is a handheld intraoral scanner and a display 101 which is a

computer screen. The operator 102 may be a dentist, an assistant and/or the like. In an example, the action performance or operation functionality of the device 100 is to record some intraoral 3D geometry, and the user interface functionality is to rotate, pan, and zoom the 3D model 105 of the scanned data on the computer screen 101. The integration of the user interface
5 functionality in the device 100 is provided by motion sensors (not visible), which can be accelerometers inside the scanner 100, whose readings determine the orientation, as seen in Figs 2a and 2b, of the display on the screen of the 3D model 105 of the teeth acquired by the scanner 100.
10 Additional functionality, e.g. to start/stop scanning, may be provided by the button 103 as seen in fig. 3. In the example system, the button 103 is located where the user's index finger can reach it conveniently.

In fig. 1 the dentist 102 uses two hands to hold the intraoral scanner 100 while scanning, but it is understood that the scanner 100 can also be held
15 with one hand while scanning. The device 100 can also be held with one or two hands, while changing the perspective of the 3D model 105 in the display 101. The example shown in Figure 1 thus illustrates the advantage of the touchless user interface functionality, because in many clinical situations, the
20 operator 102 should maintain both hands clean, disinfected, or even sterile.

The 3D user interface functionality may be exploited in a separate location than the operation functionality. For the above intraoral scanning system example, the scanning operation is performed in the oral cavity of the patient,
25 see fig. 1, while the user interface functionality is more flexibly exploited when the scanner is outside the patient's mouth, see figs 2 and 3.

Fig. 4 shows an example of a flow-chart of a method of interaction between a handheld device and a display.

In step 101 at least one action in a physical 3D environment is performed by means of the handheld device. This action may be the scanning of teeth as shown in fig. 1.

5 In step 102 the physical 3D environment is visually represented by the at least one display. This may be the display of the 3D model of the scanned teeth as seen in fig 1.

In step 103 the view of the represented 3D environment shown on the display is remotely controlled on the display by means of the handheld device. This may be the control of the viewing angle of the 3D model as seen in fig. 2.

10 All the steps of the method may be repeated one or more times. The order in which the steps are performed may be different than the order described above, which is indicated by the dotted lines in the figure. If one or more of the steps are performed more times, the order of the steps may also be different.

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Although some embodiments have been described and shown in detail, the invention is not restricted to them, but may also be embodied in other ways within the scope of the subject matter defined in the following claims. In particular, it is to be understood that other embodiments may be utilised and structural and functional modifications may be made without departing from the scope of the present invention.

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In device claims enumerating several means, several of these means can be embodied by one and the same item of hardware. The mere fact that certain measures are recited in mutually different dependent claims or described in different embodiments does not indicate that a combination of these measures cannot be used to advantage.

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It should be emphasized that the term "comprises/comprising" when used in this specification is taken to specify the presence of stated features, integers,

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steps or components but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

5 The features of the method described above and in the following may be implemented in software and carried out on a data processing system or other processing means caused by the execution of computer-executable instructions. The instructions may be program code means loaded in a memory, such as a RAM, from a storage medium or from another computer via a computer network. Alternatively, the described features may be
10 implemented by hardwired circuitry instead of software or in combination with software.

Literature:

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C. Graetzel, T. Fong, S. Grange, and C. Baur. A Non-Contact Mouse for Surgeon-Computer Interaction. *Technology and Health Care*, 12(3), 2004.

Vogt S., Khamene A., Niemann H., Sauer F., An AR system with intuitive
20 user interface for manipulation and visualization of 3D medical data, *Stud. Health Technol. Inform.* 2004;98, pp. 397-403.

25

Embodiments

The following embodiments relates to one aspect of the system as disclosed by the description herein.

- 5 1. A system comprising a handheld device and at least one display, where the handheld device is adapted for performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment, and where the handheld device is adapted for remotely controlling the view with which the 3D
- 10 environment is represented on the display.
2. The system according to any one or more of the preceding embodiments, wherein the view is defined as viewing angle and/or viewing position.
- 15 3. The system according to any one or more of the preceding embodiments, wherein the handheld device is adapted for remotely controlling the magnification with which the 3D environment is represented on the display.
4. The system according to any one or more of the preceding embodiments,
- 20 wherein the handheld device is adapted for changing the rendering of the 3D environment on the display.
5. The system according to any one or more of the preceding embodiments, wherein the at least one action comprises one or more of:
- 25 - measuring,
 - recording,
 - scanning,
 - manipulating, and/or
 - modifying.
- 30

6. The system according to any one or more of the preceding embodiments, wherein the 3D environment comprises one or more 3D objects.

5 7. The system according to any one or more of the preceding embodiments, wherein the handheld device is adapted to be held in one hand by an operator.

10 8. The system according to any one or more of the preceding embodiments, wherein the display is adapted to represent the 3D environment from multiple views..

15 9. The system according to any one or more of the preceding embodiments, wherein the view of the 3D environment represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

20 10. The system according to any one or more of the preceding embodiments, wherein the magnification represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

11. The system according to any one or more of the preceding embodiments, wherein the handheld device is adapted to record the 3D geometry of the 3D environment.

25 12. The system according to any one or more of the preceding embodiments, wherein the 3D geometry of the 3D environment is known a-priori.

30 13. The system according to any one or more of the preceding embodiments, wherein the handheld device comprises at least one user-interface element.

14. The system according to any one or more of the preceding embodiments, wherein the at least one user-interface element is at least one motion sensor.

5 15. The system according to any one or more of the preceding embodiments, wherein the handheld device comprises at least two motion sensors providing sensor fusion.

10 16. The system according to any one or more of the preceding embodiments, wherein the user interface functionality comprises the use of gestures.

17. The system according to any one or more of the preceding embodiments, wherein the gestures are detected by the at least one motion sensor.

15 18. The system according to any one or more of the preceding embodiments, wherein the handheld device comprises at least one user-interface element other than the at least one motion sensor.

20 19. The system according to any one or more of the preceding embodiments, wherein the at least one other user-interface element is a touch-sensitive element.

20. The system according to any one or more of the preceding embodiments, wherein the at least one other user-interface element is a button.

25 21. The system according to any one or more of the preceding embodiments, wherein the at least one other user-interface element is a scroll wheel.

30 22. The system according to any one or more of the preceding embodiments, wherein the handheld device is adapted to change a viewing angle with which the 3D environment is represented on the at least one display.

23. The system according to any of the preceding embodiments, wherein the handheld device is adapted to change a magnification factor with which the 3D environment is represented on the at least one display.

5 24. The system according to any one or more of the preceding embodiments, wherein the handheld device is adapted to change a viewing position with which the 3D environment is represented on the at least one display.

10 25. The system according to any one or more of the preceding embodiments, wherein the view of the 3D environment comprises a viewing angle, a magnification factor, and/or a viewing position.

15 26. The system according to any one or more of the preceding embodiments, wherein the view of the 3D environment comprises rendering of texture and/or shading.

20 27. The system according to any one or more of the preceding embodiments, wherein the at least one display is divided into multiple regions, each showing the 3D environment with a different view.

28. The system according to any one or more of the preceding embodiments, wherein the 3D geometry comprises a 3D surface of the environment.

25 29. The system according to any one or more of the preceding embodiments, wherein the 3D geometry comprises a 3D volumetric representation of the environment.

30. The system according to any one or more of the preceding embodiments, wherein the handheld device is an intra-oral 3D scanner.

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31. The system according to any one or more of the preceding embodiments, wherein the handheld device is a surgical instrument.

5 32. The system according to any one or more of the preceding embodiments, wherein the handheld device is a mechanical tool.

33. The system according to any one or more of the preceding embodiments, wherein the handheld device is an in-ear 3D scanner.

10 34. The system according to any one or more of the preceding embodiments, wherein the at least one display is arranged separate from the handheld device.

15 35. The system according to any one or more of the preceding embodiments, wherein the at least one display is arranged on a cart.

20 36. The system according to any one or more of the preceding embodiments, wherein the at least one display is defined as a first display, and where the system further comprises a second display.

37. The system according to any one or more of the preceding embodiments, wherein the second display is arranged on the handheld device.

25 38. The system according to any one or more of the preceding embodiments, wherein the second display is arranged on the handheld device in a position such that the display is adapted to be viewed by the operator, while the operator is operating the handheld device.

30 39. The system according to any one or more of the preceding embodiments, wherein the second display indicates where the handheld device is positioned relative to the 3D environment.

40. The system according to any one or more of the preceding embodiments, wherein the first display and/or the second display provides instructions for the operator.

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41. The system according to any one or more of the preceding embodiments, wherein visual information is provided to the operator on one or more means other than the first display.

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42. The system according to any one or more of the preceding embodiments, wherein audible information to the operator is provided to the operator.

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43. The system according to any one or more of the preceding embodiments, wherein the scanning is performed by means of LED scanning, laser light scanning, white light scanning, X-ray scanning, and/or CT scanning.

44. A method of interaction between a handheld device and at least one display, where the method comprises the steps of:

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- performing at least one action in a physical 3D environment by means of the handheld device;
- visually representing the physical 3D environment by the at least one display; and
- remotely controlling the view of the represented 3D environment on the display by means of the handheld device.

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45. A computer program product comprising program code means for causing a data processing system to perform the method of any one or more of the preceding embodiments, when said program code means are executed on the data processing system.

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46. A computer program product according to the previous embodiment, comprising a computer-readable medium having stored there on the program code means.

Claims

1. A system comprising a handheld device and at least one display, where the handheld device is adapted for switching between
- 5 - performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment, and
- remotely controlling the view with which the 3D environment is represented on the display.
- 10
2. A system according to any one or more of the preceding claims, wherein the handheld device is adapted to record the 3D geometry of the 3D environment.
- 15
3. A system according to any one or more of the preceding claims, wherein means for manually switching between performing the at least one action and remotely controlling the view is provided on the handheld device.
4. A system according to claim 3, wherein the means for manually switching
- 20 is an actuator, such as a button, a switch or a contact.
5. The system according to any one or more of the preceding claims, wherein the view is defined as viewing angle and/or viewing position.
- 25
6. The system according to any one or more of the preceding claims, wherein the handheld device is adapted for remotely controlling the magnification with which the 3D environment is represented on the display.
7. The system according to any one or more of the preceding claims, wherein
- 30 the handheld device is adapted for changing the rendering of the 3D environment on the display.

8. The system according to any one or more of the preceding claims, wherein the at least one action comprises one or more of:

- measuring,
- 5 - recording,
- scanning,
- manipulating, and/or
- modifying.

10 9. The system according to any one or more of the preceding claims, wherein the 3D environment comprises one or more 3D objects.

15 10. The system according to any one or more of the preceding claims, wherein the handheld device is adapted to be held in one hand by an operator.

20 11. The system according to any one or more of the preceding claims, wherein the display is adapted to represent the 3D environment from multiple views.

12. The system according to any one or more of the preceding claims, wherein the handheld device comprises at least one motion sensor.

25 13. The system according to any one or more of the preceding claims, wherein the view of the 3D environment represented in the at least one display is at least partly determined by the at least one motion sensor.

30 14. The system according to any one or more of the preceding claims, wherein the magnification represented in the at least one display is at least partly determined by the at least one motion sensor.

15. The system according to any one or more of the preceding claims, wherein the handheld device is adapted to record the 3D geometry of the 3D environment.

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16. The system according to any one or more of the preceding claims, wherein the 3D geometry of the 3D environment is known a-priori.

17. The system according to any one or more of the preceding claims, wherein the handheld device comprises at least one user-interface element.

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18. The system according to any one or more of the preceding claims, wherein the at least one user-interface element is at least one motion sensor.

19. The system according to any one or more of the preceding claims, wherein the handheld device comprises at least two motion sensors providing sensor fusion.

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20. The system according to any one or more of the preceding claims, wherein the user interface functionality comprises the use of gestures.

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21. The system according to any one or more of the preceding claims, wherein the gestures are detected by the at least one motion sensor.

22. The system according to any one or more of the preceding claims, wherein the handheld device comprises at least one user-interface element other than the at least one motion sensor.

25

23. The system according to any one or more of the preceding claims, wherein the at least one other user-interface element is a touch-sensitive element.

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24. The system according to any one or more of the preceding claims, wherein the at least one other user-interface element is a button.

5 25. The system according to any one or more of the preceding claims, wherein the at least one other user-interface element is a scroll wheel.

26. The system according to any one or more of the preceding claims, wherein the handheld device is adapted to change a viewing angle with
10 which the 3D environment is represented on the at least one display.

27. The system according to any of the preceding claims, wherein the handheld device is adapted to change a magnification factor with which the 3D environment is represented on the at least one display.

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28. The system according to any one or more of the preceding claims, wherein the handheld device is adapted to change a viewing position with which the 3D environment is represented on the at least one display.

20 29. The system according to any one or more of the preceding claims, wherein the view of the 3D environment comprises a viewing angle, a magnification factor, and/or a viewing position.

30. The system according to any one or more of the preceding claims,
25 wherein the view of the 3D environment comprises rendering of texture and/or shading.

31. The system according to any one or more of the preceding claims, wherein the at least one display is divided into multiple regions, each
30 showing the 3D environment with a different view.

32. The system according to any one or more of the preceding claims, wherein the 3D geometry comprises a 3D surface of the environment.

5 33. The system according to any one or more of the preceding claims, wherein the 3D geometry comprises a 3D volumetric representation of the environment.

34. The system according to any one or more of the preceding claims, wherein the handheld device is an intra-oral 3D scanner.

10

35. The system according to any one or more of the preceding claims, wherein the handheld device is a surgical instrument.

15 36. The system according to any one or more of the preceding claims, wherein the handheld device is a mechanical tool.

37. The system according to any one or more of the preceding claims, wherein the handheld device is an in-ear 3D scanner.

20 38. The system according to any one or more of the preceding claims, wherein the at least one display is arranged separate from the handheld device.

25 39. The system according to any one or more of the preceding claims, wherein the at least one display is arranged on a cart.

40. The system according to any one or more of the preceding claims, wherein the at least one display is defined as a first display, and where the system further comprises a second display.

30

41. The system according to any one or more of the preceding claims, wherein the second display is arranged on the handheld device.

5 42. The system according to any one or more of the preceding claims, wherein the second display is arranged on the handheld device in a position such that the display is adapted to be viewed by the operator, while the operator is operating the handheld device.

10 43. The system according to any one or more of the preceding claims, wherein the second display indicates where the handheld device is positioned relative to the 3D environment.

15 44. The system according to any one or more of the preceding claims, wherein the first display and/or the second display provides instructions for the operator.

20 45. The system according to any one or more of the preceding claims, wherein visual information is provided to the operator on one or more means other than the first display.

46. The system according to any one or more of the preceding claims, wherein audible information to the operator is provided to the operator.

25 47. The system according to any one or more of the preceding claims, wherein the scanning is performed by means of LED scanning, laser light scanning, white light scanning, X-ray scanning, and/or CT scanning.

30 48. The system according to any one or more of the preceding claims, wherein a graphical pointer is provided on the display for representing the movement of the handheld device when the handheld device is used to

remotely controlling the view with which the 3D environment is represented on the display.

5 49. The system according to any one or more of the preceding claims, wherein the handheld device is an intra-oral 3D scanner and the at least one action performed in the physical 3D environment is scanning and that the view is remotely controlled by at least one motion sensor arranged in the handheld device, and wherein an actuator provided on the handheld device switches between performing the at least one action and remotely controlling
10 the view.

50. A method of interaction between a handheld device and at least one display, where the method comprises the steps of:
- performing at least one action in a physical 3D environment by means of
15 the handheld device;
- visually representing the physical 3D environment by the at least one display; and
- remotely controlling the view of the represented 3D environment on the display by means of the handheld device.

20

51. A computer program product comprising program code means for causing a data processing system to perform the method of claim 44, when said program code means are executed on the data processing system.

25 52. A computer program product according to the previous claim, comprising a computer-readable medium having stored there on the program code means.

System with 3D user interface integration**Abstract**

5

Disclosed is a system comprising a handheld device and at least one display, where the handheld device is adapted for performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment, and where the handheld

10 device is adapted for remotely controlling the view with which the 3D environment is represented on the display.

(fig. 2a) should be published)

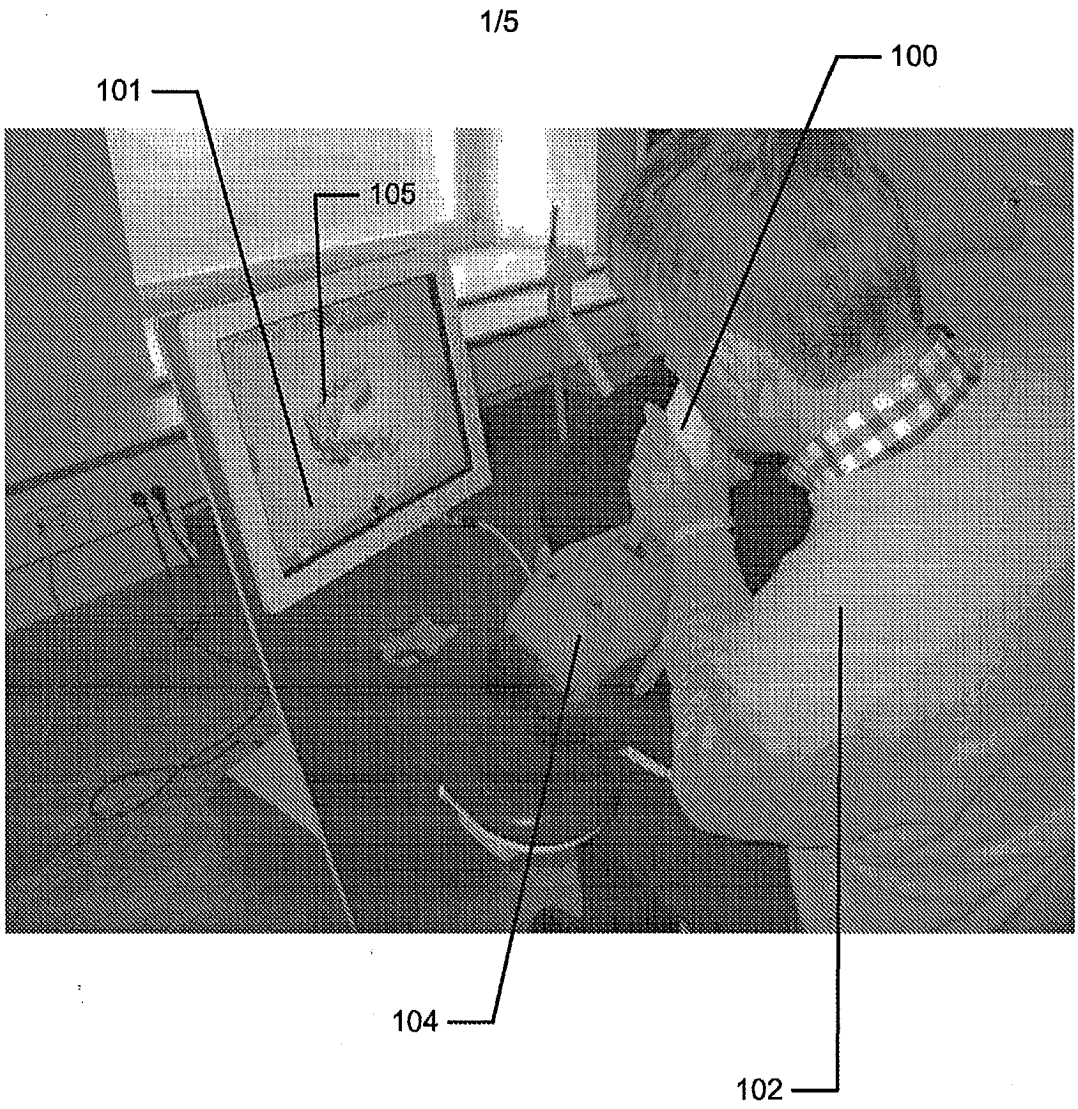


Fig. 1

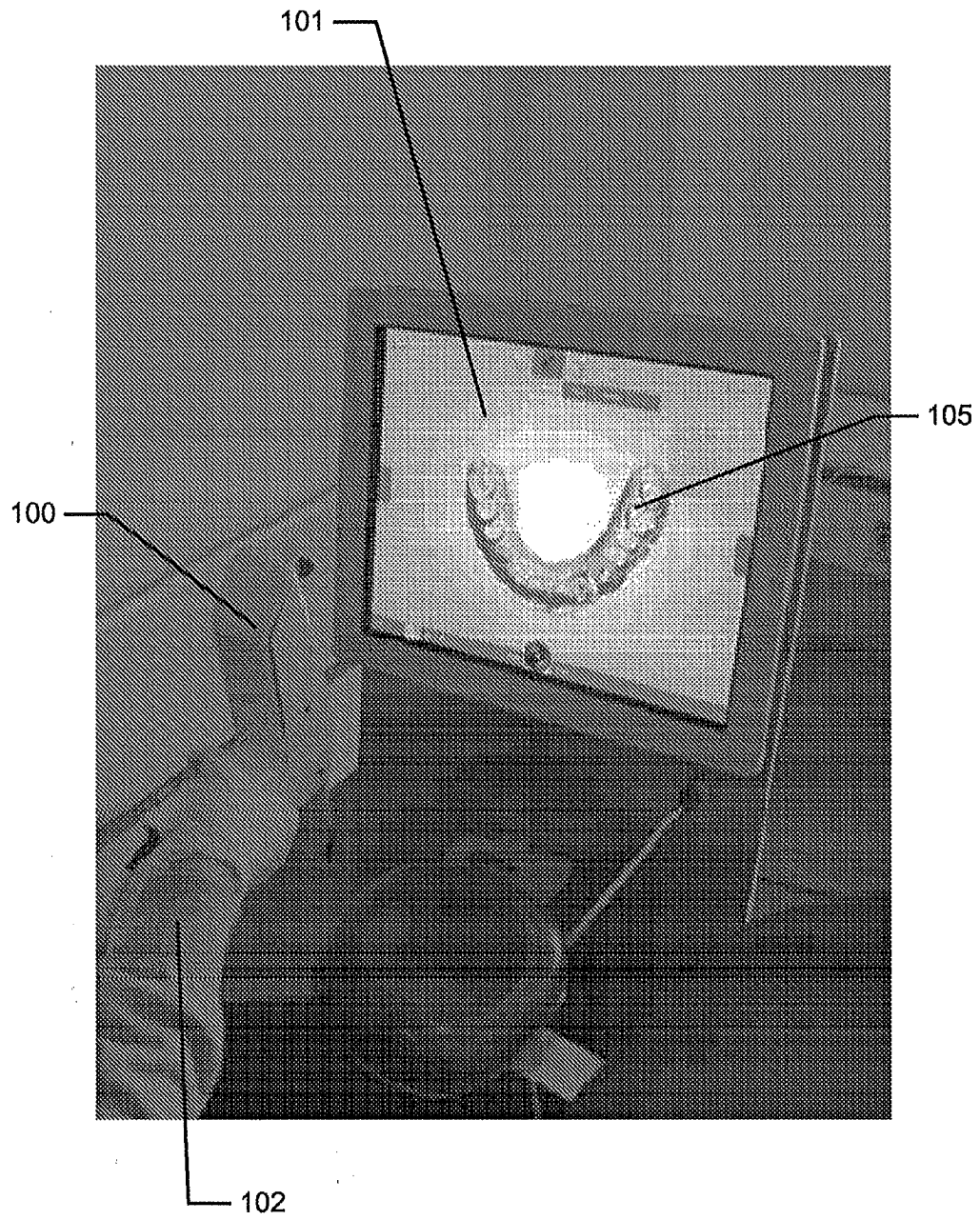


Fig. 2a)

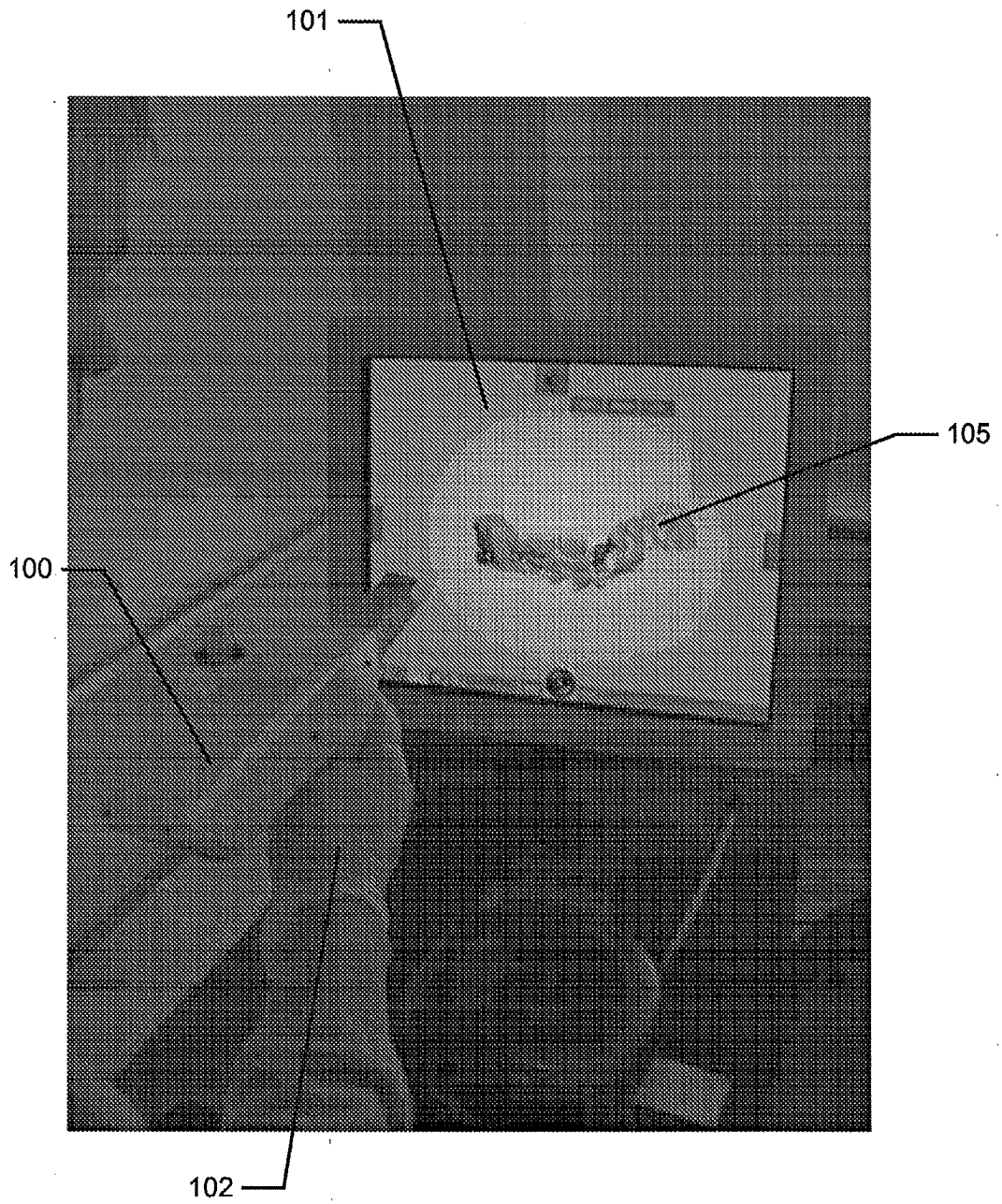


Fig. 2b)

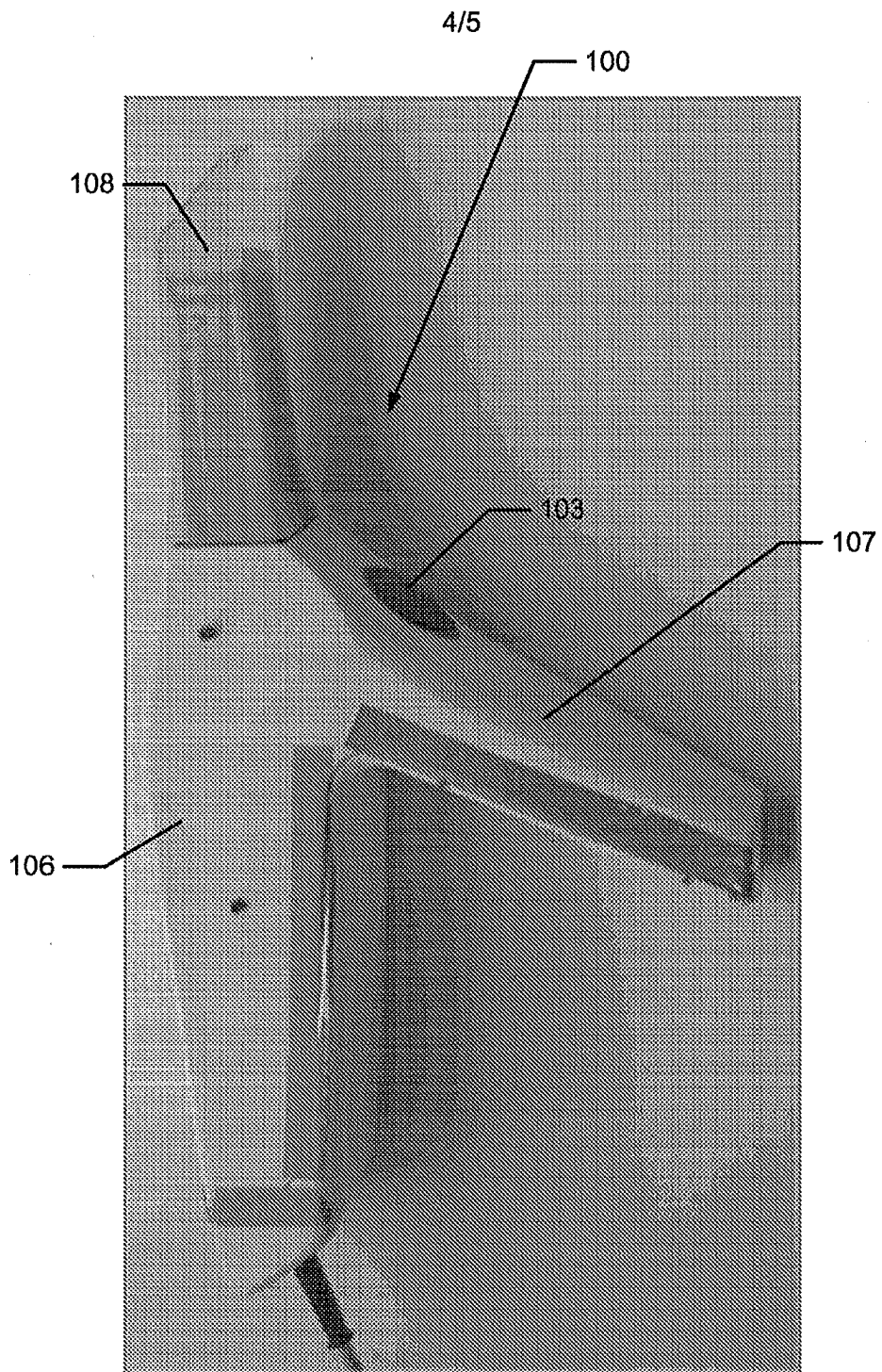


Fig. 3

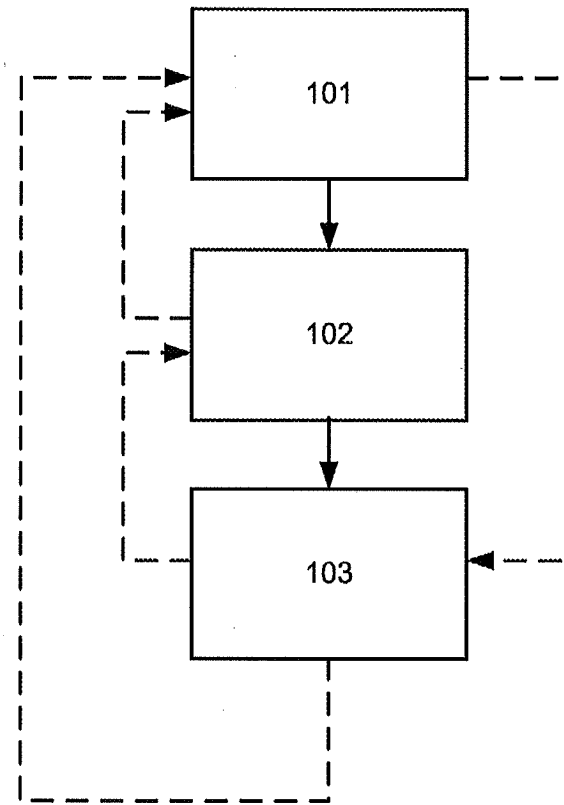


Fig. 4

ADVANCE E-MAIL

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF RECEIPT OF
RECORD COPY

(PCT Rule 24.2(a))

To:

HØIBERG A/S
St. Kongensgade 59 A
DK-1264 Copenhagen K
DANEMARK

Date of mailing (day/month/year) 19 December 2011 (19.12.2011)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference P2635PC00	International application No. PCT/DK2011/050461

The applicant is hereby notified that the International Bureau has received the record copy of the international application as detailed below.

Name(s) of the applicant(s) and State(s) for which they are applicants:

3SHAPE A/S (for all designated States except US)
HOLLENBECK, Karl Josef et al (for US)

International filing date: 05 December 2011 (05.12.2011)
Priority date(s) claimed: 06 December 2010 (06.12.2010)
06 December 2010 (06.12.2010)
Date of receipt of the record copy by the International Bureau: 12 December 2011 (12.12.2011)

List of designated Offices:

AP: BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW
EA: AM, AZ, BY, KG, KZ, MD, RU, TJ, TM
EP: AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR
OA: BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG
National: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW

ATTENTION: The applicant should carefully check the data appearing in this Notification. In case of any discrepancy between these data and the indications in the international application, the applicant should immediately inform the International Bureau. In addition, the applicant's attention is drawn to:

- time limits for entry into the national phase (see www.wipo.int/pct/en/texts/time_limits.html and *PCT Applicant's Guide*, National Phase, especially Chapters 3 and 4)
- requirements regarding priority documents (if applicable) (see *PCT Applicant's Guide*, International Phase, paragraph 5.070)

A copy of this notification is being sent to the receiving Office and to the International Searching Authority.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Ben Helal Najib e-mail pt03.pct@wipo.int Telephone No. +41 22 338 74 03
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Facsimile No. +41 22 338 70 80

Form PCT/IB/301 (July 2010)

1/FCXSN9IIKSDCSX0

ADVANCE E-MAIL

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION CONCERNING SUBMISSION,
OBTENTION OR TRANSMITTAL
OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

To:

HØIBERG A/S
St. Kongensgade 59 A
DK-1264 Copenhagen K
DANEMARK

Date of mailing (day/month/year) 03 February 2012 (03.02.2012)	
Applicant's or agent's file reference P2635PC00	IMPORTANT NOTIFICATION
International application No. PCT/DK2011/050461	International filing date (day/month/year) 05 December 2011 (05.12.2011)
International publication date (day/month/year) Not yet published	Priority date (day/month/year) 06 December 2010 (06.12.2010)
Applicant	3SHAPE A/S et al

The applicant is hereby notified of the date of receipt (or of obtaining by the International Bureau) of the priority document(s) relating to all earlier application(s) whose priority is claimed. Unless otherwise indicated by the letters "NR", in the right-hand column or by an asterisk appearing next to the date of receipt, **the priority document concerned was submitted or transmitted to or obtained by the International Bureau in compliance with Rule 17.1(a), (b) or (b-bis)**. This Form replaces any previously issued notification concerning submission, transmittal or obtaining of priority documents.

<u>Priority date</u>	<u>Priority application No.</u>	<u>Country or regional Office or PCT receiving Office</u>	<u>Date of receipt of priority document</u>
06 December 2010 (06.12.2010)	PA 2010 01104	DK	21 December 2011 (21.12.2011)
06 December 2010 (06.12.2010)	61/420,138	US	19 December 2011 (19.12.2011)

The letters "NR" denote a priority document which, on the date of mailing of this Form, had not yet been received or obtained by the International Bureau in compliance with Rule 17.1(a), (b) or (b-bis). Where the applicant has failed to either submit, request to prepare and transmit or obtain and transmit, or to request the International Bureau to obtain the priority document within the applicable time limit under that Rule, the attention of the applicant is directed to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

An asterisk "*" next to a date of receipt, denotes a priority document submitted or transmitted to or obtained by the International Bureau but not in compliance with Rule 17.1(a), (b) or (b-bis) (the priority document was received after the time limit prescribed in Rule 17.1(a); the request to prepare and transmit the priority document was submitted to the receiving Office after the applicable time limit under Rule 17.1(b) or the request to the receiving Office or the International Bureau to obtain the priority document was made after the applicable time limit under Rule 17.1(b-bis)). Even though the priority document was not furnished in compliance with Rule 17.1(a), (b) or (b-bis), the International Bureau will nevertheless transmit a copy of the document to the designated Offices, for their consideration. In case such a copy is not accepted by the designated Office as the priority document, Rule 17.1(c) provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Nora Lindner e-mail pt03.pct@wipo.int Telephone No. +41 22 338 74 03
---	--

Facsimile No. +41 22 338 70 80
Form PCT/IB/304 (July 2010)

1/ERGN2GUEPWTPL0

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

To:

MÜNZER, Marc
Guardian IP Consulting I/S
Diplomvej, Building 381
DK-2800 Kgs. Lyngby
DANEMARK

Date of mailing (day/month/year) 24 May 2012 (24.05.2012)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference P1266PC00	
International application No. PCT/DK2011/050461	International filing date (day/month/year) 05 December 2011 (05.12.2011)

1. The following indications appeared on record concerning:

the applicant the inventor the agent the common representative

Name and Address HØIBERG A/S St. Kongensgade 59 A DK-1264 Copenhagen K Denmark	State of Nationality	State of Residence
	Telephone No. +4533320337	
	Facsimile No. +4533320384	
	E-mail address hoiberg@hoiberg.com	

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

the person the name the address the nationality the residence

Name and Address MÜNZER, Marc Guardian IP Consulting I/S Diplomvej, Building 381 DK-2800 Kgs. Lyngby Denmark	State of Nationality	State of Residence
	Telephone No. +45 70 27 53 63	
	Facsimile No. +45 70 27 53 62	
	E-mail address mail@gipc.dk <input type="checkbox"/> Notifications by e-mail authorized	

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

<input type="checkbox"/> the receiving Office	<input type="checkbox"/> the International Preliminary Examining Authority
<input type="checkbox"/> the International Searching Authority	<input type="checkbox"/> the designated Offices concerned
<input type="checkbox"/> the Authority(ies) specified for supplementary search	<input type="checkbox"/> the elected Offices concerned
	<input checked="" type="checkbox"/> other: HØIBERG A/S

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Blanc Veronique
Facsimile No. +41 22 338 82 70	e-mail pt03.pct@wipo.int Telephone No. +41 22 338 74 03

From the INTERNATIONAL BUREAU

PCT

FIRST NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION (TO DESIGNATED OFFICES WHICH DO NOT APPLY THE 30 MONTH TIME LIMIT UNDER ARTICLE 22(1))

To:

MÜNZER, Marc
Guardian IP Consulting I/S
Diplomvej, Building 381
DK-2800 Kgs. Lyngby
DANEMARK

(PCT Rule 47.1(c))

Date of mailing (day/month/year) 12 July 2012 (12.07.2012)		IMPORTANT NOTICE	
Applicant's or agent's file reference P1266PC00			
International application No. PCT/DK2011/050461	International filing date (day/month/year) 05 December 2011 (05.12.2011)	Priority date (day/month/year) 06 December 2010 (06.12.2010)	
Applicant 3SHAPE A/S et al			

1. **ATTENTION:** For any designated Office(s), for which the time limit under Article 22(1), as in force from 1 April 2002 (30 months from the priority date), **does apply**, please see Form PCT/IB/308(Second and Supplementary Notice) (to be issued promptly after the expiration of 28 months from the priority date).

2. Notice is hereby given that the following designated Office(s), for which the time limit under Article 22(1), as in force from 1 April 2002, **does not apply**, has/have requested that the communication of the international application, as provided for in Article 20, be effected under Rule 93bis.1. The International Bureau has effected that communication on the date indicated below:
14 June 2012 (14.06.2012)

None

In accordance with Rule 47.1(c-bis)(i), those Offices will accept the present notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

3. The following designated Offices, for which the time limit under Article 22(1), as in force from 1 April 2002, **does not apply**, have not requested, as at the time of mailing of the present notice, that the communication of the international application be effected under Rule 93bis.1 :

LU, TZ, UG

In accordance with Rule 47.1(c-bis)(ii), those Offices accept the present notice as conclusive evidence that the Contracting State for which that Office acts as a designated Office does not require the furnishing, under Article 22, by the applicant of a copy of the international application.

4. **TIME LIMITS for entry into the national phase**

For the designated Office(s) listed above, and unless a demand for international preliminary examination has been filed before the expiration of **19 months** from the priority date (see Article 39(1)), the applicable time limit for entering the national phase will, **subject to what is said in the following paragraph**, be **20 MONTHS** from the priority date.

In practice, **time limits other than the 20-month time limit** will continue to apply, for various periods of time, in respect of certain of the designated Offices listed above. For **regular updates on the applicable time limits** (20 or 21 months, or other time limit), Office by Office, refer to the *PCT Gazette*, the *PCT Newsletter* and the *PCT Applicant's Guide*, Volume II, National Chapters, all available from WIPO's Internet site, at <http://www.wipo.int/pct/en/index.html>.

It is the applicant's **sole responsibility** to monitor all these time limits.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Nora Lindner
Facsimile No. +41 22 338 82 70	e-mail: pt03.pct@wipo.int



From the INTERNATIONAL BUREAU

PCT

SECOND AND SUPPLEMENTARY NOTICE
INFORMING THE APPLICANT OF THE
COMMUNICATION OF THE INTERNATIONAL
APPLICATION (TO DESIGNATED OFFICES
WHICH APPLY THE 30 MONTH TIME
LIMIT UNDER ARTICLE 22(1))

(PCT Rule 47.1(c))

To:

MÜNZER, Marc
Guardian IP Consulting I/S
Diplomvej, Building 381
DK-2800 Kgs. Lyngby
DANEMARK

Date of mailing (day/month/year) 11 April 2013 (11.04.2013)		IMPORTANT NOTICE	
Applicant's or agent's file reference P1266PC00			
International application No. PCT/DK2011/050461	International filing date (day/month/year) 05 December 2011 (05.12.2011)	Priority date (day/month/year) 06 December 2010 (06.12.2010)	
Applicant 3SHAPE A/S et al			

1. **ATTENTION:** For any designated Office(s), for which the time limit under Article 22(1), as in force from 1 April 2002 (30 months from the priority date), **does not apply**, please see Form PCT/IB/308(First Notice) issued previously.

2. Notice is hereby given that the following designated Office(s), for which the time limit under Article 22(1), as in force from 1 April 2002, **does apply**, has/have requested that the communication of the international application, as provided for in Article 20, be effected under Rule 93bis.1. The International Bureau has effected that communication on the date indicated below:
14 June 2012 (14.06.2012)

AZ, BY, CN, CO, DZ, EP, HU, KG, KP, KR, MD, MK, MY, MZ, NA, NG, PG, RU, SY, TM, US

In accordance with Rule 47.1(c-bis)(i), those Offices will accept the present notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

3. The following designated Offices, for which the time limit under Article 22(1), as in force from 1 April 2002, **does apply**, have not requested, as at the time of mailing of the present notice, that the communication of the international application be effected under Rule 93bis.1 :

AE, AG, AL, AM, AO, AP, AT, AU, BA, BB, BG, BH, BR, BW, BZ, CA, CH, CL, CR, CU, CZ, DE, DK, DM, DO, EA, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, ID, IL, IN, IS, JP, KE, KM, KN, KZ, LA, LC, LK, LR, LS, LT, LY, MA, ME, MG, MN, MW, MX, NI, NO, NZ, OA, OM, PE, PH, PL, PT, QA, RO, RS, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, TH, TJ, TN, TR, TT, UA, UZ, VC, VN, ZA, ZM, ZW

In accordance with Rule 47.1(c-bis)(ii), those Offices accept the present notice as conclusive evidence that the Contracting State for which that Office acts as a designated Office does not require the furnishing, under Article 22, by the applicant of a copy of the international application.

4. **TIME LIMITS for entry into the national phase**

For the designated or elected Office(s) listed above, the applicable time limit for entering the national phase will, **subject to what is said in the following paragraph**, be **30 MONTHS** from the priority date.

In practice, **time limits other than the 30-month time limit** will continue to apply, for various periods of time, in respect of certain of the designated or elected Office(s) listed above. For **regular updates on the applicable time limits** (30 or 31 months, or other time limit), Office by Office, refer to the *PCT Gazette*, the *PCT Newsletter* and the *PCT Applicant's Guide*, Volume II, National Chapters, all available from WIPO's Internet site, at <http://www.wipo.int/pct/en/index.html>.

It is the applicant's **sole responsibility** to monitor all these time limits.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Nora Lindner
Facsimile No. +41 22 338 82 70	e-mail: pt03.pct@wipo.int

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION CONCERNING
AVAILABILITY OF THE PUBLICATION
OF THE INTERNATIONAL APPLICATION

To:

MÜNZER, Marc
Guardian IP Consulting I/S
Diplomvej, Building 381
DK-2800 Kgs. Lyngby
DANEMARK

Date of mailing (day/month/year) 14 June 2012 (14.06.2012)		IMPORTANT NOTICE	
Applicant's or agent's file reference P1266PC00			
International application No. PCT/DK2011/050461	International filing date (day/month/year) 05 December 2011 (05.12.2011)	Priority date (day/month/year) 06 December 2010 (06.12.2010)	
Applicant 3SHAPE A/S et al			

The applicant is hereby **notified** that the International Bureau:

has **published** the above-indicated international application on 14 June 2012 (14.06.2012) under No. WO 2012/076013

has **republished** the above-indicated international application on under No. WO
For an explanation as to the reason for this republication of the international application, reference is made to INID codes (15), (48) or (88) (as the case may be) on the front page of the published international application.

A copy of the international application is available for viewing and downloading on WIPO's website at the following address: www.wipo.int/pctdb (in the appropriate field of the structured search, enter the PCT or WO number).

The applicant may also obtain a paper copy of the published international application from the International Bureau by sending an e-mail to patentscope@wipo.int or by submitting a written request to the contact details provided below.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Nora Lindner e-mail: pt03.pct@wipo.int
Facsimile No. +41 22 338 82 70	

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of)	
Henrik ÖJELUND et al.)	Group Art Unit: Unassigned
Application No.: Unassigned)	Confirmation No.: Unassigned
Filed: June 4, 2013)	
For: SYSTEM WITH 3D USER INTERFACE INTEGRATION)	

FIRST INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

In accordance with the duty of disclosure as set forth in 37 C.F.R. § 1.56, the accompanying information is being submitted in accordance with 37 C.F.R. §§ 1.97 and 1.98.


The listed documents were cited in the attached International Search Report in the corresponding PCT application.

To assist the Examiner, the documents are listed on the attached citation form. It is respectfully requested that an Examiner initialed copy of this form be returned to the undersigned.

Respectfully submitted,

BUCHANAN INGERSOLL & ROONEY PC

Date June 4, 2013

By: 
William C. Rowland
Registration No. 30888

Customer Number 21839
703 836 6620

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Substitute for form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Use as many sheets as necessary)			Complete if Known			
			Application Number		Unassigned	
			Filing Date		June 4, 2013	
			First Named Inventor		Henrik ÖJELUND et al.	
			Art Unit		Unassigned	
			Examiner Name		Unassigned	
Sheet	1	of	1	Attorney Docket Number	0079124-000070	

U.S. PATENT DOCUMENTS					
Examiner Initials ¹	Cite No. ¹	Document Number	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		Number-Kind Code ² (if known)			
		US-2009/0217207 A1	08-27-2009	KAGERMEIER ET AL.	
		US-2003/0158482 A1	08-21-2003	POLAND ET AL.	
		US-7,141,020 B2	11-28-2006	POLAND ET AL.	
		US-2009/0061381 A1	03-05-2009	DURBIN ET AL.	
		US-2006/0146009 A1	07-06-2006	SYRBE ET AL. (corr. to WO 2004/066615 cited below)	
		US-			
		US-			
		US-			

FOREIGN PATENT DOCUMENTS						
Examiner Initials ¹	Cite No. ¹	Foreign Patent Document	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T ⁶
		Country Code ³ Number ⁴ Kind Code ⁵ (if known)				
		WO 2004/066615 A1	08-05-2004	NOKIA CORPORATION		

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials ¹	Cite No. ¹	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ²
		International Search Report (PCT/ISA/210) issued on February 22, 2012, by the Danish Patent Office as the International Searching Authority for International Application No. PCT/DK/2011/050461.	

Examiner Signature		Date Considered	
--------------------	--	-----------------	--

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. ¹ Applicant's unique citation designation number (optional). ² See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. ³ Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). ⁴ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁵ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁶ Applicant is to place a check mark here if English language Translation is attached.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference P2635PC00	FOR FURTHER ACTION see Form PCT/ISA/220 as well as, where applicable, item 5 below.	
International application No. PCT/DK2011/050461	International filing date (<i>day/month/year</i>) 05/12/2011	(Earliest) Priority Date (<i>day/month/year</i>) 06/12/2010
Applicant 3SHAPE A/S		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 6 sheets.

It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the **language**, the international search was carried out on the basis of:

the international application in the language in which it was filed.

a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

b. This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6bis(a)).

c. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. **Certain claims were found unsearchable** (see Box No. II).

3. **Unity of invention is lacking** (see Box No. III).

4. With regard to the **title**,

the text is approved as submitted by the applicant.

the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

the text is approved as submitted by the applicant.

the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,

a. the figure of the **drawings** to be published with the abstract is Figure No. 2a

as suggested by the applicant.

as selected by this Authority, because the applicant failed to suggest a figure.

as selected by this Authority, because this figure better characterizes the invention.

b. none of the figures is to be published with the abstract.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK2011/050461

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
See extra sheet

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-34, 38-52

Remark on Protest

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK2011/050461

Box No. IV Text of the abstract (Continuation of item 5 of the first sheet)

Disclosed is a system comprising a handheld device (100) and at least one display (101), where the handheld device (100) is adapted for performing at least one action in a physical 3D environment. The actions include measuring, modifying, manipulating, recording, touching, sensing, scanning, moving, transforming, cutting, welding, chemically treating, cleaning. The display (101) is adapted for visually representing the physical 3D environment, and where the handheld device (100) is adapted for remotely controlling the view with which the 3D environment is represented on the display (101).

INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK2011/050461

A. CLASSIFICATION OF SUBJECT MATTER G01B 11/24 (2006.01), A61C 13/00 (2006.01)		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) IPC/EC: G06F, G01B, A61C; ICO: K63F; FT:4C061/CC		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched DK, SE, FI, NO (IPC classes as above)		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPODOC, WPI, TXTE		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X; A	US 2009/0217207 A1 (KAGERMEIER et al) 2009.08.27, entire application, in particular sections [0007], [0009], [0012]-[0013], [0019]-[0020], [0023], [0035]-[0039], fig. 1-4	1-33, 38-48, 50-52; 34, 49
X; A	WO 2004/066615 A1 (NOKIA CORPORATION) 2004.08.05, page 3, line 16 to page 4, line 2, page 25, line 12, to page 26, line 5.	1, 3-14, 16-33, 38-48, 50-52; 2, 15, 34, 49
X; A	US 2003/0158482 A1 (POLAND et al) 2003.08.21, sections [0032], [0034], figs 6, 8.	1-11, 15-17, 26-33, 38-39, 46, 48, 50-52; 12-14, 18-25, 34, 40, 41-45, 47
A	US 2009/0061381 A1 (DURBIN et al) 2009.03.05, sections [0018]-[0019], [0024]	1-33, 38-52
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 17/02/2012		Date of mailing of the international search report 22/02/2012
Name and mailing address of the ISA/ Nordic Patent Institute, Helgeshøj Allé 81, DK-2630 Taastrup, Denmark. Facsimile No. +45 43 50 80 08		Authorized officer Lennart Bitsch Telephone No. +45 43 50 8244

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/DK2011/050461

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US2009217207 A1	20090827	CN101513350 A DE102008010717 A1	20090826 20090827
WO2004066615 A1	20040805	US2006146009 A1 EP1588552 A1 AU2003303787 A1	20060706 20051026 20040813
US2003158482 A1	20030821	JP2005517515 A WO03071306 A1 EP1488253 A1 EP1488253 B1 DE60308495T T2 CN1636151 A CN100340867C C AU2003247479 A1 AT340365T T US7141020 B2	20050616 20030828 20041222 20060920 20070606 20050706 20071003 20030909 20061015 20061128
US2009061381 A1	20090305	WO2009033108 A1 KR20100066538 A JP2010538302 A EP2185891 A1 CA2698525 A1	20090312 20100617 20101209 20100519 20090312

Continuation of Box no. III

This International Searching Authority found multiple inventions.

US 2009/0217207 A1 (KAGERMEIER et al) 2009.08.27 describes a system comprising a handheld device (10) and at least one display (3, 22), where the handheld device is adapted for switching between

-performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment ([0013], [0037]), and
-remotely controlling the view with which the 3D environment is represented on the display ([0007], [0036], [0039])

The general concept described in the independent claim 1 is known from US 2009/0217207, and the application does therefore describe 4 inventions

A: Claims 2-34, 38-52 describe modifications of a system, a method, and a computer program product comprising a handheld device for performing at least one action, and for remotely controlling the view, and wherein the handheld device is an intra-oral 3D scanner

B: Claim 35 describes a system wherein the handheld device of claim 1 is a surgical instrument

C: Claim 36 describes a system wherein the handheld device of claim 1 is a mechanical tool

D: Claim 37 describes a system wherein the handheld device of claim 1 is an in-ear 3D scanner

There is no Single General Inventive Concept among the inventions A, B, C and D, and there is, therefore, not a technical relationship to link the invention as defined in Rules 13.1 and 13.2 PCT.

(19) World Intellectual Property Organization
International Bureau



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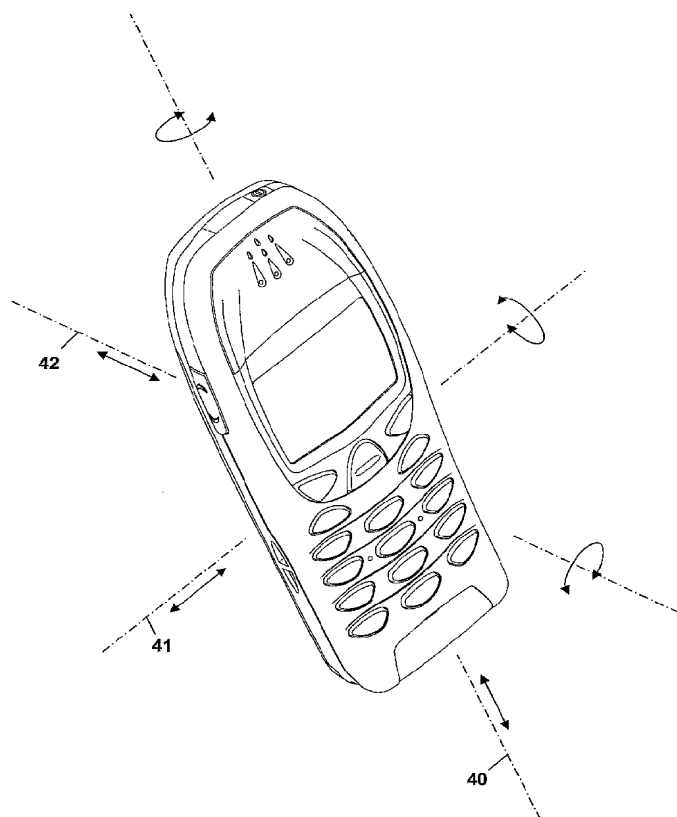
- (51) International Patent Classification⁷: **H04N 5/225**,
7/14, H04M 1/725, H04N 5/232, H04M 1/247
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PCT/EP2003/000607
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- (71) Applicant (for all designated States except US): **NOKIA CORPORATION** [FI/FI]; Keilalahdentie 4, FIN-02150 Espoo (FI).
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- (74) Agent: **VAN WALSTIJN, B., Gerard, G.**; Walstijn Intellectual Property ApS, Parkovsvej 3, DK-2820 Gentofte (DK).
- (81) Designated States (national): AE, AG, AL, AM, AT (utility model), AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ (utility model), CZ, DE (utility model), DE, DK (utility model), DK, DM, DZ, EC, EE (utility model), EE, ES, FI (utility model), FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK (utility model), SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW),

[Continued on next page]

(54) Title: IMAGE CONTROL



(57) Abstract: The present invention relates to the field of hand-held devices that are equipped with a processor and a digital camera for capturing motion video or still images. Images captured by the camera are used to determine motion of the hand-held device. A resulting motion signal is used as input to a user interface. Displayed images can be scrolled, zoomed or rotated by moving the hand-held device. The motion signal can also be used as input for a graphical user interface to move a cursor or other object of the graphical user interface over the display. The invention relates further to a hand-held device provided with means for sensing motion, a display, a keypad with at least a first- and a second key, and a graphical user interface with objects and a cursor. The hand-held device also comprises means for transforming the sensed motion of the handheld device into a signal suitable for moving the cursor over the display.

WO 2004/066615 A1



Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE,
ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, SE, SI,
SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN,
GQ, GW, ML, MR, NE, SN, TD, TG).

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Published:

— *with international search report*

IMAGE CONTROL

5 The present invention relates to the field of hand-held devices that are equipped with a processor and a digital camera for capturing motion video or still images, in particular such devices that further comprise a display for displaying images or a graphical or character based user interface.

10

BACKGROUND ART

15 Hand-held devices provided with digital image capturing equipment, digital processing power and high resolution displays are becoming increasingly more common in a wide variety of uses.

20 For example, small mobile phones are recently being equipped with digital cameras and relatively small high resolution LCD screens. Hand-held computers commonly called "personal digital assistants" (PDA) are also available and are typically equipped with small high resolution display screens and have slots for receiving e.g. a digital camera. Similarly, communicators having
25 both cellular communication and computer capabilities are available, typically having small display screens and an inbuilt or detachable digital camera. These small, hand-held devices do not, and cannot, conveniently have conventional input devices, such as a computer mouse and
30 other control keys. Therefore, conventional personal computer interfaces, which also have their own drawbacks, are not suited for these small hand-held devices.

35 As a result, there are significant limitations on using such small hand-held devices in both obtaining output, e.g. viewing data on the display screen, and in inputting

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commands, e.g. changing the area viewed on the display screen or controlling the performance of a particular parameter associated with the device. Further, given the limited area available, not only on the display screen but also on the entire device, adding additional control keys, etc., is both difficult and burdensome to a user requiring two hand operation of the device.

US 6466198 discloses a system and method for view navigation and magnification of the display of hand-held devices in response to the orientation changes along only two axes of rotation as measured by sensors inside the devices. The view navigation system can be engaged and controlled by simultaneously pressing switches on both sides of the hand-held device. Miniature sensors like accelerometers, tilt sensors, or magneto-resistive direction sensors sense the orientation changes. These miniature sensors are presently not typically standard equipment for hand-held devices. Thus, such sensors add cost, use precious space and add weight.

The present invention is directed toward overcoming one or more of the above-identified problems.

25 DISCLOSURE OF THE INVENTION

On this background, it is an object of the present invention to provide a hand-held device of the kind referred to initially, which allows user input with the same hand that holds the device, without requiring the dedicated sensory equipment used by prior art hand-held devices.

This object is achieved in accordance with claim 1, by providing a hand-held device comprising a processor, a digital camera for capturing motion video or still images,

and means for transforming a signal from the camera into a motion signal indicative of the motion of the hand-held device.

5 Thus, by using a sensor that is available to start with in many hand-held devices -- namely a digital camera -- for a secondary use, namely creating a motion signal indicative of the motion of the hand-held device, a hand-held device with motion sensing is provided in a economical and
10 reliable manner.

The hand-held device may further comprise a user interface in which motion of the hand-held device is - through the motion signal derived thereof - used as a user input.

15

The hand-held may further comprise a display, preferably a display suitable for displaying captured images.

Motion of a given type of the hand-held device can be used
20 to manipulate images shown at least in part on the display, preferably by moving the images in a manner substantially corresponding to the movement of the hand-held device.

25 Different types of motion the hand-held device can e.g. be used to move, and/or zoom, and/or expand/collapse and/or rotate images displayed on the display.

Motion substantially parallel to the plane of the display
30 of the hand-held device can be used to scroll an image displayed on the display. Motion substantially perpendicular to the plane of the display can be used to zoom an image displayed on the display. Rotational motion of the hand-held device can be used to rotate an image
35 displayed on the display.

The images that are manipulated can e.g. be images that were previously captured by the camera.

5 The movement of image can be inverted with respect to motion of the hand-held device, since some users may prefer this.

10 The user interface may comprise a graphical user interface and motion of the hand-held device can be used as an input to the graphical user interface.

15 Motion of the hand-held device can be used to manipulate an object displayed by the graphical user interface, preferably by moving the object in a manner substantially corresponding to the motion or to the inverted motion of the hand-held device, whereby the object displayed by the graphical user interface can be an icon, a dialogue box, a window, a menu or a pointer.

20 Motion of a given type of the hand-held device can be used to move, and/or zoom, and/or expand/collapse and/or rotate objects displayed by the graphical user interface.

25 Motion substantially parallel to the plane of the display of the hand-held device can be used to scroll an object displayed by the graphical user interface. Motion substantially perpendicular to the plane of the display can be used to zoom an object displayed by the graphical user interface. Rotational motion of the hand-held device
30 can be used to rotate an object displayed by the graphical user interface.

35 The digital camera can be an inbuilt camera or can be a detachable camera. The camera may be movable relative to the hand-held device.

The means for transforming a signal from the camera into a motion signal preferably derives the motion signal from changes between succeeding images captured by the camera.

5 The camera can be equipped with an autofocus system, whereby the focusing setting of the autofocus system can be used for detecting movement in the camera direction.

The hand-held device may further comprise at least one
10 key. The functionality of a motion type can be dependent on the state of the at least one key.

Rotational motion of the hand-held device about an axis substantially perpendicular to the display may be used to
15 cause an inverse rotational movement of the image or graphical user interface object relative to the display, preferably in a manner such that the image or object is static with respect to the fixed coordinate system in which the hand-held device is situated.

20

The motion signal can be used to adjust device settings, such as sound settings, keypad settings and display settings.

25 The hand-held device may further comprise a keypad with at least a first and a second key and the graphical user interface comprising a cursor, whereby motion of the hand-held device can be used to position the cursor over an object of the graphical user interface and primary
30 functions associated with the object concerned can be activated by pressing the first key and secondary functions associated with the object of the concerned can be activated by pressing the second key.

35 The functionality of the first key can be associated with selection and activation of objects of the graphical user

interface, and the functionality of the second key can be associated with calling up a context-sensitive menu.

5 The selection of the object concerned can be performed by pressing and releasing the first key. Activation of the object concerned can be performed by pressing and releasing the first key twice in rapid succession. Moving or resizing of the object concerned can be performed by holding down the first key while moving the hand-held
10 device to move the cursor.

The first key and the second key can be softkeys, whereby the current functionality of the softkeys is shown in the display, preferably in dedicated fields of the display.

15

The first key can be placed below the display on the left side of the latter, preferably proximate to lower edge of the display, and the second key can be placed below the display on the right side of the latter, preferably
20 proximate to lower edge of the display.

It is another object of the present invention to provide an improved method for providing user input to hand-held devices. This object is achieved by providing a method for
25 creating user input for a hand-held device that has a processor, a user interface and a digital camera for capturing motion video or still images comprising the steps of:

30 determining motion of the hand-held device from the camera signal;
using the determined motion of the hand-held device as an input for the user interface.

It is yet another object of the present invention to
35 provide a use of a digital camera of a hand-held device

that has a processor to produce a motion signal indicative of motion of the hand-held device.

A further object of the invention is to provide a hand-held device with an improved graphical user interface. This object is achieved by providing a hand-held device comprising a processor, means for sensing motion of the hand-held device, a display, a keypad with at least a first- and a second key, a graphical user interface with objects and a cursor, and means for transforming the sensed motion of the handheld device into a signal suitable for moving the cursor over the display.

By controlling the position of a cursor through motion of the handheld device it becomes possible to provide a user-friendly cursor controlled graphical user interface for hand-held devices.

Preferably, motion of the hand-held device is used to position the cursor over objects of the graphical user interface and primary functions associated with the object concerned are activated by pressing the first key and secondary functions associated with the object concerned are activated by pressing the second key.

The functionality of the first key can be associated with selection and activation of objects of the graphical user interface, and the functionality of the second key can be preferably associated with calling up a context-sensitive menu.

Selection of the object concerned is preferably performed by pressing and releasing the first key, and activation of the object concerned is preferably performed by pressing and releasing the first key twice in rapid succession.

Moving or resizing of the object concerned can be performed by holding down the first key while moving the hand-held device to move the cursor and the object concerned in unison therewith.

5

The first key and the second key can be softkeys, whereby the current functionality of the softkeys is shown in the display, preferably in dedicated fields of the display.

10

The first key can be placed below the display on the left side of the latter, preferably proximate to lower edge of the display, and the second key can be placed below the display on the right side of the latter, preferably proximate to lower edge of the display.

15

The means for transforming motion of the handheld device into a signal suitable for moving the cursor over the display may further comprise a tilt sensor and/or an image capturing device and/or an accelerometer.

20

The hand-held device according may further comprise means to transform a signal from the image capturing device, i.e. camera and/or tilt sensor and/or accelerometer into a position signal for the cursor.

25

The means for transforming a signal from the camera into a motion signal preferably derives the motion signal from changes between succeeding images, or parts of succeeding images captured by the camera.

30

The camera may have an autofocus system, whereby the focusing setting of the autofocus system is used for detecting movement in the camera direction.

The graphical user interface may include one or more of the following object types: icons, dialogue boxes, windows, menus, pointers.

5 Further objects, features, advantages and properties of the hand-held device, method for proving user input and use of a digital camera in a hand-held device according to the invention will become apparent from the detailed description.

10

BRIEF DESCRIPTION OF THE DRAWINGS

In the following detailed portion of the present description, the invention will be explained in more
15 detail with reference to the exemplary embodiments shown in the drawings, in which:

Fig. 1 illustrates a preferred embodiment of a hand-held device according to the invention,

20 Fig. 2 shows a block diagram of the hand-held device of the embodiment of Fig. 1,

Fig. 3 indicates the axes of movement and rotation along which the hand-held device is moved and rotated in order to create user input in accordance with the present
25 invention,

Figs. 3.1 to 3.7 illustrate the use of the present invention for zooming, scrolling and rotating images shown on the display,

30 Figs. 3.8 to 3.10 illustrate the use of the present invention for user input to a graphical user interface to scroll a table in a window and to resize a window,

Figs. 3.11 to 3.13 illustrate the use of the present invention for scrolling a magnifying window over the display,

Figs. 3.14 and 3.15 illustrate the use of the present invention for moving a part of an image by cutting and pasting,

Fig. 3.16 illustrates the use of the present invention with a text editing application,

Fig. 3.17 illustrates the use of the present invention with an application for entering musical notes in a stave,

Fig. 3.18 illustrates the use of the present invention with a labyrinth game

Fig. 3.19 illustrates the use of the present invention for controlling a video game,

Fig. 3.20 illustrates the use of the present invention with an application for controlling the sound settings of a music player function,

Fig. 4 outlines a software flow diagram for zooming, scrolling and rotating images shown on the display, and

Figs. 5 and 6 show an alternative preferred embodiment of a hand-held device according to the invention.

DETAILED DESCRIPTION

This invention allows hand-held communication or computing devices with a relatively small display to receive user input by moving or rotating the device. In particular with devices having a display, the invention allows convenient navigation of a large stored virtual display or of objects in a graphical user interface. Such devices may include PDA devices, camcorders, digital photo cameras, digital binoculars (solid-state stereoscopic imaging system incorporated for viewing and digitally recording magnified stereo images), mobile hand-held terminals, advanced pagers, mobile telephones, and communicators.

According to a preferred embodiment, the hand-held device is a hand portable phone, preferably a cellular/mobile phone.

Fig. 1 shows a mobile phone according to the invention, and it will be seen that the phone, which is generally designated by 1, comprises a user interface having a keypad 2, a display 3, an on/off button 4, a speaker 5 (only the openings are shown), and a microphone 6 (only the opening is shown). The phone 1 according to the preferred embodiment is adapted for communication via a cellular network, such as the GSM 900/1800 MHz network.

10

The keypad 7 has a first group of keys 8 as alphanumeric keys, by means of which the user can enter a telephone number, write a text message (SMS), write a name (associated with the phone number), etc. Each of the twelve alphanumeric keys 8 is provided with a figure "0-9" or a sign "#" or "*", respectively. In alpha mode each key is associated with a number of letters and special signs used in the text editing.

20

The keypad 7 additionally comprises two softkeys 9, two call handling keys 12, and an arrow key 10. The function of the softkeys depends on the state of the phone and the navigation in the menu can be performed by using the navigation-key. The present function of the softkeys 9 is shown in separate fields in the display 3, just above keys 9. The two call handling keys 12 are used for establishing a call or a conference call, terminating a call or rejecting an incoming call. This key layout is characteristic for e.g. the Nokia 6210™ phone.

30

The arrow key 10 is an up/down key which can be used for cursor movement and scrolling and is placed centrally on the front surface of the phone between the display 3 and the group of alphanumeric keys 7. A battery pack 14 is mounted on the back of the phone and supplies electrical power for the electronic components of the mobile phone.

35

The phone has a flat display 3 that is typically made of a LCD with optional back lighting, such as a TFT matrix capable of displaying color images.

5

The phone is equipped with a digital camera 35 of which only the lens 36 is visible in Fig. 1. The camera is arranged at the rear of the phone above the battery pack 14. The camera direction is therefore substantially perpendicular to the rear surface of the phone 1. Just under the camera an infrared port 38 for IrDA communication is provided (only window of the port is shown). The camera may alternatively have a rotatable connection to the phone (not shown), to allow adjustment of the camera direction relative to the housing of the phone.

Fig. 2 schematically shows the most important parts of a preferred embodiment of the phone, in the form of a block diagram. A processor 18 controls the communication with the network via the transmitter/receiver circuit 19 and an internal antenna 20. A microphone 6 transforms the user's speech into analogue signals, the analogue signals formed thereby are A/D converted in an A/D converter (not shown) before the speech is encoded in a digital signal processing unit 14 (DSP). The encoded speech signal is transferred to the processor 18, which i.e. supports the GSM terminal software. The processor 18 also forms the interface to the peripheral units of the apparatus, including a RAM memory 17a and a Flash ROM memory 17b, a SIM card 16, and the keypad 2 (as well as data, power supply, etc.). The digital signal-processing unit 14 speech-decodes the signal, which is transferred from the processor 18 to the earpiece 5 via a D/A converter (not shown). The processor communicates in two directions with the IrDA port 38 (infrared port) that allows data

35

communication with other devices that are equipped with such a port, such as PC's, laptops, personal digital assistants (PDA) and other mobile phones. The phone may further be equipped with a short range RF transmitter receiver (not shown), e.g. according to the Bluetooth standard, for data transmission with other devices as mentioned for IR data communication.

The processor 18 also forms the interface for the display controller 31. The image controller 31 receives the image files from the processor 18 and renders images for showing on the display 3.

A camera controller 37 is also connected to the processor 18 and controls the digital camera 35. The camera controller 37 sets the resolution, the refresh rate, the focus, and zoom factor of the camera 35. The camera controller 37 sets the focus automatically through any of the well-known auto focus techniques available. The output signal of the camera 35 is connected to the processor 18.

When the camera is used to detect motion of the hand-held device, the camera controller 37 automatically selects the appropriate resolution and refresh rate, so that the refresh rate is high enough to derive a smooth motion signal from the changes in the succeeding images. For motion detection it is not usually necessary to use the complete image captured by the digital camera. The software can pick out a particular section of the image for the motion detection so that the amount of data that has to be processed is reduced. These two measures (low resolution and using a section of the image) allow higher sampling rates and reduced power consumption because of lower data processing power demands.

35

Some surfaces in the camera view may not be particularly suited for detecting motion, e.g. because of a uniform surface, or because the distance to the objects in the camera view is too large to determine changes in distance accurately. Such problems may be solved (in the embodiment with the adjustable camera direction) by directing the camera to another available object with sufficient texture, such as the user. The camera direction is thus reversed compared to the "normal" direction. The motion signal derived from the camera signal is therefore automatically inversed when the camera is directed to the user.

The camera 35 is a conventional digital camera and therefore not all the features of the camera 35 are shown. The image sensor of the digital camera can be any of the known configurations for solid-state image sensors, such as frame transfer, interline transfer CCDs, or diode arrays.

Standard CCD devices are sensitive to both visual light and near infrared light. Conventional digital cameras for capturing images with visual light are therefore provided with an infrared filter for preventing influences of infrared light on the captured image. The mobile phone 1 is also provided with an infrared filter (not shown). The infrared filter can be moved out of the path of the light into the camera for capturing infrared images. The IrDA port 38 can be set to irradiate continuously to function as a light source for the camera 35 when it is in the infrared mode. Thus, the camera 35 can be used when there is little or no ambient light. The use of an IrDA port as a light source for a digital camera and the details of a device to move the infrared filter in and out of the camera path as well adjustments to the auto focus system

are disclosed in US patent application with serial nr. 10/029,968, hereby incorporated by reference.

5 The lens 36 is preferably a fixed focal length lens with movable lens group to allow auto focus, however, lens 36 could be any type of lens providing for adjustment to focus on different parts of the image received, as will be understood to those skilled in the art.

10 The characteristics of visible light and near infrared light with respect to focusing are slightly different. Therefore, the auto focus system has two settings; a first setting for capturing images with visual light and a second setting for infrared light.

15

Standard software for processing, storing and recalling pictures captured with visual light and captured with infrared light is installed on the phone 1. This software may as such be conventional and commercially available.

20 The software is also able to control the refresh rate of the images shown on the display.

Optionally, the phone 1 may also comprise one or two tilt sensors 39 which determine the direction and magnitude of the displacement relative to vertical using the planetary gravitational field. Such sensors could be any of well known types such as those operating with an encoding disk on a freely rotatable shaft connected to a weight, or of the type that uses sphere provided with an asymmetrical weight that floats in a liquid. Alternatively the tilt sensor could be of the gyroscopic type. The signals of the camera the tilt sensors can be combined for generating the motion signal.

35 The phone 1 in accordance with the preferred embodiment employs two operational modes associated with the use of

motion of the phone to generate user input, which throughout this document are referred to as navigation mode and fixed mode. When set to the navigation mode, motion of the phone 1 is used as input, and when
5 displaying an image, the display view is automatically scrolled, zoomed and rotated to follow movements of the holding hand. The navigation mode is activated by pressing the left softkey 9 "Navigate". Thus, the navigation mode is activated and the functionality of the left softkey 9
10 changes to "Fixed". When set back to the fixed mode by pressing the left softkey "Fixed" again, the display view becomes stationary and no longer follows the movements of the hand.

15 Fig. 3 indicates the relative axes of orientation along which the phone 1 is rotated or translated in order to navigate an image on the display 3. Throughout this document, axis 40 will be referred to as the Y-axis, and motion of the phone in the direction of the Y-axis is in a
20 preferred embodiment used to scroll images in the Y-direction. Similarly, axis 41 will be referred to as the X-axis and motion of the phone in the direction of the X-axis is in a preferred embodiment used to scroll images in the X-direction. Motion in the camera direction measured
25 along the Z-axis 42 is in a preferred embodiment used to control the zoom factor of the images shown on the display 3. Rotation about the Z-axis is used to rotate images shown on the display 3. Though these are the preferred functions assigned with movements along the X-, Y- and Z-
30 axes, any other functionality can be assigned to movement in the direction of these axes or to rotational movement about these axes.

While the scrolling, zooming, and rotation of the display
35 follows the movements of the device, the rate of scrolling/zooming/rotation as well as the amount of

scrolling/zooming/rotation need not follow the exact amount of change in position, and can be inverted. As will be discussed below, the control software of the present invention can smooth the movements of the phone to provide
5 a convenient effect on the display.

Figs. 3.1 to 3.13 show an overview of the operation of the phone 1 to scroll, zoom and rotate images.

10 With reference to Fig. 3.1, a high resolution image of a holiday snapshot comprising a lake, a bridge and a mountain peak stored in the RAM 17a is shown for viewing on the display 3. The display 3 is too small to show the entire image with sufficient size to appreciate all the
15 details in the image conveniently. The user presses the left softkey 9 "Navigate" to enter the navigation mode. The phone activates the navigation mode and changes the label above the left softkey 9 to "Fixed". In Fig. 3.2, the navigation process is started when the operator's hand
20 moves the phone 1 along the Z- axis 42 in the direction of arrow 42' for magnifying the view so that the display 3 shows the central portion of the image with the bridge in an enlarged manner (Fig. 3.3). By moving the phone along
25 the Y-axis 40 in the direction of arrow 40' the display 3 scrolls the images upwards and the mountain peak above the bridge can be viewed (Fig. 3.5).

In Fig. 3.6 the holiday snapshot is shown in a portrait orientation and can only be properly viewed with the phone
30 in a horizontal position. The user wishes to view the image with the phone in an upright position so that the image will be displayed in a landscape position with respect to the display 3. The user presses the left softkey 9 "Navigate" to activate the navigation mode and
35 rotates the phone a half turn anticlockwise (Fig. 3.7). The movement of the phone 1 creates a series of changing

images captured by the camera 35 from which the software on the phone derives a motion signal. Upon detection the rotational movement about the Z-axis the software on the phone rotates the displayed image in the opposite
5 direction, and when the user has completed a half anticlockwise turn the software has rotated the image a half turn clockwise, and the user can conveniently view the image with the phone in an upright position. The image is thus static with respect to the fixed coordinate system
10 in which the phone 1 device is situated.

The settings for the responses to motion of the phone 1 can thus be set in way in which the user perceives the view as that of a static image over which a magnifying
15 window (the display 3) is moved.

Fig. 3.8 shows a display 3 of the phone in a mode in which a graphical user interface is used to command the device. A window 70 containing a scrollable table is displayed on
20 the display 3. Scroll bars 71 and 72 are shown to the right and at the bottom of the table, respectively. A cursor 73 can be moved over the display by moving the phone in the direction of the X- and Y-axes. The left softkey 9 "Left-click" has the same functionality as the
25 left mouse button as known from many windows based graphical user interfaces, namely to select a primary function associated with an object marked by the cursor 73. By clicking, double clicking or holding the left softkey 9 down. The right softkey 9 "Right-click" also has
30 the same functionality as the right mouse button as known from many windows based graphical user interfaces, namely to select secondary functions associated with an object marked by the cursor 73. It is possible to assign the "Left click" and "Right click" to other keys of the phone,
35 but using a similar layout as for the keys of a computer mouse may facilitate user acceptance.

Example 1: The user wishes to scroll the table to the right to view column E. By holding the left softkey 9 "Left-click" pressed and moving the phone to the right along the X-axis the table is scrolled by dragging it with the cursor to the right as shown in Fig. 3.9.

Example 2: The user wishes to resize the window 70. After placing the cursor 73 on the upper bar of the window 70 and while holding the left softkey 9 "Left-click" movement of the phone 1 in the direction of the Z-axis resizes the window 70. Moving the phone towards the user enlarges the window as shown in Fig. 3.10 and moving away from the user reduces the size of the window (not shown).

Example 3: The user wishes to move a part of an image in an image editing program. The part of the image to be moved is marked with a sizable box 65. Holding the left softkey 9 "Left-click" down and moving the mouse by rotating the phone about the X- and Y-axis resizes the box (Fig. 3.14). After sizing the box 65 the left softkey 9 is released and the cursor 73 can be moved freely. The box can be dragged and dropped to the desired position by placing the cursor 71 in the box 65 and holding the left softkey 9 "Left-click" down whilst rotating the phone about the Y- and/or X-axis until the box has moved to the desired position. By releasing the left softkey 9 the boxed is dropped and the cursor 73 can move freely again. Thus, the part of the image in the box is cut from the original position and pasted to the new position.

In the same or manner any object e.g. text in a text editor program, or numbers/text in a spreadsheet can be marked, resized, dragged and dropped "click and drag" with the left softkey.

The most common "gestures" performed by moving the phone and pressing the softkeys are:

- point (to place the cursor over an object of the graphical user interface),
- 5 - left-click (to press and release the left softkey) to select the object which the cursor is placed,
- double-click (to press and release a softkey twice in rapid succession) to activate the object that the cursor is placed over,
- 10 - right-click (to press and release the right softkey) to call up a context-sensitive menu, and
- drag (to hold down the left softkey while moving the phone to move the cursor) to move or resize objects.

15 Figs. 3.11 to 3.13 show another method of manipulation magnified portion of an image. Fig. 3.11 shows the display 3 with an image of a several advanced type mobile phones. A magnifying window 103 enlarges a portion of the image to allow the user a view with both a good overview and the
20 possibility to view detail in a selected portion of the image. The magnifying window 103 can be moved over the display 3 by holding down the left softkey 9 "Navigate" whilst moving the phone in the direction of arrow 41' and/or arrow 40' (Fig. 3.12) to place the magnifying
25 window at the desired position (Fig 3.13). The magnifying factor of the magnifying window can be changed by moving the phone 1 in the direction of the Z-axis (not shown).

Fig 3.16 shows another example of the use of the present
30 intention in the form of an application for entering text. In the upper part of the display shows a string of characters already entered. A set of characters that can be entered, in this example the alphabet, is displayed below the upper part of the display. Other character sets
35 could comprise a number set or special signs set, etc.

The functionality of the left softkey 9 "Type" and the right softkey 9 "Options" is shown in the lower part of the display. One of the characters of the character set is marked by bold print. By rotating the phone about the Y-axis 40 the marking moves left or right. By rotating the phone about the X-axis 41 the marking moves up and down. The marked character is added to the string of characters by pressing the left softkey 9 "Type".

10 By pressing the right softkey "Options" a scrollable list of selectable menu items is displayed (not shown) comprising: "Clear last character", "Clear screen", "Number character set", "Symbol character set", and "Exit", one of the menu items being marked by inverse print. The list can be scrolled by rotating the phone about the Z-axis 41, and the marked menu item is selected by pressing the left softkey 9 "Select".

Fig 3.17 shows another example of the use of the present invention in the form of an application for entering musical notes in a stave 69. A cursor 73 (shape changed to a cross for this application) is used to indicate the position where a note is to be entered. By rotating the phone about the Y-axis 40 the cursor can be moved left and right. By rotating the phone about the X-axis 41 the cursor can move up and down.

The cursor is placed above the position in the stave at which a note is to be entered, higher tones are placed higher up in the stave and lower tones are placed lower in the stave. A tone is entered by pressing the left softkey 9 "Type". After typing a note the application prompts for entering the length of the note by displaying the text "Length? 1=1 2= $\frac{1}{2}$ 4= $\frac{1}{4}$ 8= $\frac{1}{8}$ " between the stave and the labels for the softkeys. The note length is entered by

pressing the alphanumeric key with the value associated with the desired note length.

By pressing the right softkey "Options" a scrollable list of selectable menu items is displayed (not shown) comprising: "Clear last note", "Clear stave", "Enter special notes", and "Exit", one of the menu items being marked by inverse print. The list can be scrolled by rotating the phone about the X-axis 41, and the marked menu item is selected by pressing the left softkey 9 "Select".

Fig. 3.18 shows another example of the use of the present invention in the form of an application simulating a labyrinth game. The player (user of the hand-held device) endeavors to guide a virtual ball 59 through a virtual labyrinth formed by virtual walls 57 on a virtual playing surface past a plurality of virtual openings 58 through which the virtual ball 59 may drop.

The application simulates the effect caused by gravity that tilting a real playing surface out of the horizontal plane has on a real ball, e.g. the virtual ball starts rolling to the lower side of the display 3 when the latter is tilted out of the horizontal plane. Also the effect of gravity on a real ball passing over a real opening is simulated by the application, e.g. the virtual ball drops through the virtual opening when it passes over a virtual opening.

At the start of the game, the display is held horizontally, or any other orientation that the user deems suitable as reference orientation to calibrate the virtual "horizontal" position of the display. The movement of the virtual ball over the virtual playing surface is controlled by moving the phone out of- and back into the

horizontal plane by rotating it rotating about the Y-axis
40 and/or the X-axis. The rotational movements are
detected from the changes between the succeeding images
captured by the camera and translated into changes in
5 speed and rolling direction of the virtual ball.

Fig 3.19 shows another example of the use of the present
invention in the form of an application for controlling
another computer game, in this example a car racing
10 simulation. The player (user of the hand-held device)
endeavors to "drive" a car around a racing circuit as fast
as possible. The application allows the player to control
the steering breaking and giving gas functions. The
imaginary view on the racing circuit is the main content
15 of the display, but is not shown on Fig. 3.19. The display
further shows a steering wheel and rearview mirrors. A
race is started by double clicking the left softkey 9
"Action". The control settings for speed and directions
are calibrated and set to zero for the present position
20 and orientation of the phone 1. After an audible start
signal the driver is supposed to attempt to follow the
displayed racing circuit. The "car" is steered by rotating
the phone about the z-axis 42. Rotating the phone
clockwise out of the calibrated position about the Z-axis
25 makes the "car" turn right. Rotating the phone further out
of the calibrated orientation, make the "car" turn sharper
and vice versa. Similarly, rotating the phone anti-
clockwise about the Z-axis out of the calibrated position
makes the "car" turn left. The speed of the "car" is
30 controlled by tilting the phone 1 about the X-axis 41.
Rotating the phone 1 out of the calibrated position in one
direction is used to give "gas". Rotating the phone 1
further out of the calibrated orientation increases the
amount of "gas", and vice versa. The amount of breaking
35 applied to the car is similarly controlled by rotating the
phone 1 out of the calibrated position in the opposite

direction. The user may select which direction of rotation about the X-axis is used to give "gas", whereby the breaking direction is always the opposite. Other computer games that can be controlled in a similar manner but using more axes of motion/control include motor bike racing, and helicopter flying. For motorbike racing the factor balance can be included in relation to motion about one of the axes, to produce a very realistic experience, with e.g. steering bar rotation connected to rotation about the Z-axis, giving gas and breaking connected to rotation about the X-axis and balance connected to translative motion along the X-axis. For enhancing the games the capacity of the mobile phone to generate sound via the loudspeaker, in particular a hands-free loudspeaker is used to simulate e.g. motor, and/or propeller sound. The vibrator function (not shown) of the mobile phone can be used to give feedback in connection with shocks and crashes.

Fig 3.20 shows another example of the use of the present invention in the form of an application for controlling the sound setting of a music player function of the phone. The application allows a user to control volume, bass and treble. The application shows a volume button, a bass button and a treble button on the display 3. The button that is to be manipulated is be marked by a higher line thickness (as shown for the "Volume" button in Fig. 3.20). The marking can be moved to other buttons by rotating the phone about the Y-axis 40. The marked button is manipulated by holding the left softkey 9 "Control" down while rotating the phone about the Z-axis 42. Clockwise rotation of the phone results in an increased setting of the parameter concerned, anticlockwise rotation of the phone results in a decreased setting of the parameter concerned. The application ends by pressing the right softkey 9 "Exit". Alternatively, the display shows slide control knobs for each of the parameters to be controlled

(not shown). The knob that is to be manipulated is be marked by a higher line thickness. The marking can be moved to other knobs by rotating the phone about the Y-axis 40. The marked knob is manipulated by holding the left softkey 9 "Control" down while moving the phone in the direction of the Z-axis 42. Moving the phone in the direction in which the display 3 is facing increases the parameter setting concerned, moving the phone in the opposite direction results in a decreased setting of the parameter concerned.

Another example of the use of the present invention is in connection with another terminal such as a PC (not shown). The motion signal of the phone is transmitted to the PC to control the movement of an object. The object could be a 3-D object displayed on a screen connected to the PC, whereby orientation changes of the phone are used to change the orientation of the displayed object. The orientation of the object on the screen can be completely synchronized with the orientation of the phone. After an initial calibration of the relative positions, e.g. when the phone is upright, the displayed object is also upright. For e.g. presenting a product, the product can be shown as an object on a large screen. To change the orientation of the object the user changes the orientation of the phone by rotating it, and the PC rotates the displayed object in the same way in response to the signal that it receives from the phone.

Another example of using the phone with another terminal, i.e. a workstation or a PC is for moving through an imaginary 3-D space displayed on a screen by e.g. a CAD program. The movements of the phone in the real 3-D world are incorporated in the signal that is sent to the workstation and the PC or workstation translates the signal to movements of the viewing position in the "3-D

space" displayed on the screen. Changes in the orientation of the phone are also incorporated in the signal that is sent to the workstation and translated to changes of the viewing direction in the "3-D space" displayed on the screen. Thus the user can "walk" through an imaginary room by walking around in the real world whilst holding or carrying the phone, and change the viewing direction by pointing the phone in the desired viewing direction. To facilitate this manner of use, the invention could be incorporated in a smaller device that is integrated in a helmet or mounted to another kind of headgear, so that viewing direction can be changed by the user turning his/her head in the desired direction of view.

This manner of controlling the viewing position and the viewing direction can equally well be used for computer games and any other software applications that display a virtual 3-D space on a screen, i.e. to move through and observe a room, or any other place created in a virtual world. Another example of a use of this manner of controlling is game application that guides, i.e. instructs a user to follow a virtual path and checks through the motion signal if the user really travels this path. Such games could be used by a group of users with interactive mobile phones in a suitable open space such as a sports ground.

Fig. 4 outlines the software flow diagram for the manipulation of an image as described with reference to Figs. 3.1 to 3.7. The flow from start 80 to end 98 is performed several times a second in a standard polling process of the processor 18. At the initialization step at block 82, the current view settings are marked. The label above the left softkey 9 is set to "Navigation" in block 84. The status of the left softkey 9 is checked in block 86. If the left softkey 9 is pressed, the system is set to

the navigation mode in block 88 and the label above the left softkey is changed to "Fixed".

At block 90 the camera image and auto focus settings are
5 acquired, stored and compared to the previous readings. If
a change in image or in auto focus setting is detected at
block 92, the program derives the movement of the phone 1
from the changes in block 94 and computes the new view
10 settings i.e. zoom factor, rotation angle and portion of
the image to be displayed. It also instructs the display
controller 31 to refresh the display 3 to show the new
view and it saves the present camera image as the basis
for comparison in the next iteration of the process.

15 In block 96 the status of the left softkey 9 is checked
and if it is pressed the process ends at block 98 until
the program is polled again. If the check for the left
softkey 9 is negative, the program goes to step 90 and the
above process repeats itself.

20

The program can be set with different response curves for
computing the new view setting in response to changes in
camera image and/or auto focus setting at block 94. Fine
or coarse modes of response can be set by the operator or
25 can be changed dynamically during the time the system is
in the navigation mode. With fine response, the display
view changes at a relatively slow rate in response to the
movements of the phone. With coarse response, the display
view changes rapidly in response to the movements of the
30 phone. The response can also be inverted to adapt to user
preferences.

The functionality associated with a given type of motion
of the phone 1 can be set. Thus, the user can e.g. set the
35 program such that the cursor 73 can be moved up and down
by rotation about the X- axis and can be moved left and

right by rotation about the Z-axis. Given types of motion of the phone 1 can be associated with functionality that does not relate to the display 3, such as sound settings (e.g. volume and balance) and display settings (e.g. 5 brightness, color balance and contrast).

Figs. 5 and 6 show an alternative preferred embodiment of a hand-held device according to the invention in the form of a communicator 101. The communicator 101 is basically 10 built up in the same way as the mobile phone 1 though with a larger display 103 and a larger keyboard 107. A camera 135 (only lens 136 is shown) is mounted in the back/bottom of the communicator and has the same functionality as the camera in the phone 1. The internal hardware is also build 15 up in the same way as the phone 1, but with increased processing power and a larger memory. Movements of the communicator 101 in the direction of or about the X-axis 141, the Y-axis 140 and Z-axis 142 have the same functionality as in the phone 1.

20

Although the present invention has been described in detail for purpose of illustration, it is understood that such detail is solely for that purpose, and variations can 25 be made therein by those skilled in the art without departing from the scope of the invention.

Thus, while the preferred embodiments of the devices and methods have been described in reference to the 30 environment in which they were developed, they are merely illustrative of the principles of the inventions. Other embodiments and configurations may be devised without departing from the scope of the appended claims.

CLAIMS:

1. A hand-held device comprising a processor, a digital camera for capturing motion video or still images, and
5 means for transforming a signal from the camera into a motion signal indicative of the motion of the hand-held device.
2. A hand-held device according to claim 1, further
10 comprising a user interface in which motion of the hand-held device is - through the motion signal derived thereof - used as a user input.
3. A hand-held device according to claim 1 or 2, further
15 comprising a display suitable for displaying captured images.
4. A hand-held device according to claim 3, in which
20 motion of a given type of the hand-held device is used to manipulate images shown at least in part on the display, preferably by moving the images in a manner substantially corresponding to the movement of the hand-held device.
5. A hand-held device according to claim 4, in which a
25 given type of motion the hand-held device is used to move, and/or zoom, and/or expand/collapse and/or rotate images displayed on the display.
6. A hand-held device according to claim 5, in which
30 motion substantially parallel to the plane of the display of the hand-held device is used to scroll an image displayed on the display, and/or motion substantially perpendicular to the plane of the display is used to zoom an image displayed on the display and/or rotational motion
35 of the hand-held device is used to rotate an image displayed on the display.

7. A hand-held device according to any of claims 4 to 6, in which the images are images previously captured by the camera.

5

8. A hand-held device according to any of claims 4 to 7, in which movement of image is inverted with respect to motion of the hand-held device.

10

9. A hand-held device according to any of claims 2 to 8, in which the user interface comprises a graphical user interface, and wherein motion of the hand-held device is used as an input to the graphical user interface.

15

10. A hand-held device according to claim 9, in which motion of the hand-held device is used to manipulate an object displayed by the graphical user interface, preferably by moving the object in a manner substantially corresponding to the motion or to the inverted motion of the hand-held device, whereby the object displayed by the graphical user interface can be, an icon, a dialogue box, a window, a menu or a pointer.

20

11. A hand-held device according to claim 9, in which motion of a given type of the hand-held device is used to move, and/or zoom, and/or expand/collapse and/or rotate objects displayed by the graphical user interface.

25

12. A hand-held device according to claim 11, in which motion substantially parallel to the plane of the display of the hand-held device is used to scroll an object displayed by the graphical user interface, and/or motion substantially perpendicular to the plane of the display is used to zoom an object displayed by the graphical user interface and/or rotational motion of the hand-held device

30

35

is used to rotate an object displayed by the graphical user interface.

13. A hand-held device according to any of claims 2 to 12,
5 in which the digital camera is detachable.

14. A hand-held device according to any of claims 2 to 13,
in which the digital camera is movable relative to the
hand-held device.

10

15. A hand-held device according to any of claims 2 to 14,
in which the means for transforming a signal from the
camera into a motion signal derives the motion signal from
changes between succeeding images, or parts of succeeding
15 images captured by the camera.

16. A hand-held device according to any of claims 2 to 15,
in which the camera has an autofocus system, whereby the
focusing setting of the autofocus system is used for
20 detecting movement in the camera direction.

17. A hand-held device according to any of claims 2 to 16,
further comprising at least one key, wherein the
functionality of a motion type is dependent on the state
25 of the at least one key.

18. A hand-held device according to any of claims 2 to 17,
in which rotational motion of the hand-held device about
an axis substantially perpendicular to the display results
30 in an inverse rotational movement of the image or
graphical user interface object relative to the display,
preferably in a manner such that the image or object is
static with respect to the fixed coordinate system in
which the hand-held device is situated.

35

19. A hand-held device according to any of claims 2 to 18, in which the motion signal is used to adjust device settings, the device settings preferably comprising sound settings and display settings.

5

20. A hand-held device according to any of claims 9 to 19, further comprising a keypad with at least a first- and a second key and the graphical user interface comprises a cursor, whereby motion of the hand-held device is used to
10 position the cursor over an object of the graphical user interface and primary functions associated with the object concerned are activated by pressing the first key and secondary functions associated with the object of the concerned are activated by pressing the second key.

15

21. A hand-held device according to claim 20, in which the functionality of the first key is associated with selection and activation of objects of the graphical user interface, and in which the functionality of the second
20 key is preferably associated with calling up a context-sensitive menu.

22. A hand-held device according to claim 21, in which selection of the object concerned is performed by pressing
25 and releasing the first key, and activation of the object concerned is preferably performed by pressing and releasing the first key twice in rapid succession.

23. A hand-held device according to claim 21 or 22, in
30 which moving or resizing of the object concerned is performed by holding down the first key while moving the hand-held device to move the cursor.

24. A hand-held device according to any of claims 20 to
35 23, in which the first key and the second key are softkeys whereby the current functionality of the softkeys is

shown in the display, preferably in dedicated fields of the display.

25. A hand-held device according to claim 24, in which the
5 first key is placed below the display on the left side of the latter, preferably proximate to lower edge of the display, and the second key is placed below the display on the right side of the latter, preferably proximate to lower edge of the display.

10

26. A hand-held device according to any of claims 1 to 25, further comprising at least one gravity based tilt sensor, and whereby the signal from the at least one tilt sensor is used in combination with the signal from the camera for
15 creating the motion signal.

27. A hand-held device according to claim 26, wherein a tilt sensor is associated with the X-axis and/or a tilt sensor is associated with the Z-axis.

20

28. A hand-held device according to claim 27, wherein the signal from the at least one tilt sensor is used to determine the absolute orientation of the handheld device relative to the direction of the gravitational pull.

25

29. A hand-held device according to any of claims 1 to 28, further comprising means for sending the motion signal to another terminal via cable, infrared waves or radio frequency waves.

30

30. A system comprising a hand-held device according to claim 29 and a terminal capable of displaying imaginary three-dimensional objects on a two-dimensional screen, said terminal comprising means to change the orientation
35 of the displayed object in response to signals received from the handheld device, whereby orientation changes of

the hand-held device are translated to corresponding orientation changes of the displayed object.

31. A system according to claim 30, in which position
5 changes of the handheld device are translated to position changes of the displayed object.

32. A system comprising a hand-held device according to
claim 29 and a terminal capable of displaying an imaginary
10 three-dimensional space on a two-dimensional screen, said terminal comprising means to change the viewing position in the imaginary three-dimensional space in response to signals received from the handheld device, whereby positional changes of the hand-held device are translated
15 to corresponding changes in the viewing position.

33. A system according to claim 30, in which orientation changes of the handheld device are translated into corresponding changes in the viewing direction in the
20 imaginary three-dimensional space.

34. A method for creating user input for a hand-held device that has a processor, a user interface and a digital camera for capturing motion video or still images
25 comprising the steps of:

determining motion of the hand-held device from the camera signal;
using the determined motion of the hand-held device as an input for the user interface.

30

35. Use of a digital camera for capturing motion video or still images of a hand-held device that has a processor to produce a motion signal indicative of motion of the hand-held device.

35

36. A hand-held device comprising a processor, means for sensing motion of the hand-held device, a display, a keypad with at least a first- and a second key, a graphical user interface with objects and a cursor, and
5 means for transforming the sensed motion of the handheld device into a signal suitable for moving the cursor over the display.

37. A hand-held device according to claim 36, in which
10 motion of the hand-held device is used to position the cursor over an object of the graphical user interface and primary functions associated with the object concerned are activated by pressing the first key and secondary functions associated with the object concerned are
15 activated by pressing the second key.

38. A hand-held device according to claim 37, in which the functionality of the first key is associated with selection and activation of objects of the graphical user
20 interface, and in which the functionality of the second key is preferably associated with calling up a context-sensitive menu.

39. A hand-held device according to claim 38, in which
25 selection of the object concerned is performed by pressing and releasing the first key, and activation of the object concerned is preferably performed by pressing and releasing the first key twice in rapid succession.

30 40. A hand-held device according to claim 38 or 39, in which moving or resizing of the object concerned is performed by holding down the first key while moving the hand-held device to move the cursor and the object concerned in unison therewith.

35

41. A hand-held device according to any of claims 36 to 40, in which the first key and the second key are softkeys whereby the current functionality of the softkeys is shown in the display, preferably in dedicated fields of the display.
5

42. A hand-held device according to claim 41, in which the first key is placed below the display on the left side of the latter, preferably proximate to lower edge of the display, and the second key is placed below the display on the right side of the latter, preferably proximate to lower edge of the display.
10

43. A hand-held device according to any of claims 36 to 42, in which said means for transforming motion of the handheld device into a signal suitable for moving the cursor over the display comprises a tilt sensor and/or an image capturing device and/or an accelerometer.
15

44. A hand-held device according to claim 43, in which said image capturing device is a motion video or still image digital camera.
20

45. A hand-held device according to any of claims 36 to 44, further comprising means to transform a signal from the camera and/or tilt sensor and/or accelerometer into a position signal for the cursor.
25

46. A hand-held device according to claim 45, in which said means for transforming a signal from the camera into a motion signal derives the motion signal from changes between succeeding images, or parts of succeeding images captured by the camera.
30

47. A hand-held device according to any of claims 44 to 46, in which the camera has an autofocus system, whereby
35

the focusing setting of the autofocus system is used for detecting movement in the camera direction.

48. A hand-held device according to any of claims 36 to
5 47, in which the graphical user interface includes one or more of the following object types: icons, dialogue boxes, windows, menus, pointers.

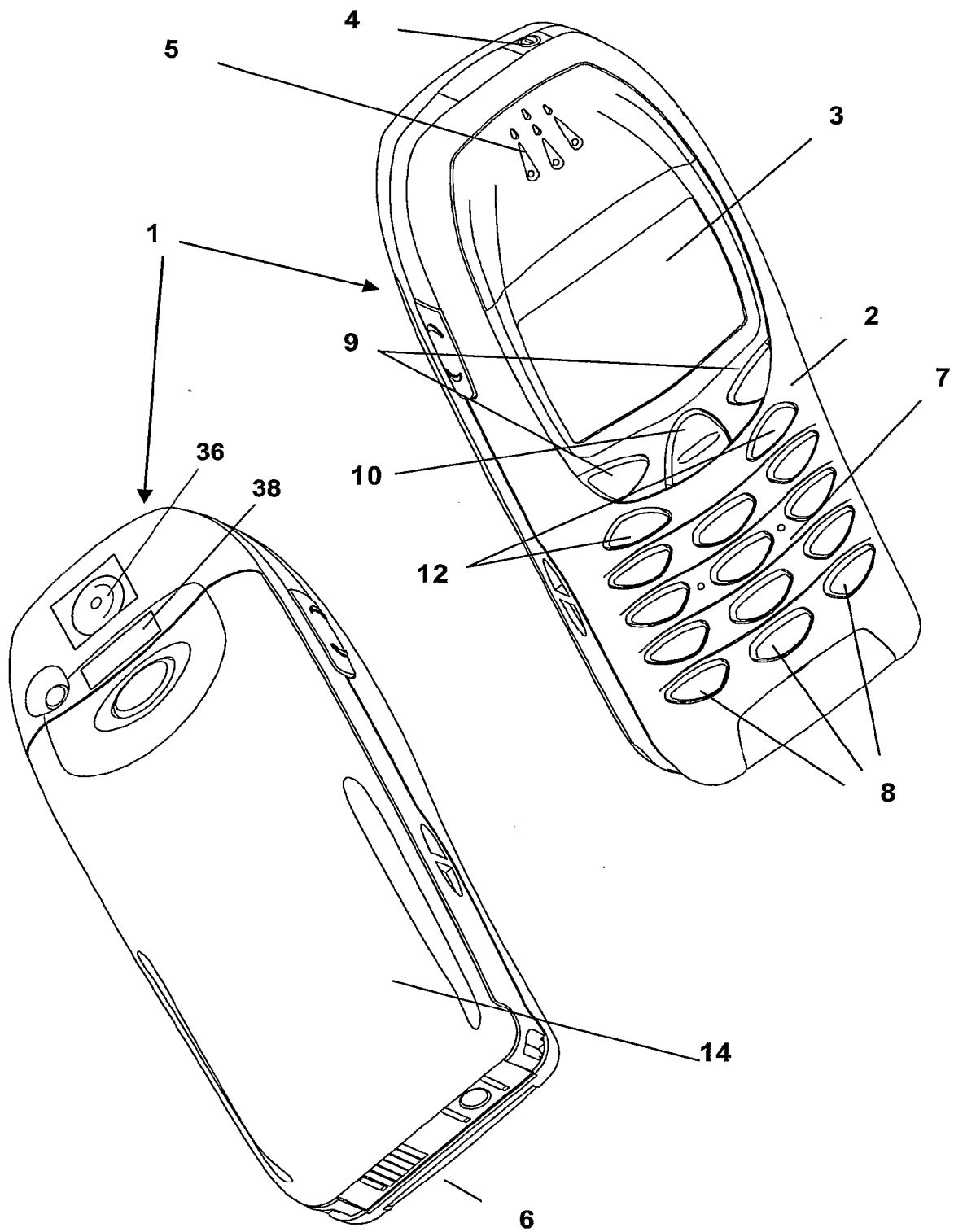


Fig. 1

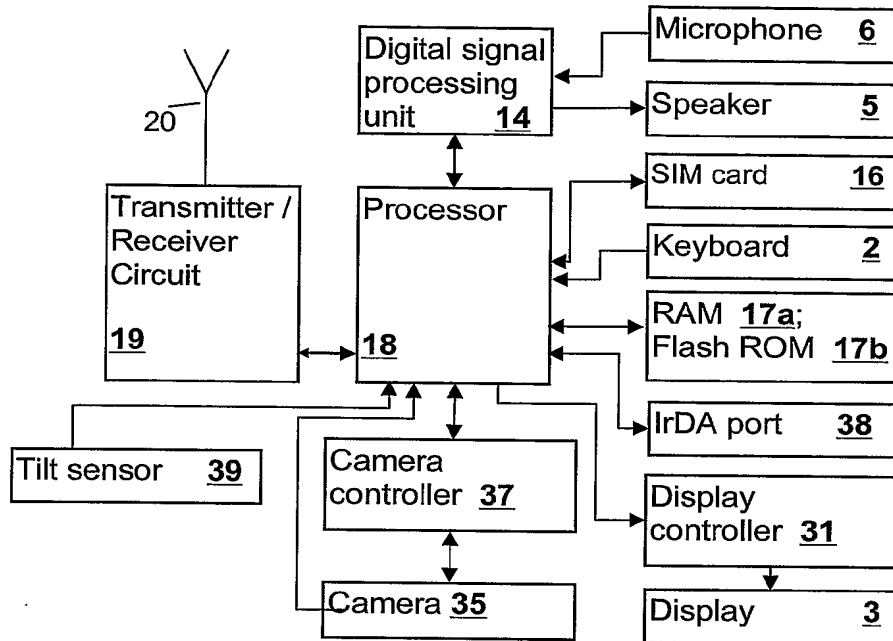


Fig. 2

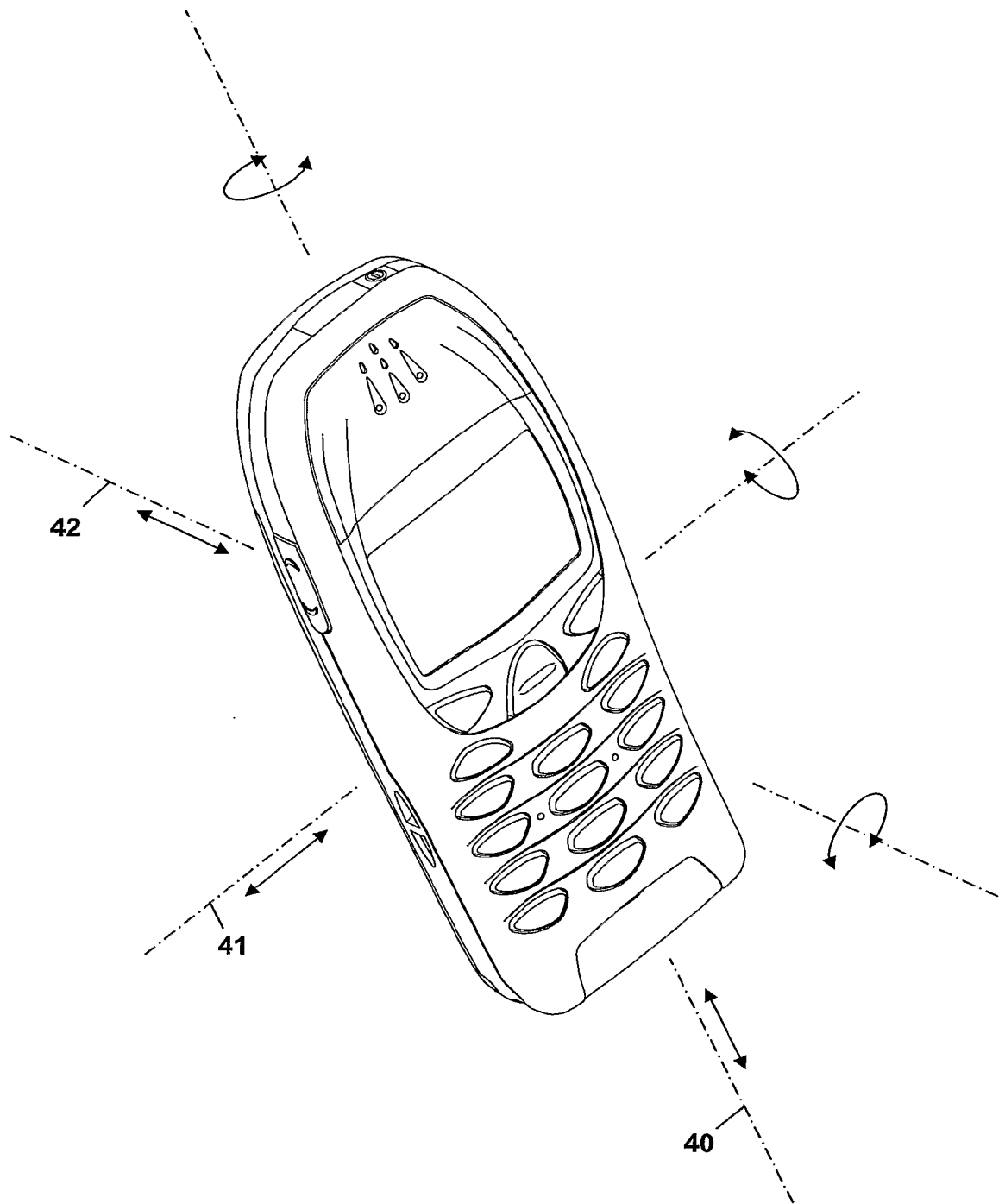


Fig. 3

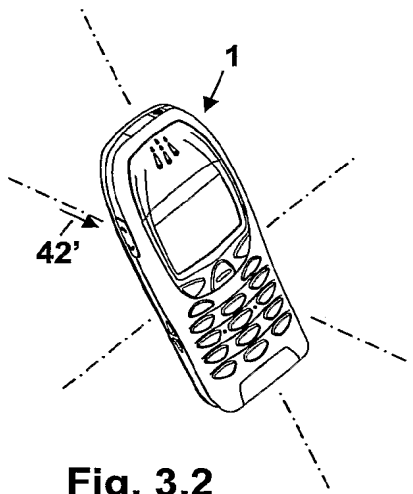


Fig. 3.2

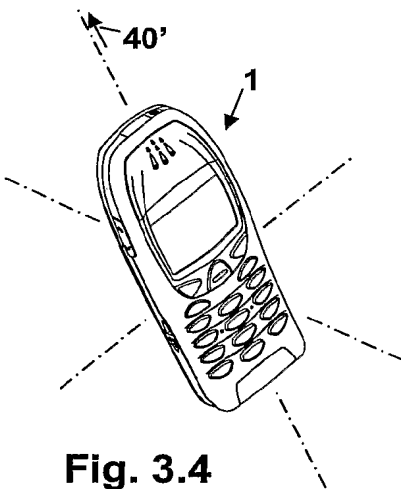


Fig. 3.4

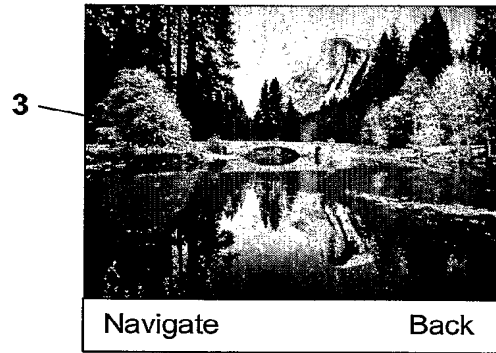


Fig. 3.1

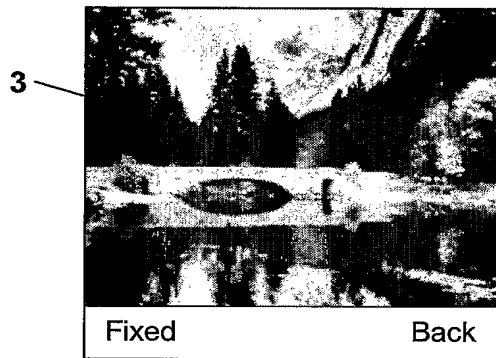


Fig. 3.3

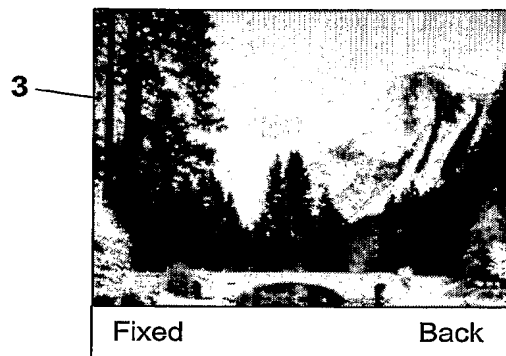


Fig. 3.5

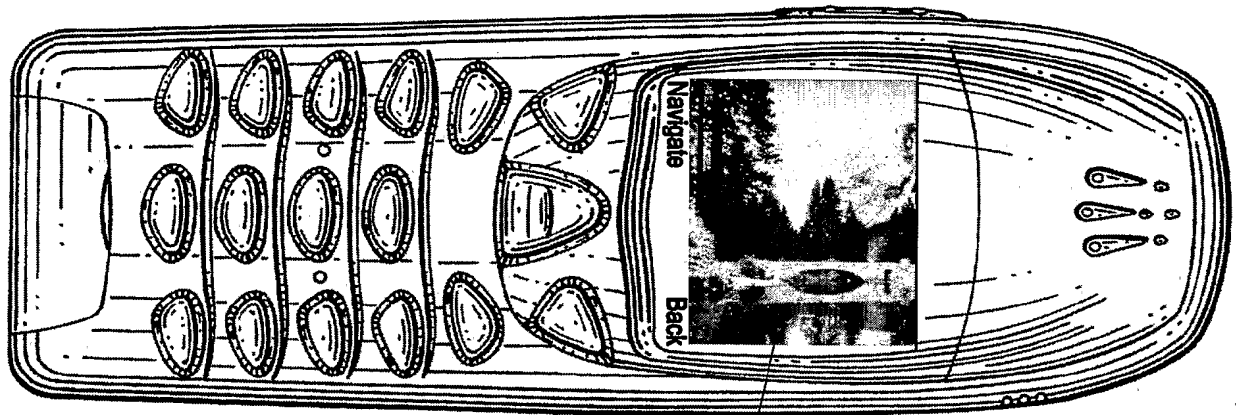


Fig. 3.6

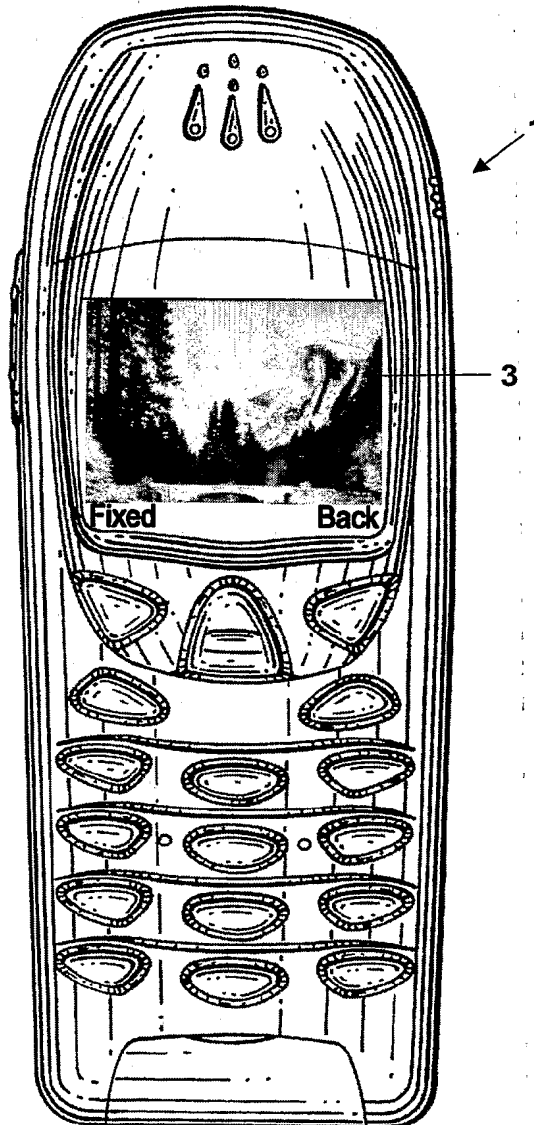
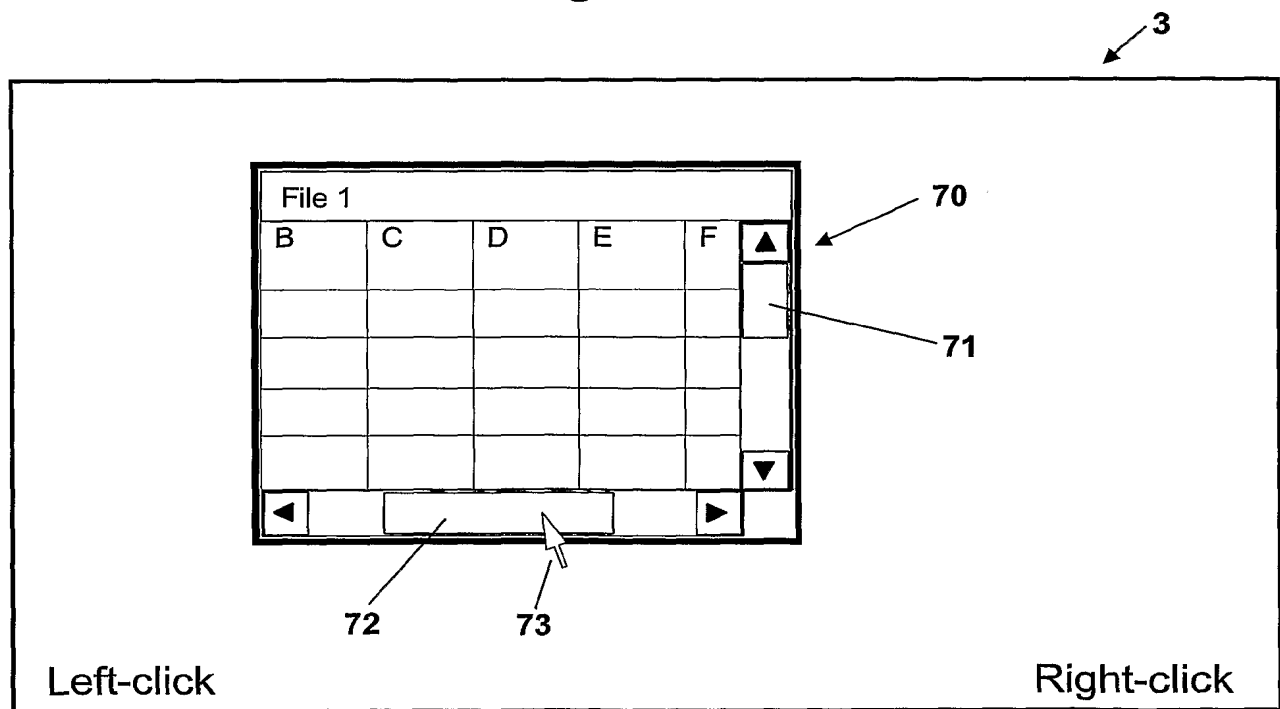
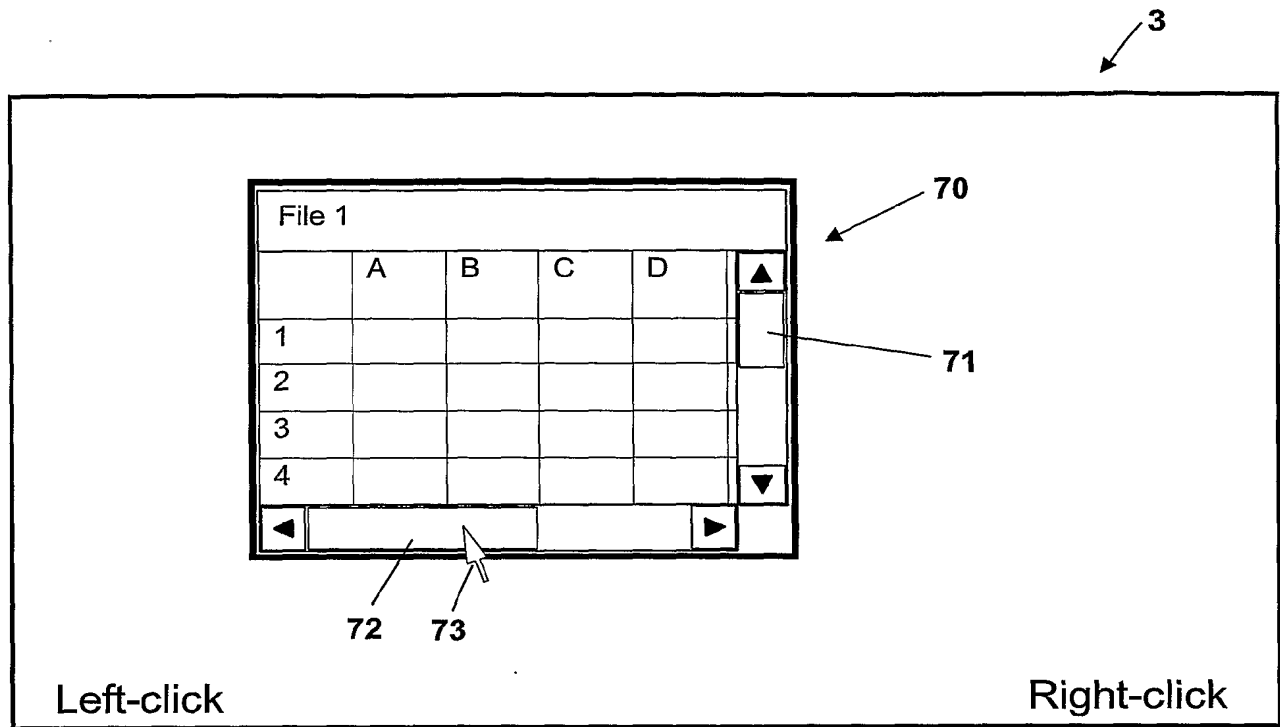


Fig. 3.7



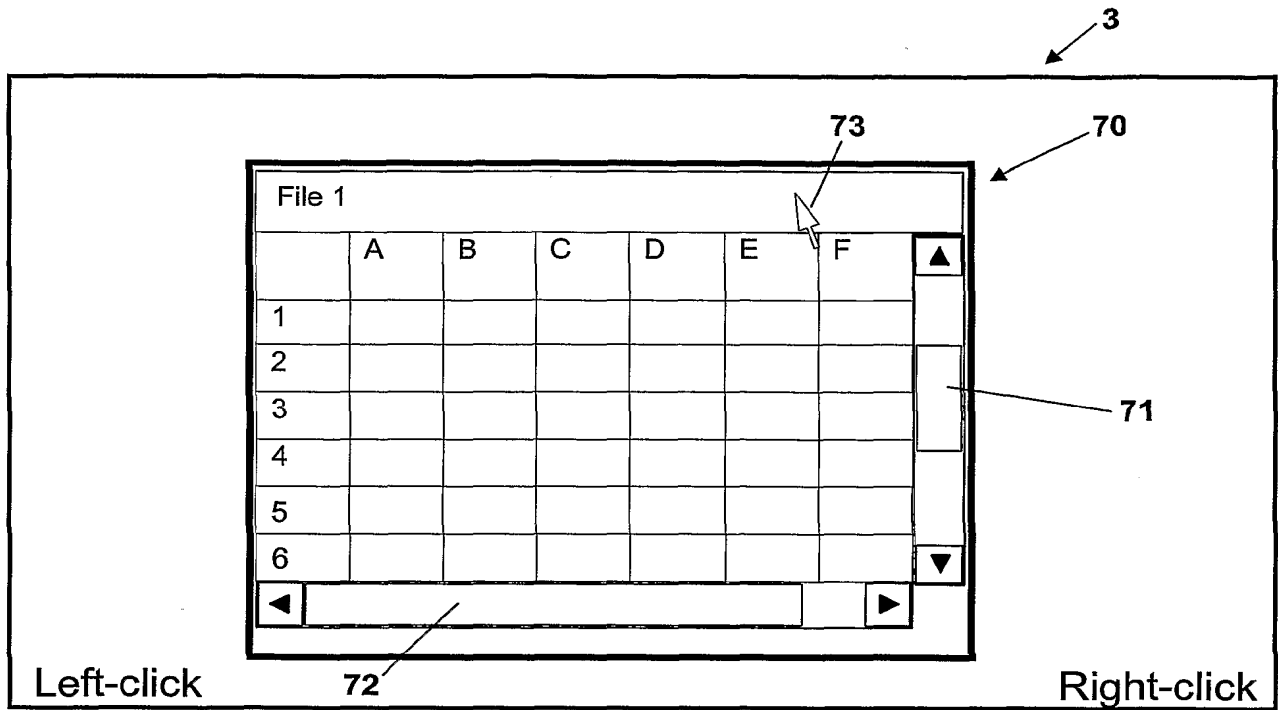


Fig. 3.10

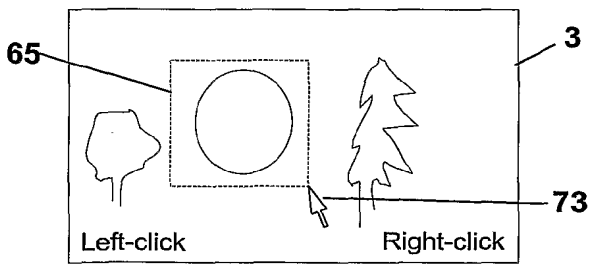


Fig. 3.14

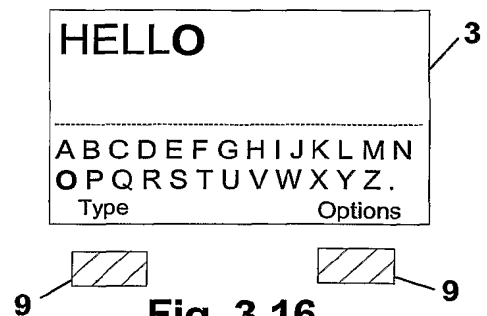


Fig. 3.16

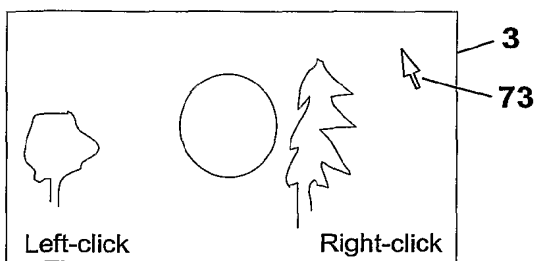


Fig. 3.15

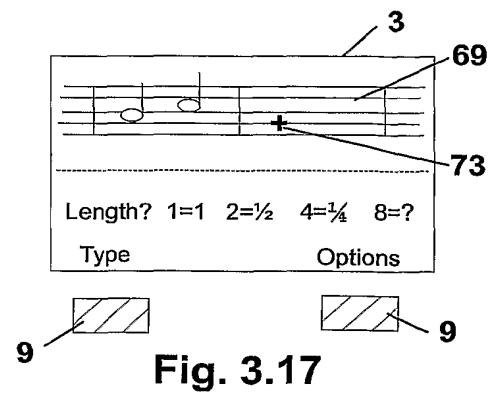


Fig. 3.17

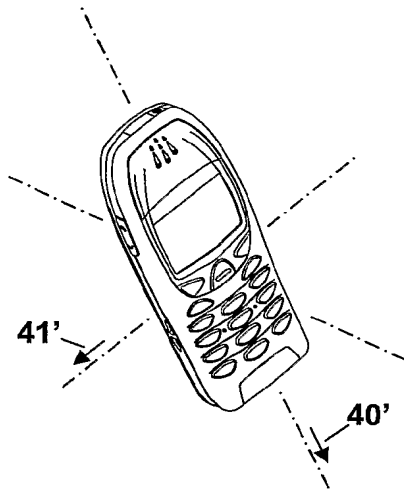


Fig. 3.12

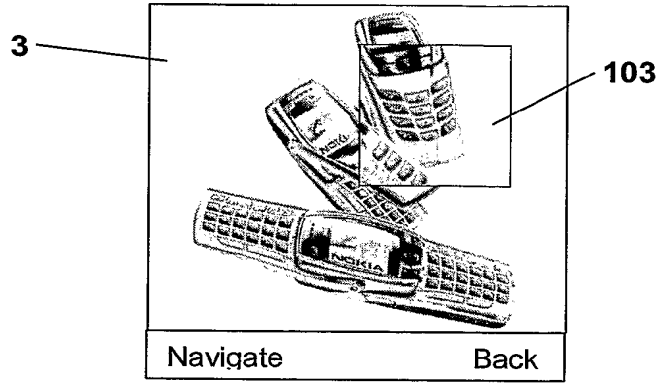


Fig. 3.11

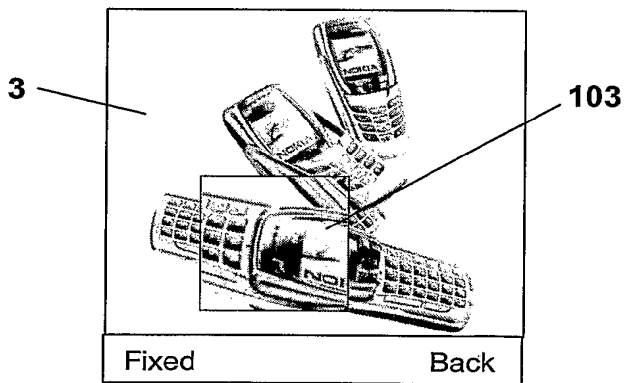


Fig. 3.13

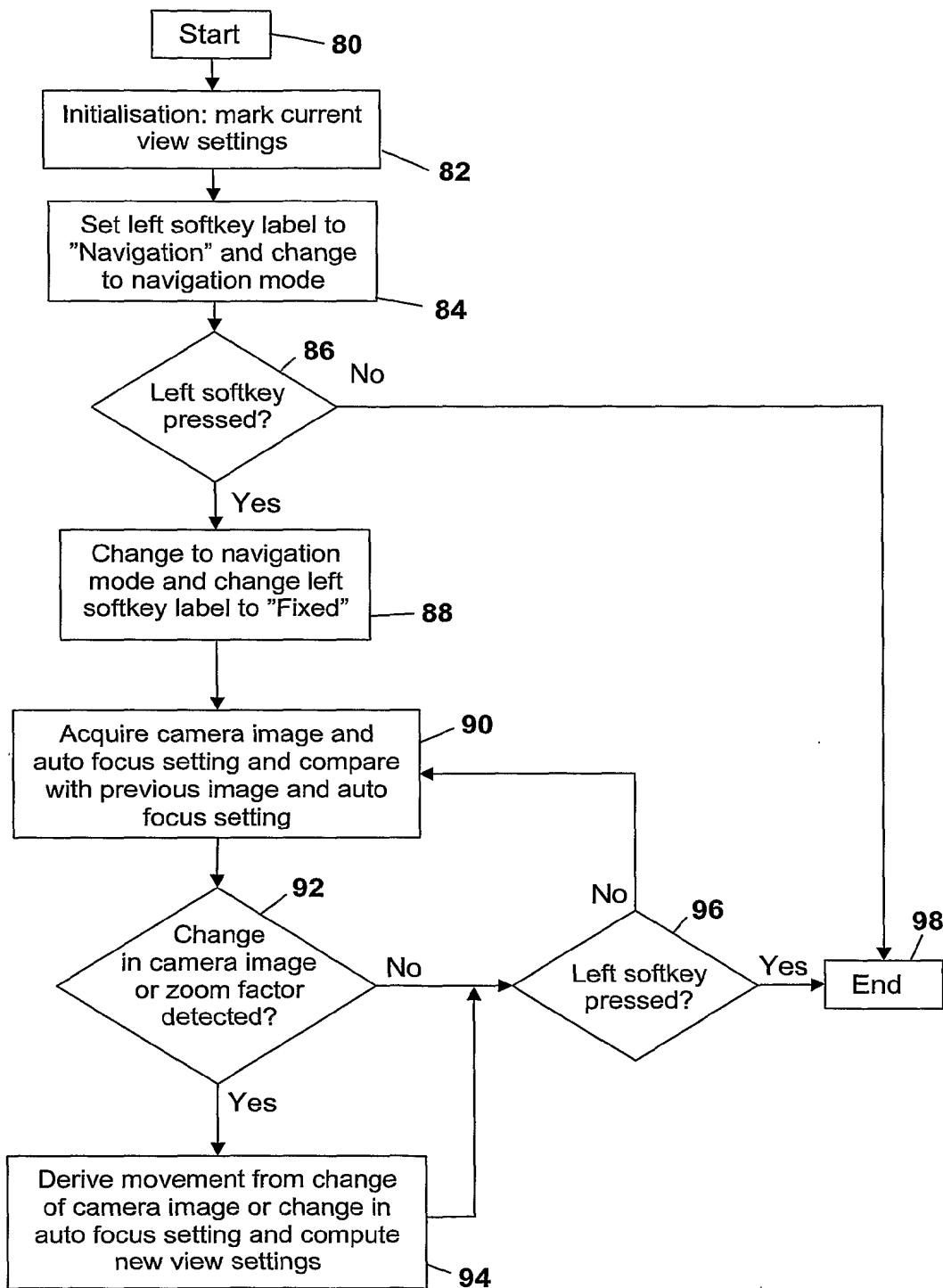


Fig. 4

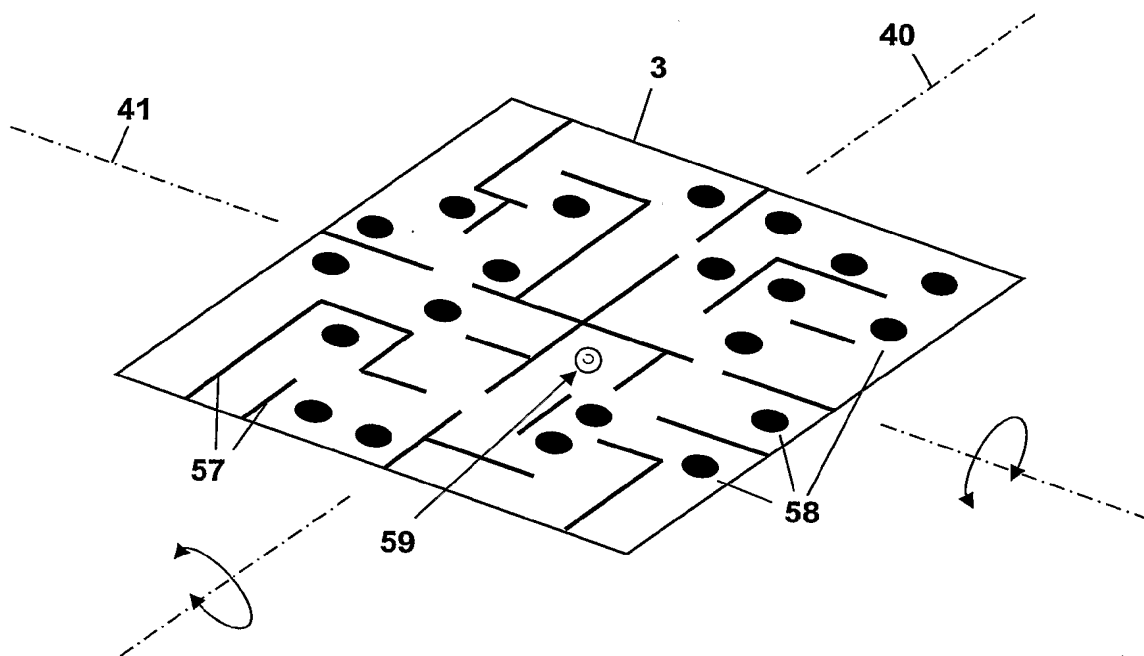


Fig. 3.18

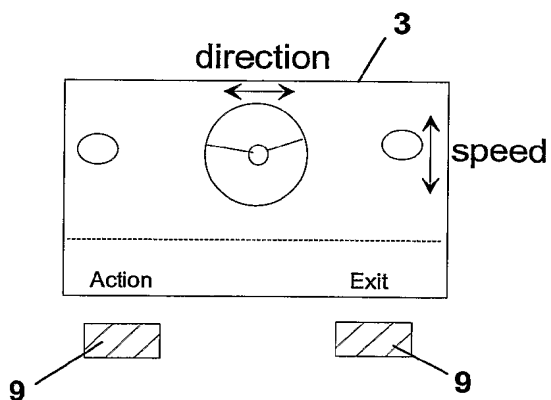


Fig. 3.19

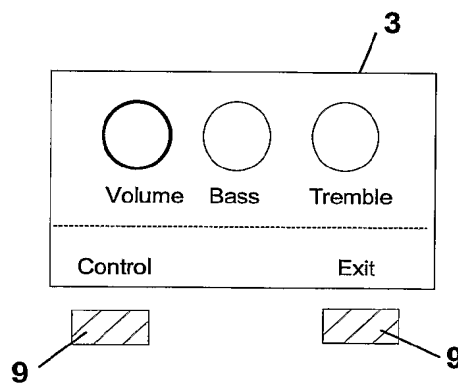


Fig. 3.20

11/12

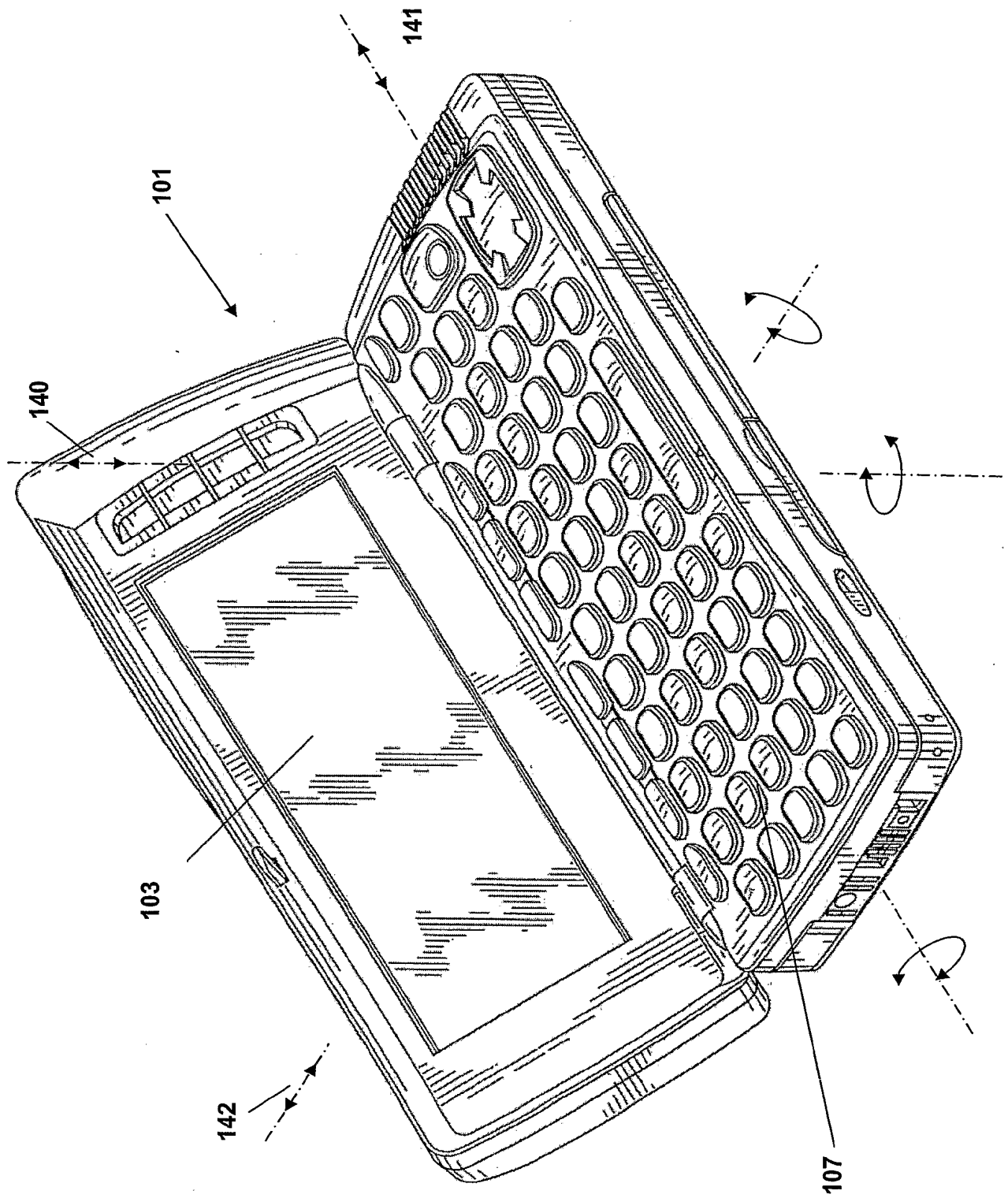


Fig. 5

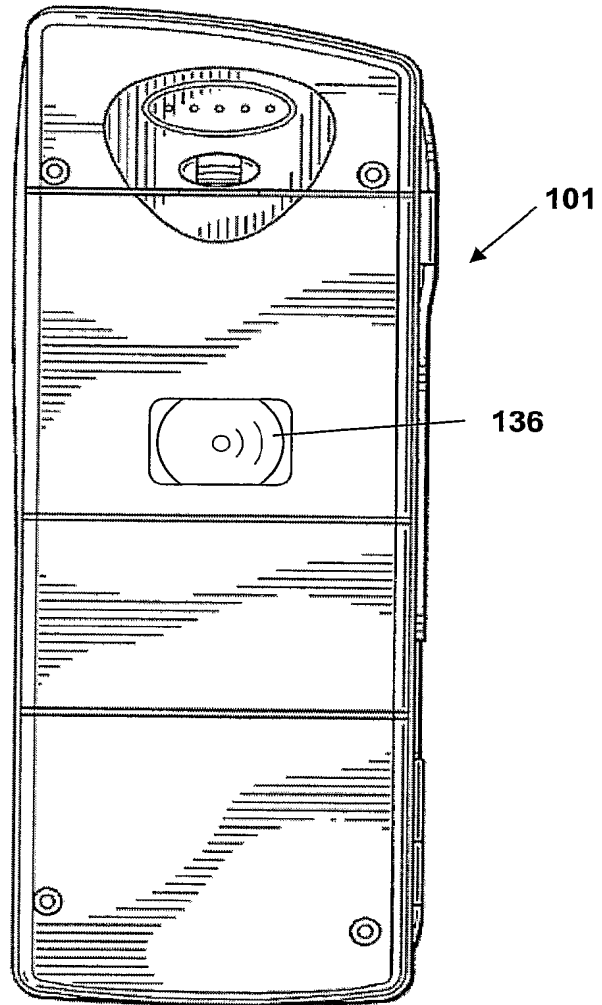


Fig. 6

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 03/00607

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H04N5/225 H04N7/14 H04M1/725 H04N5/232 H04M1/247

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04N H04M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 01 86920 A (LAPIDOT ZVI) 15 November 2001 (2001-11-15)	1-7, 9-12, 15, 17, 20, 21, 24, 25, 34-38, 41-46
Y	page 5, line 15 -page 11	16, 26-29, 47
Y	EP 0 884 905 A (NOKIA MOBILE PHONES LTD) 16 December 1998 (1998-12-16) page 3, line 39 -page 5, line 34	16, 47
Y	EP 1 246 464 A (MITSUBISHI ELECTRIC CORP) 2 October 2002 (2002-10-02) paragraph '0041! - paragraph '0066!	26-28
	-/--	

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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Date of the actual completion of the international search

19 June 2003

Date of mailing of the international search report

26/06/2003

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Authorized officer

Materne, A

INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 03/00607

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 01 97495 A (SLOTZNICK BENJAMIN) 20 December 2001 (2001-12-20) page 8, line 20 -page 24 -----	29
X	EP 1 071 285 A (TEXAS INSTRUMENTS FRANCE ;TEXAS INSTRUMENTS INC (US)) 24 January 2001 (2001-01-24) column 5 -column 10, line 2 -----	1,34
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A	WO 01 78055 A (FEINSTEIN DAVID Y) 18 October 2001 (2001-10-18) cited in the application page 8, line 11 -page 22 -----	1-48
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 03/00607

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US 2002160724	A1	31-10-2002	JP 2001245267 A CN 1363182 T GB 2364194 A WO 0163926 A1	07-09-2001 07-08-2002 16-01-2002 30-08-2001

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	SYSTEM WITH 3D USER INTERFACE INTEGRATION
First Named Inventor/Applicant Name:	Henrik OJELUND
Filer:	William C. Rowland/Albina Torres-Price
Attorney Docket Number:	00791.24-000070

Filed as Small Entity

U.S. National Stage under 35 USC 371 Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Basic National Stage Fee	2631	1	140	140

Pages:

Claims:

Miscellaneous-Filing:

Petition:

Patent-Appeals-and-Interference:

Post-Allowance-and-Post-Issuance:

Extension-of-Time:

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Miscellaneous:				
Total in USD (\$)				140

Electronic Acknowledgement Receipt

EFS ID:	15940386
Application Number:	13991513
International Application Number:	PCT/DK11/50461
Confirmation Number:	9282
Title of Invention:	SYSTEM WITH 3D USER INTERFACE INTEGRATION
First Named Inventor/Applicant Name:	Henrik OJELUND
Customer Number:	21839
Filer:	William C. Rowland/Albina Torres-Price
Filer Authorized By:	William C. Rowland
Attorney Docket Number:	0079124-000070
Receipt Date:	04-JUN-2013
Filing Date:	
Time Stamp:	14:50:22
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	\$140
RAM confirmation Number	1351
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
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1	Transmittal of New Application	TransmittalLetter.pdf	191067 5f5fe509426777698082e8084bc97d16a93fcb71	no	3
Warnings:					
Information:					
2	Application Data Sheet	ADS.pdf	106691 80dd33505a431c6bb43291fe78d624d9c5556181	no	7
Warnings:					
Information:					
This is not an USPTO supplied ADS fillable form					
3		SpecClaimsAbst.pdf	140547 ce4d1f844cd6ed161d1b3e3878d9c0cb7fb6278c	yes	41
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Specification		1	33	
	Claims		34	40	
	Abstract		41	41	
Warnings:					
Information:					
4	Drawings-only black and white line drawings	Drawings.pdf	978997 fbd35892f5d35e2be4ae0cdaad4d7b2e11cc8581	no	5
Warnings:					
Information:					
5	Documents submitted with 371 Applications	PCTIB301.pdf	62495 448f15cedbeb3d50cc0219be9d67c3dbf07c3c52	no	1
Warnings:					
Information:					
6	Documents submitted with 371 Applications	PCTIB304.pdf	76457 b5e6dff5f0be28ec9810e3307f1e21695fcb61f7	no	1
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7	Documents submitted with 371 Applications	PCTIB306.pdf	59475 e6898971dff9e49d2c9189ca9f7e57bd690b90	no	1
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8	Documents submitted with 371 Applications	PCTIB308.pdf	147560	no	2
			4509db4450a8cf01d1bb7ff625072bb37bfad b40d		
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9	Documents submitted with 371 Applications	PCTIB311.pdf	44667	no	1
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10	Transmittal Letter	IDS.pdf	30619	no	1
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Information:					
Total Files Size (in bytes):			5010855		

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.



Kingdom of Denmark

Patent application No.: PA 2010 01104

Date of filing: 6 December 2010

Applicant:
(Name and address) 3Shape A/S
Holmens Kanal 7, 4
1060 København K
Denmark

Title: System with 3D user interface integration

IPC: (I): G 01 B 11/24 (2006.01), A 61 C 13/00 (2006.01), G 06 F 1/00 (2006.01)

This is to certify that the attached documents are exact copies of the above mentioned patent application as originally filed.

20 December 2011

Danish Patent and Trademark Office
Ministry of Economic and Business Affairs
General Director Jesper Kongstad

System with 3D user interface integration

Field of the invention

5

This invention generally relates to a method and a system comprising a handheld device and at least one display.

Background of the invention

10

3D visualization is important in many fields of industry and medicine, where 3D information is becoming more and more predominant.

15

Displaying and inspecting 3D information is inherently difficult. To fully understand a 3D object or entire environment on a screen, the user should generally be able to rotate the object or scene, such that many or preferentially all surfaces are displayed. This is true even if for 3D displays, e.g. stereoscopic or holographic, where from a given viewing position and with a given viewing angle, the user will only see some surfaces of an arbitrary 3D environment. Often, the user will also want to zoom into details or zoom out for an overview.

20

25

Various user interaction devices are in use for software that displays 3D data; these devices are: 3D mice, space balls, and touch screens. The operation of these current interaction devices requires physically touching them.

30

Physically touching a user-interaction device can be a disadvantage in medical applications due to risks of cross-contamination between patients or between patient and operator, or in industrial applications in dirty environments.

Several non-touch user interfaces for 3D data viewing in medical applications have been described in the literature. Vogt et al (2004) describe a touchless interactive system for in-situ visualization of 3D medical imaging data. The user interface is based on tracking of reflective markers, where a camera is mounted on the physician's head. Graetzel et al (2004) describe a touchless system that interprets hand gestures as mouse actions. It is based on stereo vision and intended for use in minimally invasive surgery.

It remains a problem to improve systems that require user interfaces for view control, which for example can be used for clinical purposes.

Summary

Disclosed is a system comprising a handheld device and at least one display, where the handheld device is adapted for performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment, and where the handheld device is adapted for remotely controlling the view with which said 3D environment is represented on the display

The system disclosed here performs the integration of 3D user interface functionality with any other handheld device with other operating functionality, such that the operator ideally only touches this latter device that is intended to be touched. A particular example of such a handheld device is one that records some 3D geometry, for example a handheld 3D scanner.

The handheld device is a multi-purpose device, such as a dual-purpose or two-purpose device, i.e. a device both for performing actions in the physical 3D environment, such as measuring and manipulating, and for remotely controlling the view of the 3D environment on the display.

Geometrically, a view is determined by the virtual observer's/camera's position and orientation relative to the 3D environment or its visual representation. If the display is two-dimensional, the view is also determined by the type of projection. A view may also be determined by a magnification factor.

The virtual observer's and the 3D environment's position and orientation are always relative to each other. In terms of user experience in software systems with 3D input devices, the user may feel that for example, he/she is moving the 3D environment while remaining stationary himself/herself, but there is always an equivalent movement of the virtual observer/camera that gives the same results on the display. Often, descriptions of 3D software systems use the expression "pan" to indicate an apparent translational movement of the 3D environment, "rotate" to indicate a rotational movement of the 3D environment, and "zoom" to indicate a change in magnification factor.

Graphically, a view can represent a 3D environment by means of photographs or as some kind of virtual representation such as a computer graphic, or similar. A computer graphic can be rendered for example with texture and/or shading and/or virtual light sources and/or light models for surface properties. A computer graphic can also be a simplified representation of the 3D environment, for example a mesh, an outline, or an otherwise simplified representation. All or parts of the 3D environment can also be rendered with some degree of transparency. A view may represent the 3D environment in total or only parts thereof.

All of the touch-less prior art systems are 3D user interface devices only. In many prior art applications, the operator using such user interface device will also hold and work with another device that really is the central device in the overall application, e.g. a medical instrument.

It is thus an advantage of the present system that the 3D user-interface functionality is integrated in the central device, which is used for performing some kind of action.

5

In some embodiments the handheld device is adapted for remotely controlling the magnification with which the 3D environment is represented on the display.

10 In some embodiments the handheld device is adapted for changing the rendering of the 3D environment on the display.

In some embodiments the view is defined as viewing angle and/or viewing position.

15

In some embodiments the at least one action comprises one or more of the actions of:

- measuring,

- recording,

20 - scanning,

- manipulating,

- modifying.

25 In some embodiments the 3D environment comprises one or more 3D objects.

In some embodiments the handheld device is adapted to be held in one hand by an operator.

30 In some embodiments the display is adapted to represent the 3D environment from multiple views.

In some embodiments the display is adapted to represent the 3D environment from different viewing angles and/or viewing positions.

- 5 In some embodiments the view of the 3D environment in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

- 10 In some embodiments the magnification represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

In some embodiments the handheld device is adapted to record the 3D geometry of the 3D environment.

- 15 Thus the handheld device may be an intraoral dental scanner, which records the 3D geometry of a patient's teeth. The operator may move the scanner along the teeth of the patient for capturing the 3D geometry of the relevant teeth, e.g. all teeth. The scanner may comprise motion sensors for taken the movement of the scanner into account while creating the 3D model of the scanned teeth.

20 The 3D model of the teeth may be shown on a display, and the display may for example be a PC screen and/or the like.

- 25 The user interface functionality may comprise incorporating motion sensors in the scanner to provide that the user can determine the view on the screen by moving the scanner. Pointing the scanner down can provide that the scanned teeth are shown given a downward viewing angle. Holding the scanner in a horizontal position can provide that the viewing angle is likewise horizontal.

30

In some embodiments the handheld device comprises at least one user-interface element.

The system may be equipped with a button as an additional element providing the user-interface functionality.

5

In an example the handheld device is a handheld intraoral scanner, and the display is a computer screen. The operator or user may be a dentist, an assistant and/or the like. The operation functionality of the device may be to record some intraoral 3D geometry, and the user interface functionality may be to rotate, pan, and zoom the scanned data on the computer screen.

10

In some embodiments the at least one user-interface element is at least one motion sensor.

Thus the integration of the user interface functionality in the device may be provided by motion sensors, which can be accelerometers inside the scanner, whose readings determine the orientation of the display on the screen of the 3D model of the teeth acquired by the scanner. Additional functionality, e.g. to start/stop scanning, may be provided by a button. The button may be located where the operator's or user's index finger can reach it conveniently.

15

20

Prior art intraoral scanners use a touch screen, a trackball, or a mouse to determine the view in the display. These prior art user interface devices can be inconvenient, awkward and difficult to use, and they can be labor-intensive, and thus costly to sterilize or disinfect. An intraoral scanner should always be disinfected between scanning different patients, because the scanner is in and may come in contact with the mouth or other parts of the patient being scanned.

25

30

The operator or user, e.g. dentist, may use one hand or both hands to hold the intraoral scanner while scanning, and the scanner may be light enough

and comfortable to be held with just one hand for a longer time while scanning.

5 The device can also be held with one or two hands, while using the device as remote control for e.g. changing the view in the display. It is an advantage of the touchless user interface functionality that in clinical situations, the operator can maintain both hands clean, disinfected, or even sterile.

10 An advantage of the system is that it allows an iterative process of working in a 3D environment without releasing the handheld device during said process. For the above intraoral scanning system example, the operator, e.g. dentist, can record some teeth surface geometry with a handheld device that is an intraoral scanner, inspect coverage of the surface recording by using that same handheld device to move, e.g. rotate, the recorded surface on the display, e.g. a computer screen, detect possible gaps or holes in the coverage of the scanned teeth, and then for example arrange the scanner in the region where the gaps were located and continue recording teeth surface geometry there. Over this entire iterative cycle, which can be repeated more than once, such as as many times as required for obtaining a desired scan coverage of the teeth, the dentist does not have to lay the handheld intraoral scanner out of his or her hands.

25 In some embodiments, the 3D user interface functionality is exploited in a separate location than the operation functionality. For the above intraoral scanning system example, the scanning operation is performed in the oral cavity of the patient, while the user interface functionality is more flexibly exploited when the scanner is outside the patient's mouth. The key characteristic and advantage of the system, again, is that the dentist can exploit the dual and integrated functionality, that is operation and user interface, of the scanner without laying it out of his or her hands.

The above intraoral scanning system is an example of an embodiment. Other examples for operation functionality or performing actions could be drilling, welding, grinding, cutting, soldering, photographing, filming, measuring, executing some surgical procedure etc..

5

The display of the system can be a 2D computer screen, a 3D display that projects stereoscopic image pairs, a volumetric display creating a 3D effect, such as a swept-volume display, a static volume display, a parallax barrier display, a holographic display etc.. Even with a 3D display, the operator has only one viewing position and viewing angle relative to the 3D environment at a time. The operator can move his/her head to assume another viewing position and/or viewing angle physically, but generally, it may be more convenient to use the handheld device with its built-in user interface functionality, e.g. the remote controlling, to change the viewing position and/or viewing angle represented in the display.

10
15

In some embodiments the system comprises multiple displays, or one or more displays that are divided into regions. For example, several sub-windows on a PC screen can represent different views of the 3D environment. The handheld device can be used to change the view in all of them, or only some of them.

20

In some embodiments the user interface functionality comprises the use of gestures.

25

Gestures made by e.g. the operator can be used to change, shift or toggle between sub-windows, and the user-interface functionality can be limited to an active sub-window or one of several displays.

30

In some embodiments the gestures are adapted to be detected by the at least one motion sensor. Gestures can alternatively and/or additionally be detected by range sensors or other sensors that record body motion.

The operator does not have to constantly watch the at least one display of the system. In many applications, the operator will shift between viewing and possible manipulating the display and performing another operation with the handheld device. Thus it is an advantage that the operator does not have to touch other user interface devices. However, in some cases it may not be possible for the operator to fully avoid touching other devices, and in these cases it is an advantage that fewer touches are required compared to a system where a handheld device does not provide any user interface functionality at all.

In some embodiments the at least one display is arranged separate from the handheld device.

In some embodiments the at least one display is defined as a first display, and where the system further comprises a second display.

In some embodiments the second display is arranged on the handheld device.

In some embodiments the second display is arranged on the handheld device in a position such that the display is adapted to be viewed by the operator, while the operator is operating the handheld device.

In some embodiments the second display indicates where the handheld device is positioned relative to the 3D environment.

In some embodiments the first display and/or the second display provides instructions for the operator.

The display(s) can be arranged in multiple ways. For example, they can be mounted on a wall, placed on some sort of stand or a cart, placed on a rack or desk, or other.

5 In some embodiments at least one display is mounted on the device itself. It can be advantageous to have a display on the device itself because with such an arrangement, the operator's eyes need not focus alternatingly between different distances. In some cases, the operating functionality may require a close look at the device and the vicinity of the 3D environment it
10 operates in, and this may be at a distance at most as far away as the operator's hand. Especially in crowded environments such as dentist's clinics, surgical operation theatres, or industrial workplaces, it may be difficult to place an external display closely to the device.

15 In some embodiments visual information is provided to the operator on one or more means other than the first display.

In some embodiments audible information to the operator is provided to the operator.

20

Thus in some embodiments, the system provides additional information to the operator. In some embodiments, the system includes other visual clues shown on means other than the display(s), such as LEDs on the device. In some embodiments, the system provides audible information to the operator,
25 for example by different sounds and/or by speech.

Said information provided to the operator can comprise instructions for use, warnings, and the like.

The information can aid with improving the action performance or operation
30 functionality of the device, for example by indicating how well an action or operation is being performed, and/or instructions to the operator aimed at

improving the ease of the action or operation and/or the quality of the action or operation's results. For example, a LED can change in color and/or flashing frequency. In a scanner, the information can relate to how well the scanned 3D environment is in focus and/or to scan quality and/or to scan coverage. The information can comprise instructions on how best to position the scanner such as to attain good scan quality and/or scan coverage. The instructions can be used for planning and/or performing bracket placement. The instructions can be in the form of a messenger system to the operator.

10 In some embodiments, some 3D user interface functionality is provided by at least one motion sensor built into the device. Examples of motion sensors are accelerometers, gyros, and magnetometers and/or the like. These sensors can sense rotations, lateral motion, and/or combinations thereof. Other motion sensors use infrared sensing. For example, at least one infrared sensor can be mounted on the device and at least one infrared emitter can be mounted in the surroundings of the device. Conversely, the at least one emitter can be mounted on the device, and the at least one sensors in the surroundings. Yet another possibility is to use infrared reflector(s) on the device and both sensor(s) and emitter(s) on the surroundings, or again conversely. Thus motion can be sensed by a variety of principles.

Through proper signal processing, some sensors can recognize additional operator actions; for example gestures such as taps, waving, or shaking of the handheld device. Thus, these gestures can also be exploited in the 3D user interface functionality.

In some embodiments the handheld device comprises at least two motion sensors providing sensor fusion. Sensor fusion can be used to achieve a better motion signal from for example raw gyro, accelerometer, and/or magnetometer data. Sensor fusion can be implemented in ICs such as the InvenSense MPU 3000.

In some embodiments the handheld device comprises at least one user-interface element other than the at least one motion sensor.

- 5 In some embodiments the at least one other user-interface element is a touch-sensitive element.

In some embodiments the at least one other user-interface element is a button.

10

In some embodiments the at least one other user-interface element is a scroll-wheel.

- 15 In some embodiments, user interface functionality is provided through additional elements on the device. Thus these additional elements can for example be buttons, scroll wheels, touch-sensitive fields, proximity sensors and/or the like

- 20 The additional user interface elements can be exploited or utilized in a workflow suitable for the field of application of the device. The workflow may be implemented in some user software application that may also control the display and thus the view represented thereon. A given interface element can supply multiple user inputs to the software. For example, a button can provide both a single click and a double click. For example, a double click
- 25 can mean to advance to a subsequent step in a workflow. For the example of intraoral scanning, three steps within the workflow can be to scan the lower mouth, the upper mouth, and the bite. A touch-sensitive field can provide strokes in multiple directions each with a different effect, etc. Providing multiple user inputs from a user interface elements is advantageous because
- 30 the number of user interface elements on the device can be reduced relative

to a situation where each user interface element only provides one user input.

5 The motion sensors can also be exploited in a workflow. For example, lifting the device, which can be sensed by an accelerometer, can represent some type of user input, for example to start some action. In a device that is a scanner, it may start scanning. Conversely, placing the device back in some sort of holder, which can be sensed by an accelerometer as no acceleration occur over some period of time, can stop said action.

10

If the action performed by the device is some kind of recording, for example scanning, for example 3D scanning, the results of the recording can also be exploited as user inputs, possibly along with user inputs from other user interface elements. For example, with a 3D scanner with a limited depth of field, it may be possible to detect whether any objects within the 3D environments are present in the volume corresponding to this depth of field by detecting whether any 3D points are recorded. User inputs can depend on such detected presence. For example, a button click on an intraoral scanner can provide a different user input depending on whether the scanner is in the mouth, where teeth are detectable, or significantly away from and outside the mouth. Also the effect of motion sensor signals can be interpreted differently for either situation. For example, the scanner may only change the view represented on the display when it is outside the mouth.

25 In some embodiments the handheld device is adapted to change a viewing angle with which the 3D environment is represented on the at least one display.

30 In some embodiments the handheld device is adapted to change a magnification factor with which the 3D environment is represented on the at least one display.

In some embodiments the handheld device is adapted to change a viewing position with which the 3D environment is represented on the at least one display.

5

In some embodiments the view of the 3D environment comprises a viewing angle, a magnification factor, and/or a viewing position.

10

In some embodiments the view of the 3D environment comprises rendering of texture and/or shading.

In some embodiments the at least one display is divided into multiple regions, each showing the 3D environment with a different view.

15

Thus in some embodiments the user interface functionality comprises changing the view with which the 3D environment is displayed. Changes in view can comprise changes in viewing angle, viewing position, magnification and/or the like. A change in viewing angle can naturally be effected by rotating the device. Rotation is naturally sensed by the aid of gyros and/or relative to gravity sensed by an accelerometer. Zooming, i.e. a change in magnification, can for example be achieved by pushing the handheld device forward and backward, respectively. A translational change of the viewing position, i.e., panning, can for example be achieved by pushing the handheld device up/down and/or sideways.

25

In some embodiments the user interface functionality comprises selecting or choosing items on a display or any other functionality provided by graphical user interfaces in computers known in the art. The operator may perform the selection. The Lava C.O.S scanner marketed by 3M ESPE has additional buttons on the handheld device, but it is not possible to manipulate the view

30

by these. Their only purpose is to allow navigation through a menu system, and to start/stop scanning.

5 In some embodiments the user interface functionality comprises manipulating the 3D environment displayed on the screen. For example, the operator may effect deformations or change the position or orientation of objects in the 3D environment. Thus, in some embodiments the user interface functionality comprises virtual user interface functionality, which can be that the 3D data are manipulated, but the physical 3D environment in which the device
10 operates may not be manipulated.

In some embodiments the handheld device is an intraoral scanner and/or an in-the-ear scanner. If the scanner comprises a tip, this tip may be exchanged whereby the scanner can become suitable for scanning in the mouth or in the
15 ear. Since the ear is a smaller cavity than the mouth, the tip for fitting into an ear may be smaller than a tip for fitting in the mouth.

In some embodiments the handheld device is a surgical instrument. In some embodiments, the surgical instrument comprises at least one motion sensor, which is built-in in the instrument.
20

In some embodiments the handheld device is a mechanical tool. In some embodiments, the tool has at least one motion sensor built in. In other embodiments, other user-interface elements are built in as well, for example
25 buttons, scroll wheels, touch-sensitive fields, or proximity sensors.

In some embodiment the 3D geometry of the 3D environment is known a-priori or a 3D representation of the environment is known a priori, i.e. before the actions (s) are performed. For example in surgery, a CT scan may have
30 been taken before the surgical procedure. The handheld device in this example could be a surgical instrument that a physician needs to apply in the

proper 3D position. To make sure this proper position is reached, it could be beneficial to view the 3D environment from multiple perspectives interactively, i.e. without having to release the surgical instrument.

- 5 An advantage of the system, also in the above surgery example, is the ability of the handheld device to record the 3D environment at least partially, typically in a 3D field-of-view that is smaller than the volume represented in the a-priori data. The 3D data recorded by the handheld device can be registered in real time with the a-priori data, such that the position and
10 orientation of the device can be detected.

In some embodiments the 3D geometry comprises a 3D surface of the environment.

- 15 In some embodiments the 3D geometry comprises a 3D volumetric representation of the environment.

Thus the 3D environment can be displayed as volumetric data, or as surface, or a combination thereof. Volumetric data are typically represented by voxels.
20 Voxels can comprise multiple scalar values. Surface data are typically represented as meshed, such as triangulated meshes, or point clouds.

The scanning may be performed by means of LED scanning, laser light scanning, white light scanning, X-ray scanning, and/or CT scanning.
25

The present invention relates to different aspects including the system described above and in the following, and corresponding systems, methods, devices, uses, and/or product means, each yielding one or more of the benefits and advantages described in connection with the first mentioned
30 aspect, and each having one or more embodiments corresponding to the

embodiments described in connection with the first mentioned aspect and/or disclosed in the appended claims.

In particular, disclosed herein is a method of interaction between a handheld
5 device and at least one display, where the method comprises the steps of:

- performing at least one action in a physical 3D environment by means of the handheld device;

- visually representing the physical 3D environment by the at least one display; and

- 10 - remotely controlling the view of the represented 3D environment on the display by means of the handheld device.

Furthermore, the invention relates to a computer program product comprising
program code means for causing a data processing system to perform the
15 method according to any of the embodiments, when said program code means are executed on the data processing system, and a computer program product, comprising a computer-readable medium having stored there on the program code means.

20 According to another aspect, disclosed is a system comprising a handheld device for operating in a 3D environment and at least one display for visualizing said environment, where the display is adapted to represent said environment from multiple perspectives,

where said device is adapted to be held in one hand by an operator, and

25 where the perspective represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

According to another aspect, disclosed is a system comprising a handheld
device for operating in a 3D environment and at least one display for
30 visualizing said environment, where the display is adapted to represent said environment in multiple views,

where said device is adapted to be held in one hand by an operator, where the view represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device, and where the device has at least one touch-sensitive user interface element.

5

Definitions

3D geometry: A constellation of matter or its virtual representation in a three-dimensional space.

10

3D environment: A constellation of physical objects each having a 3D geometry in a three-dimensional space.

View: The way a 3D environment is represented on a display. Geometrically, a view is determined by the virtual observer's/camera's position and orientation. If the display is two-dimensional, the view is also determined by the type of projection. A view may also be determined by a magnification factor. Graphically, a view can show the 3D environment by means of photographs or as some kind of virtual representation such as a computer graphic, or similar. A computer graphic can be rendered for example with texture and/or shading and/or virtual light sources and/or light models for surface properties. A computer graphic can also be a simplified representation of the 3D environment, for example a mesh, an outline, or an otherwise simplified representation. All or parts of the 3D environment can also be rendered with some degree of transparency. A view may represent the 3D environment in total or only parts thereof.

20

25

Functionality: A purpose or intended use.

30

Performing action(s) or operating functionality: Actions or functionality that includes some type of interaction with a 3D environment, such as measuring, modifying, manipulating, recording, touching, sensing, scanning, moving, transforming, cutting, welding, chemically treating, cleaning, etc. The term
5 “operating” is thus not directed to surgical procedures, but operating may comprise surgical procedures.

User Interface Functionality: Functionality for interaction between a human user and a machine with a display.
10

Handheld device: An object that has at least one functionality and that is held by a human operator’s hand or both hands while performing this at least one functionality.

15 3D scanner: A device that analyzes a real-world object or 3D environment to collect data on its shape and possibly its appearance.

Coverage of scan: The degree to which a physical surface is represented by recorded data after a scanning operation.

20 Motion sensor: A sensor detecting motion. Motion can be detected by: sound (acoustic sensors), opacity (optical and infrared sensors and video image processors), geomagnetism (magnetic sensors, magnetometers), reflection of transmitted energy (infrared laser radar, ultrasonic sensors, and
25 microwave radar sensors), electromagnetic induction (inductive-loop detectors), and vibration (triboelectric, seismic, and inertia-switch sensors). MEMS accelerometers, gyros, and magnetometers are examples of motions sensors.

30 Workflow: a sequence of tasks implemented in software.

Brief description of the drawings

5 The above and/or additional objects, features and advantages of the present invention, will be further elucidated by the following illustrative and non-limiting detailed description of embodiments of the present invention, with reference to the appended drawings, wherein:

10 Fig. 1 shows an example of the system comprising a handheld device and a display.

Fig. 2 shows an example of user interface functionality in the form of remote controlling using the handheld device.

15 Fig. 3 shows an example of the handheld device.

Fig. 4 shows an example of a flow-chart of a method of interaction between a handheld device and a display.

20

Detailed description

In the following description, reference is made to the accompanying figures, which show by way of illustration how the invention may be practiced.

25

Fig. 1 shows an example of the system comprising a handheld device and a display. The handheld device 100 is in this example an intraoral dental scanner, which records the 3D geometry of the patient's teeth. The operator 102 moves the scanner along the teeth of the patient 104 for capturing the
30 3D geometry of the relevant teeth, e.g. all teeth. The scanner comprises motion sensors (not visible) for taken the movement of the scanner into

account while creating the 3D model 105 of the scanned teeth. The display 101 is in this example a PC screen displaying the data recorded by the scanner.

5 Fig. 2 shows an example of user interface functionality in the form of remote controlling using the handheld device. The motion sensors (not shown) in the handheld device 100, e.g. scanner, provide that the user 102 can determine the view shown on the display 101, e.g. screen, by moving the handheld device 100.

10 Fig. 2a) shows that pointing the device 100 down can provide that the 3D model 105 of the scanned teeth is shown from a downward viewing angle. Fig. 2b) shows that holding the scanner in a horizontal position can provide that the viewing angle is likewise horizontally from the front, such that the 3D model 105 of the scanned teeth is shown from the front.

15

Fig. 3 shows an example of the handheld device.

The handheld device 100 is in this example an intraoral scanner with a pistol-grip. The scanner comprises a housing 106 comprising the pistol-grip part 107, and a tip 108 adapted for insertion in the mouth of the patient. In this
20 example the scanner also is equipped with a button 103 which is an additional element providing user-interface functionality.

The example system as shown in fig. 1, fig. 2 and fig. 3 comprises a device
25 100 which is a handheld intraoral scanner and a display 101 which is a computer screen. The operator 102 may be a dentist, an assistant and/or the like. In an example, the action performance or operation functionality of the device 100 is to record some intraoral 3D geometry, and the user interface functionality is to rotate, pan, and zoom the 3D model 105 of the scanned data on the computer screen 101. The integration of the user interface
30 functionality in the device 100 is provided by motion sensors (not visible), which can be accelerometers inside the scanner 100, whose readings

determine the orientation, as seen in Figs 2a and 2b, of the display on the screen of the 3D model 105 of the teeth acquired by the scanner 100. Additional functionality, e.g. to start/stop scanning, may be provided by the button 103 as seen in fig. 3. In the example system, the button 103 is located
5 where the user's index finger can reach it conveniently.

In fig. 1 the dentist 102 uses two hands to hold the intraoral scanner 100 while scanning, but it is understood that the scanner 100 can also be held with one hand while scanning. The device 100 can also be held with one or
10 two hands, while changing the perspective of the 3D model 105 in the display 101. The example shown in Figure 1 thus illustrates the advantage of the touchless user interface functionality, because in many clinical situations, the operator 102 should maintain both hands clean, disinfected, or even sterile.

15 The 3D user interface functionality may be exploited in a separate location than the operation functionality. For the above intraoral scanning system example, the scanning operation is performed in the oral cavity of the patient, see fig. 1, while the user interface functionality is more flexibly exploited when the scanner is outside the patient's mouth, see figs 2 and 3.

20

Fig. 4 shows an example of a flow-chart of a method of interaction between a handheld device and a display.

In step 101 at least one action in a physical 3D environment is performed by means of the handheld device. This action may be the scanning of teeth as
25 shown in fig. 1.

In step 102 the physical 3D environment is visually represented by the at least one display. This may be the display of the 3D model of the scanned teeth as seen in fig 1.

In step 103 the view of the represented 3D environment shown on the display is remotely controlled on the display by means of the handheld device. This
30 may be the control of the viewing angle of the 3D model as seen in fig. 2.

All the steps of the method may be repeated one or more times. The order in which the steps are performed may be different than the order described above, which is indicated by the dotted lines in the figure. If one or more of the steps are performed more times, the order of the steps may also be different.

Although some embodiments have been described and shown in detail, the invention is not restricted to them, but may also be embodied in other ways within the scope of the subject matter defined in the following claims. In particular, it is to be understood that other embodiments may be utilised and structural and functional modifications may be made without departing from the scope of the present invention.

In device claims enumerating several means, several of these means can be embodied by one and the same item of hardware. The mere fact that certain measures are recited in mutually different dependent claims or described in different embodiments does not indicate that a combination of these measures cannot be used to advantage.

It should be emphasized that the term "comprises/comprising" when used in this specification is taken to specify the presence of stated features, integers, steps or components but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

The features of the method described above and in the following may be implemented in software and carried out on a data processing system or other processing means caused by the execution of computer-executable instructions. The instructions may be program code means loaded in a memory, such as a RAM, from a storage medium or from another computer via a computer network. Alternatively, the described features may be

implemented by hardwired circuitry instead of software or in combination with software.

5 **Literature:**

C. Graetzel, T. Fong, S. Grange, and C. Baur. A Non-Contact Mouse for Surgeon-Computer Interaction. *Technology and Health Care*, 12(3), 2004.

- 10 Vogt S., Khamene A., Niemann H., Sauer F., An AR system with intuitive user interface for manipulation and visualization of 3D medical data, *Stud. Health Technol. Inform.* 2004;98, pp. 397-403.

15

Claims:

- 5 1. A system comprising a handheld device and at least one display, where the handheld device is adapted for performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment, and where the handheld device is adapted for remotely controlling the view with which the 3D environment is represented on the display.
- 10 2. The system according to any one or more of the preceding claims, wherein the view is defined as viewing angle and/or viewing position.
- 15 3. The system according to any one or more of the preceding claims, wherein the handheld device is adapted for changing the rendering of the 3D environment on the display.
- 20 4. The system according to any one or more of the preceding claims, wherein the at least one action comprises one or more of:
- measuring,
 - recording,
 - scanning,
 - manipulating, and/or
 - modifying.
- 25 5. The system according to any one or more of the preceding claims, wherein the display is adapted to represent the 3D environment from multiple views.
- 30 6. The system according to any one or more of the preceding claims, wherein the view of the 3D environment represented in the at least one display is at

least partly determined by the motion of the operator's hand holding said device.

5 7. The system according to any one or more of the preceding claims, wherein the magnification represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

10 8. The system according to any one or more of the preceding claims, wherein the view of the 3D environment comprises a viewing angle, a magnification factor, and/or a viewing position.

15 9. The system according to any one or more of the preceding claims, wherein the view of the 3D environment comprises rendering of texture and/or shading.

20 10. The system according to any one or more of the preceding claims, wherein the handheld device is an intra-oral 3D scanner.

System with 3D user interface integration5 **Abstract**

Disclosed is a system comprising a handheld device and at least one display, where the handheld device is adapted for performing at least one action in a physical 3D environment, where the at least one display is adapted for
10 visually representing the physical 3D environment, and where the handheld device is adapted for remotely controlling the view with which the 3D environment is represented on the display.

(fig. 2a) should be published)

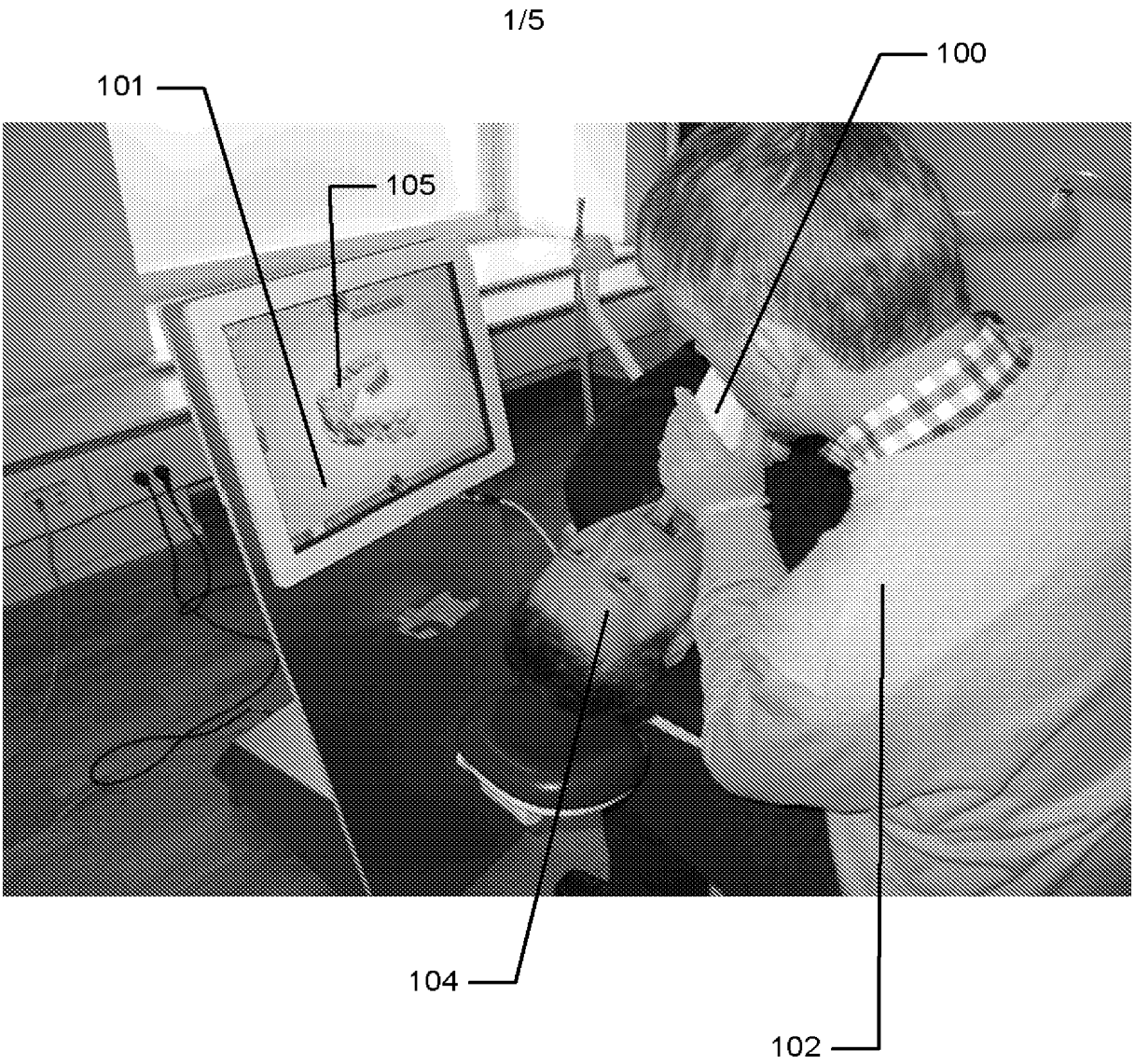


Fig. 1

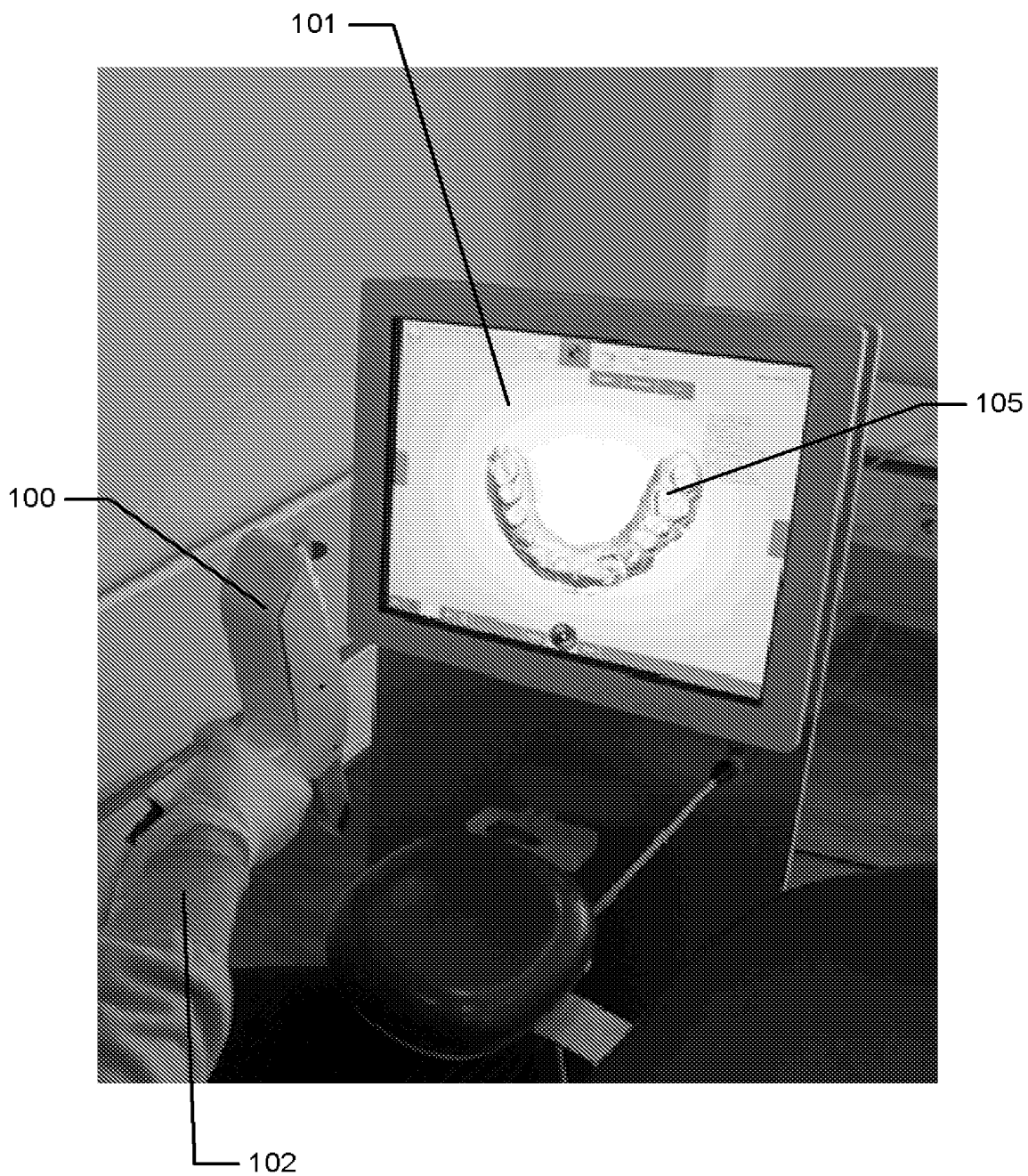


Fig. 2a)

3/5

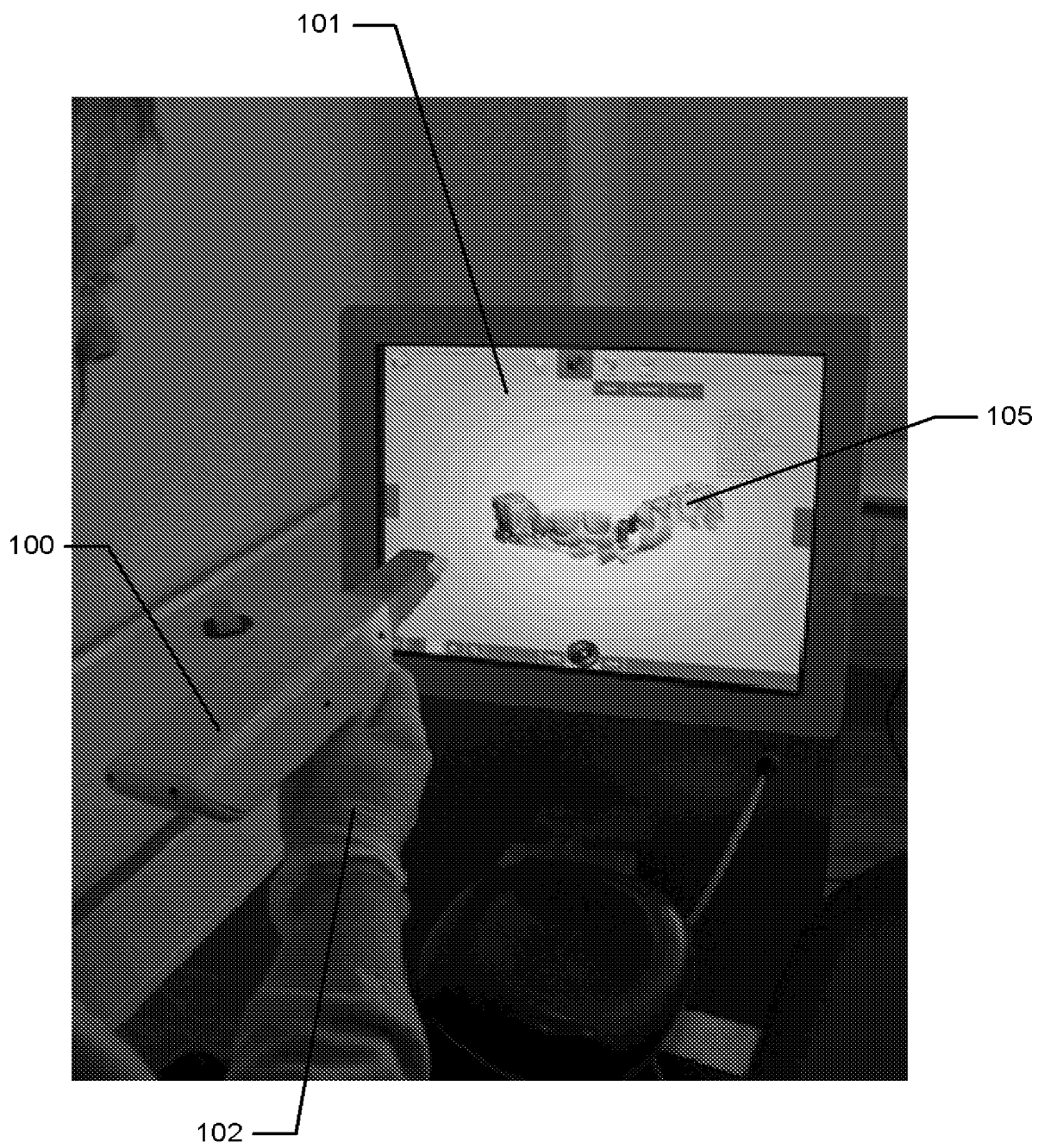


Fig. 2b)

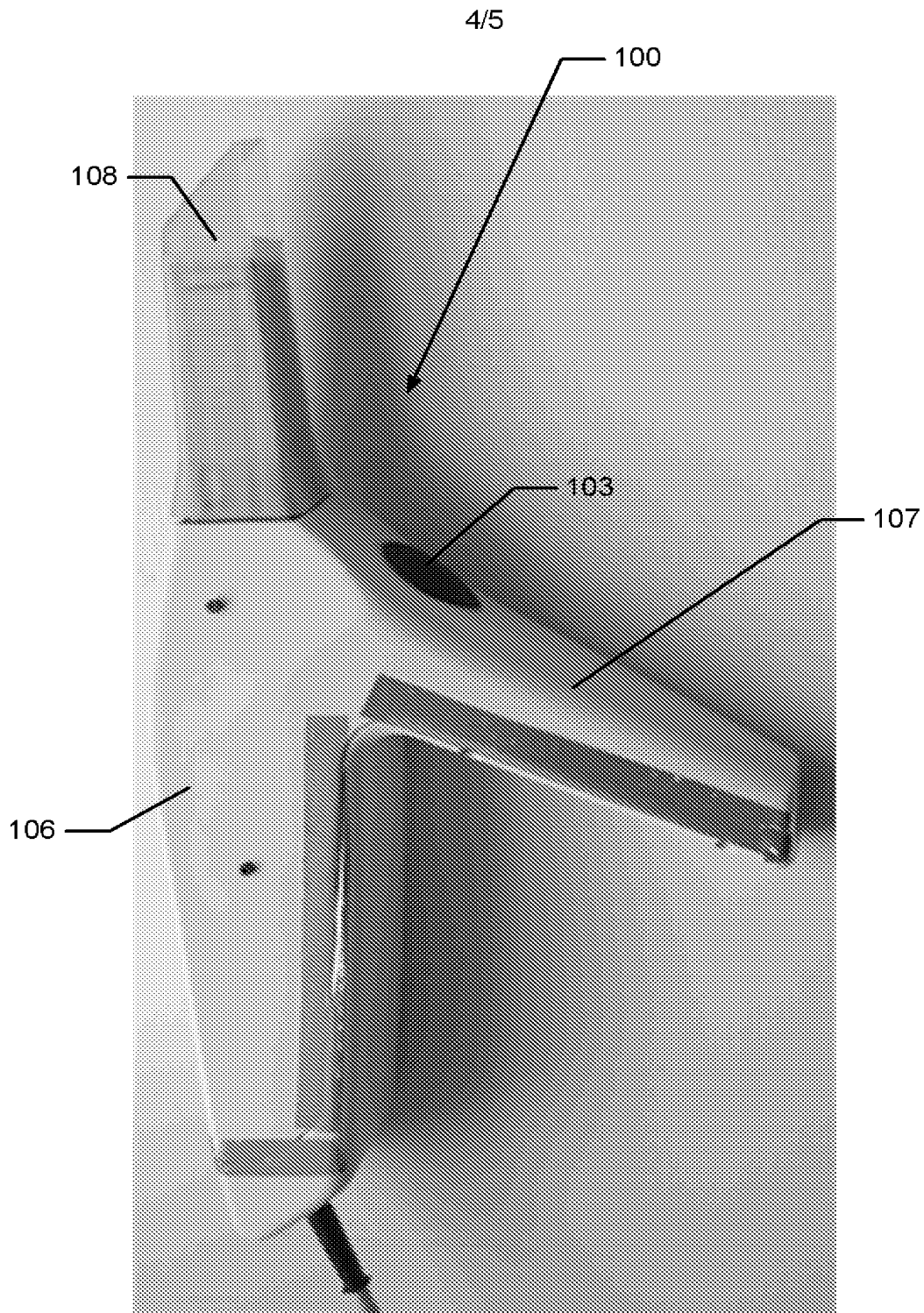


Fig. 3

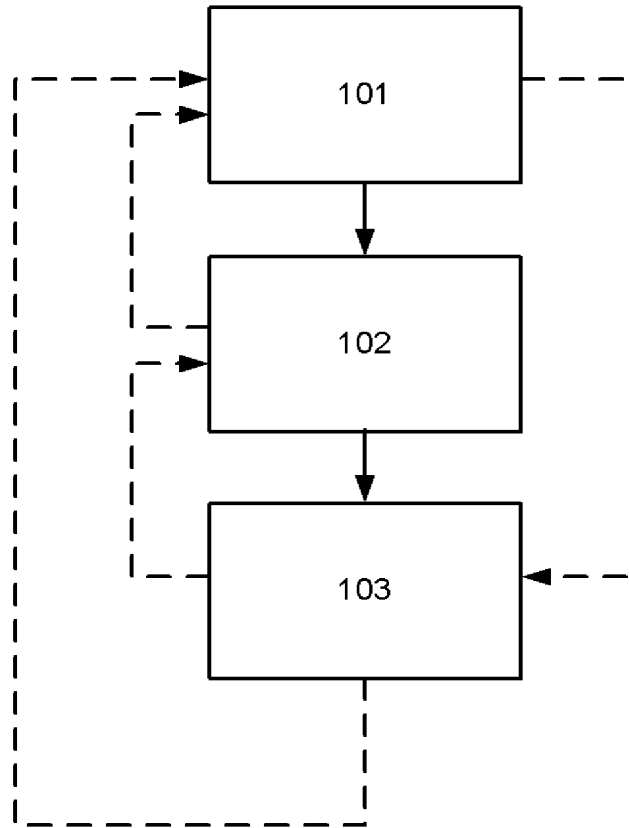


Fig. 4


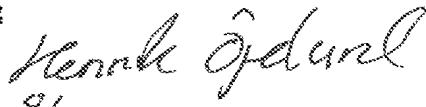
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VIII-2-1	<p>Declaration: Entitlement to apply for and be granted a patent Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent (Rules 4.17(ii) and 51bis.1(a)(ii)), in a case where the declaration under Rule 4.17(iv) is not appropriate: Name (LAST, First)</p>	<p>In relation to the international application No. PCT/DK2011/050461</p> <p>3SHAPE A/S is entitled to apply for and be granted a patent by virtue of the following:</p>
VIII-2-1(i v)		<p>an assignment from HOLLENBECK, Karl Josef to 3SHAPE A/S, dated 08 December 2011 (08.12.2011)</p>
VIII-2-1(i v)		<p>an assignment from ÖJELUND, Henrik to 3SHAPE A/S, dated 08 December 2011 (08.12.2011)</p>
VIII-2-1(i v)		<p>an assignment from FISCHER, David to 3SHAPE A/S, dated 14 December 2011 (14.12.2011)</p>

VIII-4-1	<p>Declaration: inventorship (only for the purposes of the designation of the United States of America) Declaration of inventorship (Rules 4.17(iv) and 51bis.1(a)(iv)) for the purposes of the designation of the United States of America:</p>	<p>I hereby declare that I believe I am the original, first and sole (if only one inventor is listed below) or joint (if more than one inventor is listed below) inventor of the subject matter which is claimed and for which a patent is sought.</p> <p>This declaration is directed to international application PCT/DK2011/050461 (if furnishing declaration pursuant to Rule 26ter).</p> <p>I hereby declare that my residence, mailing address, and citizenship are as stated next to my name.</p> <p>I hereby state that I have reviewed and understand the contents of the above-identified international application, including the claims of said application. I have identified in the request of said application, in compliance with PCT Rule 4.10, any claim to foreign priority, and I have identified below, under the heading "Prior Applications", by application number, country or Member of the World Trade Organization, day, month, and year of filing, any application for a patent or inventor's certificate filed in a country other than the United States of America, including any PCT international application designating at least one country other than the United States of America, having a filing date before that of the application on which foreign priority is claimed.</p>
VIII-4-1-1	Prior applications:	PA 2010 01104, DK, 06 December 2010 (06.12.2010) ; 61/420,138, US, 06 December 2010 (06.12.2010)

		<p>I hereby acknowledge the duty to disclose information that is known by me to be material to patentability as defined by 37 C.F.R. § 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the PCT international filing date of the continuation-in-part application.</p> <p>I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.</p>
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111

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APPLICATION NUMBER: 61/420,138
FILING DATE: *December 06, 2010*

THE COUNTRY CODE AND NUMBER OF YOUR PRIORITY APPLICATION, TO BE USED FOR FILING ABROAD UNDER THE PARIS CONVENTION, IS *US61/420,138*



Certified by

David J. Kappas

Under Secretary of Commerce
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System with 3D user interface integration5 **Abstract**

Disclosed is a system comprising a handheld device and at least one display, where the handheld device is adapted for performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment, and where the handheld device is adapted for remotely controlling the view with which the 3D environment is represented on the display.

(fig. 2a) should be published)

Claims:

- 5 1. A system comprising a handheld device and at least one display, where the handheld device is adapted for performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment, and where the handheld device is adapted for remotely controlling the view with which the 3D environment is represented on the display.
- 10 2. The system according to any one or more of the preceding claims, wherein the view is defined as viewing angle and/or viewing position.
- 15 3. The system according to any one or more of the preceding claims, wherein the handheld device is adapted for remotely controlling the magnification with which the 3D environment is represented on the display.
- 20 4. The system according to any one or more of the preceding claims, wherein the handheld device is adapted for changing the rendering of the 3D environment on the display.
- 25 5. The system according to any one or more of the preceding claims, wherein the at least one action comprises one or more of:
- measuring,
 - recording,
 - scanning,
 - manipulating, and/or
 - modifying.
- 30 6. The system according to any one or more of the preceding claims, wherein the 3D environment comprises one or more 3D objects.

7. The system according to any one or more of the preceding claims, wherein the handheld device is adapted to be held in one hand by an operator.

5 8. The system according to any one or more of the preceding claims, wherein the display is adapted to represent the 3D environment from multiple views..

9. The system according to any one or more of the preceding claims, wherein the view of the 3D environment represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device.
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10. The system according to any one or more of the preceding claims, wherein the magnification represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device.
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11. The system according to any one or more of the preceding claims, wherein the handheld device is adapted to record the 3D geometry of the 3D environment.
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12. The system according to any one or more of the preceding claims, wherein the 3D geometry of the 3D environment is known a-priori.

13. The system according to any one or more of the preceding claims, wherein the handheld device comprises at least one user-interface element.
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14. The system according to any one or more of the preceding claims, wherein the at least one user-interface element is at least one motion sensor.

15. The system according to any one or more of the preceding claims, wherein the handheld device comprises at least two motion sensors providing sensor fusion.

5 16. The system according to any one or more of the preceding claims, wherein the user interface functionality comprises the use of gestures.

17. The system according to any one or more of the preceding claims, wherein the gestures are detected by the at least one motion sensor.

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18. The system according to any one or more of the preceding claims, wherein the handheld device comprises at least one user-interface element other than the at least one motion sensor.

15 19. The system according to any one or more of the preceding claims, wherein the at least one other user-interface element is a touch-sensitive element.

20 20. The system according to any one or more of the preceding claims, wherein the at least one other user-interface element is a button.

21. The system according to any one or more of the preceding claims, wherein the at least one other user-interface element is a scroll wheel.

25 22. The system according to any one or more of the preceding claims, wherein the handheld device is adapted to change a viewing angle with which the 3D environment is represented on the at least one display.

30 23. The system according to any of the preceding claims, wherein the handheld device is adapted to change a magnification factor with which the 3D environment is represented on the at least one display.

24. The system according to any one or more of the preceding claims, wherein the handheld device is adapted to change a viewing position with which the 3D environment is represented on the at least one display.

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25. The system according to any one or more of the preceding claims, wherein the view of the 3D environment comprises a viewing angle, a magnification factor, and/or a viewing position.

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26. The system according to any one or more of the preceding claims, wherein the view of the 3D environment comprises rendering of texture and/or shading.

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27. The system according to any one or more of the preceding claims, wherein the at least one display is divided into multiple regions, each showing the 3D environment with a different view.

28. The system according to any one or more of the preceding claims, wherein the 3D geometry comprises a 3D surface of the environment.

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29. The system according to any one or more of the preceding claims, wherein the 3D geometry comprises a 3D volumetric representation of the environment.

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30. The system according to any one or more of the preceding claims, wherein the handheld device is an intra-oral 3D scanner.

31. The system according to any one or more of the preceding claims, wherein the handheld device is a surgical instrument.

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32. The system according to any one or more of the preceding claims, wherein the handheld device is a mechanical tool.

5 33. The system according to any one or more of the preceding claims, wherein the handheld device is an in-ear 3D scanner.

34. The system according to any one or more of the preceding claims, wherein the at least one display is arranged separate from the handheld device.

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35. The system according to any one or more of the preceding claims, wherein the at least one display is arranged on a cart.

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36. The system according to any one or more of the preceding claims, wherein the at least one display is defined as a first display, and where the system further comprises a second display.

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37. The system according to any one or more of the preceding claims, wherein the second display is arranged on the handheld device.

38. The system according to any one or more of the preceding claims, wherein the second display is arranged on the handheld device in a position such that the display is adapted to be viewed by the operator, while the operator is operating the handheld device.

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39. The system according to any one or more of the preceding claims, wherein the second display indicates where the handheld device is positioned relative to the 3D environment.

40. The system according to any one or more of the preceding claims, wherein the first display and/or the second display provides instructions for the operator.

5 41. The system according to any one or more of the preceding claims, wherein visual information is provided to the operator on one or more means other than the first display.

10 42. The system according to any one or more of the preceding claims, wherein audible information to the operator is provided to the operator.

15 43. The system according to any one or more of the preceding claims, wherein the scanning is performed by means of LED scanning, laser light scanning, white light scanning, X-ray scanning, and/or CT scanning.

20 44. A method of interaction between a handheld device and at least one display, where the method comprises the steps of:
- performing at least one action in a physical 3D environment by means of the handheld device;
- visually representing the physical 3D environment by the at least one display; and
- remotely controlling the view of the represented 3D environment on the display by means of the handheld device.

25 45. A computer program product comprising program code means for causing a data processing system to perform the method of any one or more of the preceding claims, when said program code means are executed on the data processing system.

46. A computer program product according to the previous claim, comprising a computer-readable medium having stored there on the program code means.

System with 3D user interface integration

Field of the invention

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This invention generally relates to a method and a system comprising a handheld device and at least one display.

Background of the invention

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3D visualization is important in many fields of industry and medicine, where 3D information is becoming more and more predominant.

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Displaying and inspecting 3D information is inherently difficult. To fully understand a 3D object or entire environment on a screen, the user should generally be able to rotate the object or scene, such that many or preferentially all surfaces are displayed. This is true even if for 3D displays, e.g. stereoscopic or holographic, where from a given viewing position and with a given viewing angle, the user will only see some surfaces of an arbitrary 3D environment. Often, the user will also want to zoom into details or zoom out for an overview.

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Various user interaction devices are in use for software that displays 3D data; these devices are: 3D mice, space balls, and touch screens. The operation of these current interaction devices requires physically touching them.

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Physically touching a user-interaction device can be a disadvantage in medical applications due to risks of cross-contamination between patients or between patient and operator, or in industrial applications in dirty environments.

Several non-touch user interfaces for 3D data viewing in medical applications have been described in the literature. Vogt et al (2004) describe a touchless interactive system for in-situ visualization of 3D medical imaging data. The user interface is based on tracking of reflective markers, where a camera is mounted on the physician's head. Graetzel et al (2004) describe a touchless system that interprets hand gestures as mouse actions. It is based on stereo vision and intended for use in minimally invasive surgery.

It remains a problem to improve systems that require user interfaces for view control, which for example can be used for clinical purposes.

Summary

Disclosed is a system comprising a handheld device and at least one display, where the handheld device is adapted for performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment, and where the handheld device is adapted for remotely controlling the view with which said 3D environment is represented on the display

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The system disclosed here performs the integration of 3D user interface functionality with any other handheld device with other operating functionality, such that the operator ideally only touches this latter device that is intended to be touched. A particular example of such a handheld device is one that records some 3D geometry, for example a handheld 3D scanner.

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The handheld device is a multi-purpose device, such as a dual-purpose or two-purpose device, i.e. a device both for performing actions in the physical 3D environment, such as measuring and manipulating, and for remotely controlling the view of the 3D environment on the display.

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Geometrically, a view is determined by the virtual observer's/camera's position and orientation relative to the 3D environment or its visual representation. If the display is two-dimensional, the view is also determined by the type of projection. A view may also be determined by a magnification
5 factor.

The virtual observer's and the 3D environment's position and orientation are always relative to each other. In terms of user experience in software systems with 3D input devices, the user may feel that for example, he/she is
10 moving the 3D environment while remaining stationary himself/herself, but there is always an equivalent movement of the virtual observer/camera that gives the same results on the display. Often, descriptions of 3D software systems use the expression "pan" to indicate an apparent translational movement of the 3D environment, "rotate" to indicate a rotational movement
15 of the 3D environment, and "zoom" to indicate a change in magnification factor.

Graphically, a view can represent a 3D environment by means of photographs or as some kind of virtual representation such as a computer
20 graphic, or similar. A computer graphic can be rendered for example with texture and/or shading and/or virtual light sources and/or light models for surface properties. A computer graphic can also be a simplified representation of the 3D environment, for example a mesh, an outline, or an otherwise simplified representation. All or parts of the 3D environment can
25 also be rendered with some degree of transparency. A view may represent the 3D environment in total or only parts thereof.

All of the touch-less prior art systems are 3D user interface devices only. In many prior art applications, the operator using such user interface device will
30 also hold and work with another device that really is the central device in the overall application, e.g. a medical instrument.

It is thus an advantage of the present system that the 3D user-interface functionality is integrated in the central device, which is used for performing some kind of action.

5

In some embodiments the handheld device is adapted for remotely controlling the magnification with which the 3D environment is represented on the display.

10 In some embodiments the handheld device is adapted for changing the rendering of the 3D environment on the display.

In some embodiments the view is defined as viewing angle and/or viewing position.

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In some embodiments the at least one action comprises one or more of the actions of:

- measuring,

- recording,

20 - scanning,

- manipulating,

- modifying.

25 In some embodiments the 3D environment comprises one or more 3D objects.

In some embodiments the handheld device is adapted to be held in one hand by an operator.

30 In some embodiments the display is adapted to represent the 3D environment from multiple views.

In some embodiments the display is adapted to represent the 3D environment from different viewing angles and/or viewing positions.

- 5 In some embodiments the view of the 3D environment in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

- 10 In some embodiments the magnification represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

In some embodiments the handheld device is adapted to record the 3D geometry of the 3D environment.

- 15 Thus the handheld device may be an intraoral dental scanner, which records the 3D geometry of a patient's teeth. The operator may move the scanner along the teeth of the patient for capturing the 3D geometry of the relevant teeth, e.g. all teeth. The scanner may comprise motion sensors for taken the movement of the scanner into account while creating the 3D model of the scanned teeth.

20 The 3D model of the teeth may be shown on a display, and the display may for example be a PC screen and/or the like.

- 25 The user interface functionality may comprise incorporating motion sensors in the scanner to provide that the user can determine the view on the screen by moving the scanner. Pointing the scanner down can provide that the scanned teeth are shown given a downward viewing angle. Holding the scanner in a horizontal position can provide that the viewing angle is likewise horizontal.

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In some embodiments the handheld device comprises at least one user-interface element.

The system may be equipped with a button as an additional element providing the user-interface functionality.

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In an example the handheld device is a handheld intraoral scanner, and the display is a computer screen. The operator or user may be a dentist, an assistant and/or the like. The operation functionality of the device may be to record some intraoral 3D geometry, and the user interface functionality may be to rotate, pan, and zoom the scanned data on the computer screen.

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In some embodiments the at least one user-interface element is at least one motion sensor.

Thus the integration of the user interface functionality in the device may be provided by motion sensors, which can be accelerometers inside the scanner, whose readings determine the orientation of the display on the screen of the 3D model of the teeth acquired by the scanner. Additional functionality, e.g. to start/stop scanning, may be provided by a button. The button may be located where the operator's or user's index finger can reach it conveniently.

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Prior art intraoral scanners use a touch screen, a trackball, or a mouse to determine the view in the display. These prior art user interface devices can be inconvenient, awkward and difficult to use, and they can be labor-intensive, and thus costly to sterilize or disinfect. An intraoral scanner should always be disinfected between scanning different patients, because the scanner is in and may come in contact with the mouth or other parts of the patient being scanned.

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The operator or user, e.g. dentist, may use one hand or both hands to hold the intraoral scanner while scanning, and the scanner may be light enough

and comfortable to be held with just one hand for a longer time while scanning.

5 The device can also be held with one or two hands, while using the device as remote control for e.g. changing the view in the display. It is an advantage of the touchless user interface functionality that in clinical situations, the operator can maintain both hands clean, disinfected, or even sterile.

10 An advantage of the system is that it allows an iterative process of working in a 3D environment without releasing the handheld device during said process. For the above intraoral scanning system example, the operator, e.g. dentist, can record some teeth surface geometry with a handheld device that is an intraoral scanner, inspect coverage of the surface recording by using that same handheld device to move, e.g. rotate, the recorded surface on the display, e.g. a computer screen, detect possible gaps or holes in the coverage of the scanned teeth, and then for example arrange the scanner in the region where the gaps were located and continue recording teeth surface geometry there. Over this entire iterative cycle, which can be repeated more than once, such as as many times as required for obtaining a desired scan coverage of the teeth, the dentist does not have to lay the handheld intraoral scanner out of his or her hands.

25 In some embodiments, the 3D user interface functionality is exploited in a separate location than the operation functionality. For the above intraoral scanning system example, the scanning operation is performed in the oral cavity of the patient, while the user interface functionality is more flexibly exploited when the scanner is outside the patient's mouth. The key characteristic and advantage of the system, again, is that the dentist can exploit the dual and integrated functionality, that is operation and user interface, of the scanner without laying it out of his or her hands.

The above intraoral scanning system is an example of an embodiment. Other examples for operation functionality or performing actions could be drilling, welding, grinding, cutting, soldering, photographing, filming, measuring, executing some surgical procedure etc..

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The display of the system can be a 2D computer screen, a 3D display that projects stereoscopic image pairs, a volumetric display creating a 3D effect, such as a swept-volume display, a static volume display, a parallax barrier display, a holographic display etc.. Even with a 3D display, the operator has only one viewing position and viewing angle relative to the 3D environment at a time. The operator can move his/her head to assume another viewing position and/or viewing angle physically, but generally, it may be more convenient to use the handheld device with its built-in user interface functionality, e.g. the remote controlling, to change the viewing position and/or viewing angle represented in the display.

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In some embodiments the system comprises multiple displays, or one or more displays that are divided into regions. For example, several sub-windows on a PC screen can represent different views of the 3D environment. The handheld device can be used to change the view in all of them, or only some of them.

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In some embodiments the user interface functionality comprises the use of gestures.

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Gestures made by e.g. the operator can be used to change, shift or toggle between sub-windows, and the user-interface functionality can be limited to an active sub-window or one of several displays.

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In some embodiments the gestures are adapted to be detected by the at least one motion sensor. Gestures can alternatively and/or additionally be detected by range sensors or other sensors that record body motion.

The operator does not have to constantly watch the at least one display of the system. In many applications, the operator will shift between viewing and possible manipulating the display and performing another operation with the handheld device. Thus it is an advantage that the operator does not have to touch other user interface devices. However, in some cases it may not be possible for the operator to fully avoid touching other devices, and in these cases it is an advantage that fewer touches are required compared to a system where a handheld device does not provide any user interface functionality at all.

In some embodiments the at least one display is arranged separate from the handheld device.

In some embodiments the at least one display is defined as a first display, and where the system further comprises a second display.

In some embodiments the second display is arranged on the handheld device.

In some embodiments the second display is arranged on the handheld device in a position such that the display is adapted to be viewed by the operator, while the operator is operating the handheld device.

In some embodiments the second display indicates where the handheld device is positioned relative to the 3D environment.

In some embodiments the first display and/or the second display provides instructions for the operator.

The display(s) can be arranged in multiple ways. For example, they can be mounted on a wall, placed on some sort of stand or a cart, placed on a rack or desk, or other.

5 In some embodiments at least one display is mounted on the device itself. It can be advantageous to have a display on the device itself because with such an arrangement, the operator's eyes need not focus alternatingly between different distances. In some cases, the operating functionality may require a close look at the device and the vicinity of the 3D environment it
10 operates in, and this may be at a distance at most as far away as the operator's hand. Especially in crowded environments such as dentist's clinics, surgical operation theatres, or industrial workplaces, it may be difficult to place an external display closely to the device.

15 In some embodiments visual information is provided to the operator on one or more means other than the first display.

In some embodiments audible information to the operator is provided to the operator.

20

Thus in some embodiments, the system provides additional information to the operator. In some embodiments, the system includes other visual clues shown on means other than the display(s), such as LEDs on the device. In some embodiments, the system provides audible information to the operator,
25 for example by different sounds and/or by speech.

Said information provided to the operator can comprise instructions for use, warnings, and the like.

The information can aid with improving the action performance or operation
30 functionality of the device, for example by indicating how well an action or operation is being performed, and/or instructions to the operator aimed at

improving the ease of the action or operation and/or the quality of the action or operation's results. For example, a LED can change in color and/or flashing frequency. In a scanner, the information can relate to how well the scanned 3D environment is in focus and/or to scan quality and/or to scan coverage. The information can comprise instructions on how best to position the scanner such as to attain good scan quality and/or scan coverage. The instructions can be used for planning and/or performing bracket placement. The instructions can be in the form of a messenger system to the operator.

10 In some embodiments, some 3D user interface functionality is provided by at least one motion sensor built into the device. Examples of motion sensors are accelerometers, gyros, and magnetometers and/or the like. These sensors can sense rotations, lateral motion, and/or combinations thereof. Other motion sensors use infrared sensing. For example, at least one infrared sensor can be mounted on the device and at least one infrared emitter can be mounted in the surroundings of the device. Conversely, the at least one emitter can be mounted on the device, and the at least one sensors in the surroundings. Yet another possibility is to use infrared reflector(s) on the device and both sensor(s) and emitter(s) on the surroundings, or again conversely. Thus motion can be sensed by a variety of principles.

25 Through proper signal processing, some sensors can recognize additional operator actions; for example gestures such as taps, waving, or shaking of the handheld device. Thus, these gestures can also be exploited in the 3D user interface functionality.

In some embodiments the handheld device comprises at least two motion sensors providing sensor fusion. Sensor fusion can be used to achieve a better motion signal from for example raw gyro, accelerometer, and/or magnetometer data. Sensor fusion can be implemented in ICs such as the InvenSense MPU 3000.

In some embodiments the handheld device comprises at least one user-interface element other than the at least one motion sensor.

- 5 In some embodiments the at least one other user-interface element is a touch-sensitive element.

In some embodiments the at least one other user-interface element is a button.

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In some embodiments the at least one other user-interface element is a scroll-wheel.

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In some embodiments, user interface functionality is provided through additional elements on the device. Thus these additional elements can for example be buttons, scroll wheels, touch-sensitive fields, proximity sensors and/or the like

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The additional user interface elements can be exploited or utilized in a workflow suitable for the field of application of the device. The workflow may be implemented in some user software application that may also control the display and thus the view represented thereon. A given interface element can supply multiple user inputs to the software. For example, a button can provide both a single click and a double click. For example, a double click can mean to advance to a subsequent step in a workflow. For the example of intraoral scanning, three steps within the workflow can be to scan the lower mouth, the upper mouth, and the bite. A touch-sensitive field can provide strokes in multiple directions each with a different effect, etc. Providing multiple user inputs from a user interface elements is advantageous because

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the number of user interface elements on the device can be reduced relative

to a situation where each user interface element only provides one user input.

5 The motion sensors can also be exploited in a workflow. For example, lifting the device, which can be sensed by an accelerometer, can represent some type of user input, for example to start some action. In a device that is a scanner, it may start scanning. Conversely, placing the device back in some sort of holder, which can be sensed by an accelerometer as no acceleration occur over some period of time, can stop said action.

10

If the action performed by the device is some kind of recording, for example scanning, for example 3D scanning, the results of the recording can also be exploited as user inputs, possibly along with user inputs from other user interface elements. For example, with a 3D scanner with a limited depth of field, it may be possible to detect whether any objects within the 3D environments are present in the volume corresponding to this depth of field by detecting whether any 3D points are recorded. User inputs can depend on such detected presence. For example, a button click on an intraoral scanner can provide a different user input depending on whether the scanner is in the mouth, where teeth are detectable, or significantly away from and outside the mouth. Also the effect of motion sensor signals can be interpreted differently for either situation. For example, the scanner may only change the view represented on the display when it is outside the mouth.

20

25 In some embodiments the handheld device is adapted to change a viewing angle with which the 3D environment is represented on the at least one display.

30 In some embodiments the handheld device is adapted to change a magnification factor with which the 3D environment is represented on the at least one display.

In some embodiments the handheld device is adapted to change a viewing position with which the 3D environment is represented on the at least one display.

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In some embodiments the view of the 3D environment comprises a viewing angle, a magnification factor, and/or a viewing position.

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In some embodiments the view of the 3D environment comprises rendering of texture and/or shading.

In some embodiments the at least one display is divided into multiple regions, each showing the 3D environment with a different view.

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Thus in some embodiments the user interface functionality comprises changing the view with which the 3D environment is displayed. Changes in view can comprise changes in viewing angle, viewing position, magnification and/or the like. A change in viewing angle can naturally be effected by rotating the device. Rotation is naturally sensed by the aid of gyros and/or relative to gravity sensed by an accelerometer. Zooming, i.e. a change in magnification, can for example be achieved by pushing the handheld device forward and backward, respectively. A translational change of the viewing position, i.e., panning, can for example be achieved by pushing the handheld device up/down and/or sideways.

25

In some embodiments the user interface functionality comprises selecting or choosing items on a display or any other functionality provided by graphical user interfaces in computers known in the art. The operator may perform the selection. The Lava C.O.S scanner marketed by 3M ESPE has additional buttons on the handheld device, but it is not possible to manipulate the view

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by these. Their only purpose is to allow navigation through a menu system, and to start/stop scanning.

5 In some embodiments the user interface functionality comprises manipulating the 3D environment displayed on the screen. For example, the operator may effect deformations or change the position or orientation of objects in the 3D environment. Thus, in some embodiments the user interface functionality comprises virtual user interface functionality, which can be that the 3D data are manipulated, but the physical 3D environment in which the device
10 operates may not be manipulated.

In some embodiments the handheld device is an intraoral scanner and/or an in-the-ear scanner. If the scanner comprises a tip, this tip may be exchanged whereby the scanner can become suitable for scanning in the mouth or in the
15 ear. Since the ear is a smaller cavity than the mouth, the tip for fitting into an ear may be smaller than a tip for fitting in the mouth.

In some embodiments the handheld device is a surgical instrument. In some embodiments, the surgical instrument comprises at least one motion sensor,
20 which is built-in in the instrument.

In some embodiments the handheld device is a mechanical tool. In some embodiments, the tool has at least one motion sensor built in. In other embodiments, other user-interface elements are built in as well, for example
25 buttons, scroll wheels, touch-sensitive fields, or proximity sensors.

In some embodiment the 3D geometry of the 3D environment is known a-priori or a 3D representation of the environment is known a priori, i.e. before the actions (s) are performed. For example in surgery, a CT scan may have
30 been taken before the surgical procedure. The handheld device in this example could be a surgical instrument that a physician needs to apply in the

proper 3D position. To make sure this proper position is reached, it could be beneficial to view the 3D environment from multiple perspectives interactively, i.e. without having to release the surgical instrument.

- 5 An advantage of the system, also in the above surgery example, is the ability of the handheld device to record the 3D environment at least partially, typically in a 3D field-of-view that is smaller than the volume represented in the a-priori data. The 3D data recorded by the handheld device can be registered in real time with the a-priori data, such that the position and
10 orientation of the device can be detected.

In some embodiments the 3D geometry comprises a 3D surface of the environment.

- 15 In some embodiments the 3D geometry comprises a 3D volumetric representation of the environment.

Thus the 3D environment can be displayed as volumetric data, or as surface, or a combination thereof. Volumetric data are typically represented by voxels.
20 Voxels can comprise multiple scalar values. Surface data are typically represented as meshed, such as triangulated meshes, or point clouds.

The scanning may be performed by means of LED scanning, laser light scanning, white light scanning, X-ray scanning, and/or CT scanning.
25

The present invention relates to different aspects including the system described above and in the following, and corresponding systems, methods, devices, uses, and/or product means, each yielding one or more of the benefits and advantages described in connection with the first mentioned
30 aspect, and each having one or more embodiments corresponding to the

embodiments described in connection with the first mentioned aspect and/or disclosed in the appended claims.

In particular, disclosed herein is a method of interaction between a handheld device and at least one display, where the method comprises the steps of:

5 - performing at least one action in a physical 3D environment by means of the handheld device;

- visually representing the physical 3D environment by the at least one display; and

10 - remotely controlling the view of the represented 3D environment on the display by means of the handheld device.

Furthermore, the invention relates to a computer program product comprising program code means for causing a data processing system to perform the method according to any of the embodiments, when said program code means are executed on the data processing system, and a computer program product, comprising a computer-readable medium having stored there on the program code means.

15

20 According to another aspect, disclosed is a system comprising a handheld device for operating in a 3D environment and at least one display for visualizing said environment, where the display is adapted to represent said environment from multiple perspectives,

where said device is adapted to be held in one hand by an operator, and

25 where the perspective represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

According to another aspect, disclosed is a system comprising a handheld device for operating in a 3D environment and at least one display for visualizing said environment, where the display is adapted to represent said environment in multiple views,

30

where said device is adapted to be held in one hand by an operator, where the view represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device, and where the device has at least one touch-sensitive user interface element.

5

Definitions

3D geometry: A constellation of matter or its virtual representation in a three-dimensional space.

10

3D environment: A constellation of physical objects each having a 3D geometry in a three-dimensional space.

View: The way a 3D environment is represented on a display. Geometrically, a view is determined by the virtual observer's/camera's position and orientation. If the display is two-dimensional, the view is also determined by the type of projection. A view may also be determined by a magnification factor. Graphically, a view can show the 3D environment by means of photographs or as some kind of virtual representation such as a computer graphic, or similar. A computer graphic can be rendered for example with texture and/or shading and/or virtual light sources and/or light models for surface properties. A computer graphic can also be a simplified representation of the 3D environment, for example a mesh, an outline, or an otherwise simplified representation. All or parts of the 3D environment can also be rendered with some degree of transparency. A view may represent the 3D environment in total or only parts thereof.

20

25

Functionality: A purpose or intended use.

30

Performing action(s) or operating functionality: Actions or functionality that includes some type of interaction with a 3D environment, such as measuring, modifying, manipulating, recording, touching, sensing, scanning, moving, transforming, cutting, welding, chemically treating, cleaning, etc. The term
5 “operating” is thus not directed to surgical procedures, but operating may comprise surgical procedures.

User Interface Functionality: Functionality for interaction between a human user and a machine with a display.
10

Handheld device: An object that has at least one functionality and that is held by a human operator’s hand or both hands while performing this at least one functionality.

15 3D scanner: A device that analyzes a real-world object or 3D environment to collect data on its shape and possibly its appearance.

Coverage of scan: The degree to which a physical surface is represented by recorded data after a scanning operation.

20

Motion sensor: A sensor detecting motion. Motion can be detected by: sound (acoustic sensors), opacity (optical and infrared sensors and video image processors), geomagnetism (magnetic sensors, magnetometers), reflection of transmitted energy (infrared laser radar, ultrasonic sensors, and
25 microwave radar sensors), electromagnetic induction (inductive-loop detectors), and vibration (triboelectric, seismic, and inertia-switch sensors). MEMS accelerometers, gyros, and magnetometers are examples of motions sensors.

30 Workflow: a sequence of tasks implemented in software.

Brief description of the drawings

5 The above and/or additional objects, features and advantages of the present invention, will be further elucidated by the following illustrative and non-limiting detailed description of embodiments of the present invention, with reference to the appended drawings, wherein:

10 Fig. 1 shows an example of the system comprising a handheld device and a display.

Fig. 2 shows an example of user interface functionality in the form of remote controlling using the handheld device.

15 Fig. 3 shows an example of the handheld device.

Fig. 4 shows an example of a flow-chart of a method of interaction between a handheld device and a display.

20

Detailed description

In the following description, reference is made to the accompanying figures, which show by way of illustration how the invention may be practiced.

25

Fig. 1 shows an example of the system comprising a handheld device and a display. The handheld device 100 is in this example an intraoral dental scanner, which records the 3D geometry of the patient's teeth. The operator 102 moves the scanner along the teeth of the patient 104 for capturing the
30 3D geometry of the relevant teeth, e.g. all teeth. The scanner comprises motion sensors (not visible) for taken the movement of the scanner into

account while creating the 3D model 105 of the scanned teeth. The display 101 is in this example a PC screen displaying the data recorded by the scanner.

5 Fig. 2 shows an example of user interface functionality in the form of remote controlling using the handheld device. The motion sensors (not shown) in the handheld device 100, e.g. scanner, provide that the user 102 can determine the view shown on the display 101, e.g. screen, by moving the handheld device 100.

10 Fig. 2a) shows that pointing the device 100 down can provide that the 3D model 105 of the scanned teeth is shown from a downward viewing angle. Fig. 2b) shows that holding the scanner in a horizontal position can provide that the viewing angle is likewise horizontally from the front, such that the 3D model 105 of the scanned teeth is shown from the front.

15

Fig. 3 shows an example of the handheld device.

The handheld device 100 is in this example an intraoral scanner with a pistol-grip. The scanner comprises a housing 106 comprising the pistol-grip part 107, and a tip 108 adapted for insertion in the mouth of the patient. In this
20 example the scanner also is equipped with a button 103 which is an additional element providing user-interface functionality.

The example system as shown in fig. 1, fig. 2 and fig. 3 comprises a device
25 100 which is a handheld intraoral scanner and a display 101 which is a computer screen. The operator 102 may be a dentist, an assistant and/or the like. In an example, the action performance or operation functionality of the device 100 is to record some intraoral 3D geometry, and the user interface functionality is to rotate, pan, and zoom the 3D model 105 of the scanned data on the computer screen 101. The integration of the user interface
30 functionality in the device 100 is provided by motion sensors (not visible), which can be accelerometers inside the scanner 100, whose readings

determine the orientation, as seen in Figs 2a and 2b, of the display on the screen of the 3D model 105 of the teeth acquired by the scanner 100. Additional functionality, e.g. to start/stop scanning, may be provided by the button 103 as seen in fig. 3. In the example system, the button 103 is located
5 where the user's index finger can reach it conveniently.

In fig. 1 the dentist 102 uses two hands to hold the intraoral scanner 100 while scanning, but it is understood that the scanner 100 can also be held with one hand while scanning. The device 100 can also be held with one or
10 two hands, while changing the perspective of the 3D model 105 in the display 101. The example shown in Figure 1 thus illustrates the advantage of the touchless user interface functionality, because in many clinical situations, the operator 102 should maintain both hands clean, disinfected, or even sterile.

15 The 3D user interface functionality may be exploited in a separate location than the operation functionality. For the above intraoral scanning system example, the scanning operation is performed in the oral cavity of the patient, see fig. 1, while the user interface functionality is more flexibly exploited when the scanner is outside the patient's mouth, see figs 2 and 3.

20

Fig. 4 shows an example of a flow-chart of a method of interaction between a handheld device and a display.

In step 101 at least one action in a physical 3D environment is performed by means of the handheld device. This action may be the scanning of teeth as
25 shown in fig. 1.

In step 102 the physical 3D environment is visually represented by the at least one display. This may be the display of the 3D model of the scanned teeth as seen in fig 1.

In step 103 the view of the represented 3D environment shown on the display
30 is remotely controlled on the display by means of the handheld device. This may be the control of the viewing angle of the 3D model as seen in fig. 2.

All the steps of the method may be repeated one or more times. The order in which the steps are performed may be different than the order described above, which is indicated by the dotted lines in the figure. If one or more of the steps are performed more times, the order of the steps may also be
5 different.

Although some embodiments have been described and shown in detail, the invention is not restricted to them, but may also be embodied in other ways within the scope of the subject matter defined in the following claims. In
10 particular, it is to be understood that other embodiments may be utilised and structural and functional modifications may be made without departing from the scope of the present invention.

In device claims enumerating several means, several of these means can be embodied by one and the same item of hardware. The mere fact that certain
15 measures are recited in mutually different dependent claims or described in different embodiments does not indicate that a combination of these measures cannot be used to advantage.

20 It should be emphasized that the term "comprises/comprising" when used in this specification is taken to specify the presence of stated features, integers, steps or components but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

25 The features of the method described above and in the following may be implemented in software and carried out on a data processing system or other processing means caused by the execution of computer-executable instructions. The instructions may be program code means loaded in a memory, such as a RAM, from a storage medium or from another computer
30 via a computer network. Alternatively, the described features may be

implemented by hardwired circuitry instead of software or in combination with software.

5 **Literature:**

C. Graetzel, T. Fong, S. Grange, and C. Baur. A Non-Contact Mouse for Surgeon-Computer Interaction. *Technology and Health Care*, 12(3), 2004.

- 10 Vogt S., Khamene A., Niemann H., Sauer F., An AR system with intuitive user interface for manipulation and visualization of 3D medical data, *Stud. Health Technol. Inform.* 2004;98, pp. 397-403.

15

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PTO/SB/16 (04-07)

Approved for use through 06/30/2010 OMB 0651-0032

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Provisional Application for Patent Cover Sheet

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c)

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All Inventors Must Be Listed – Additional Inventor Information blocks may be generated within this form by selecting the **Add** button.

Title of Invention

System with 3D user interface integration

Attorney Docket Number (if applicable)

3SHAPEP015P

Correspondence Address

Direct all correspondence to (select one):

The address corresponding to Customer Number Firm or Individual Name

Customer Number

64974

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

No.

Yes, the name of the U.S. Government agency and the Government contract number are:

Doc Code: **TR.PROV**

Document Description: Provisional Cover Sheet (SB16)

PTO/SB/16 (04-07)

Approved for use through 06/30/2010 OMB 0651-0032

U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

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Entity Status

Applicant claims small entity status under 37 CFR 1.27

- Yes, applicant qualifies for small entity status under 37 CFR 1.27
 No

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Signature

Please see 37 CFR 1.4(d) for the form of the signature.

Signature	/Fredrik Mollborn/			Date (YYYY-MM-DD)	2010-12-06
First Name	Fredrik	Last Name	Mollborn	Registration Number (If appropriate)	48587

This collection of information is required by 37 CFR 1.51. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. **DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. This form can only be used when in conjunction with EFS-Web. If this form is mailed to the USPTO, it may cause delays in handling the provisional application.**

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
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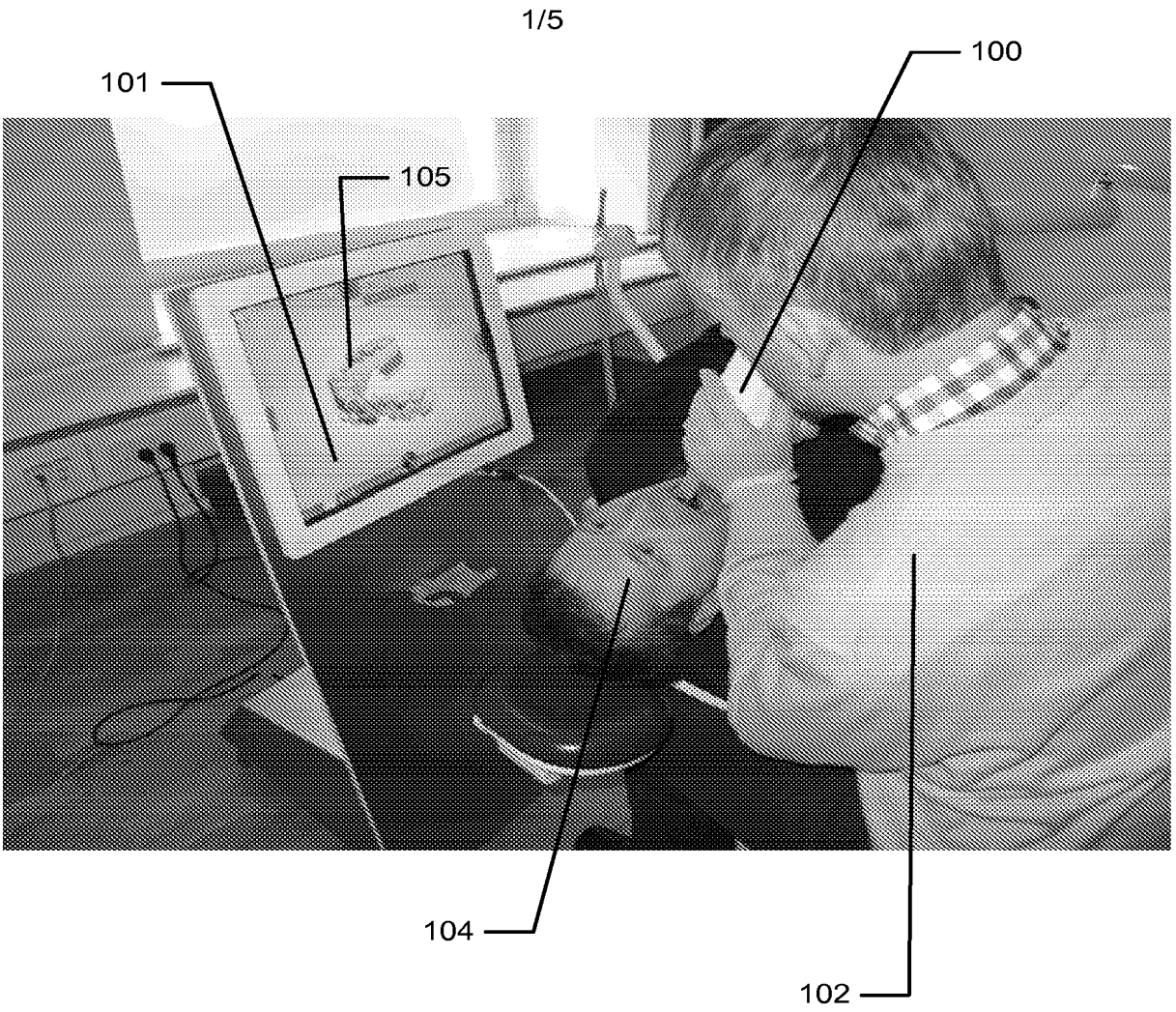


Fig. 1

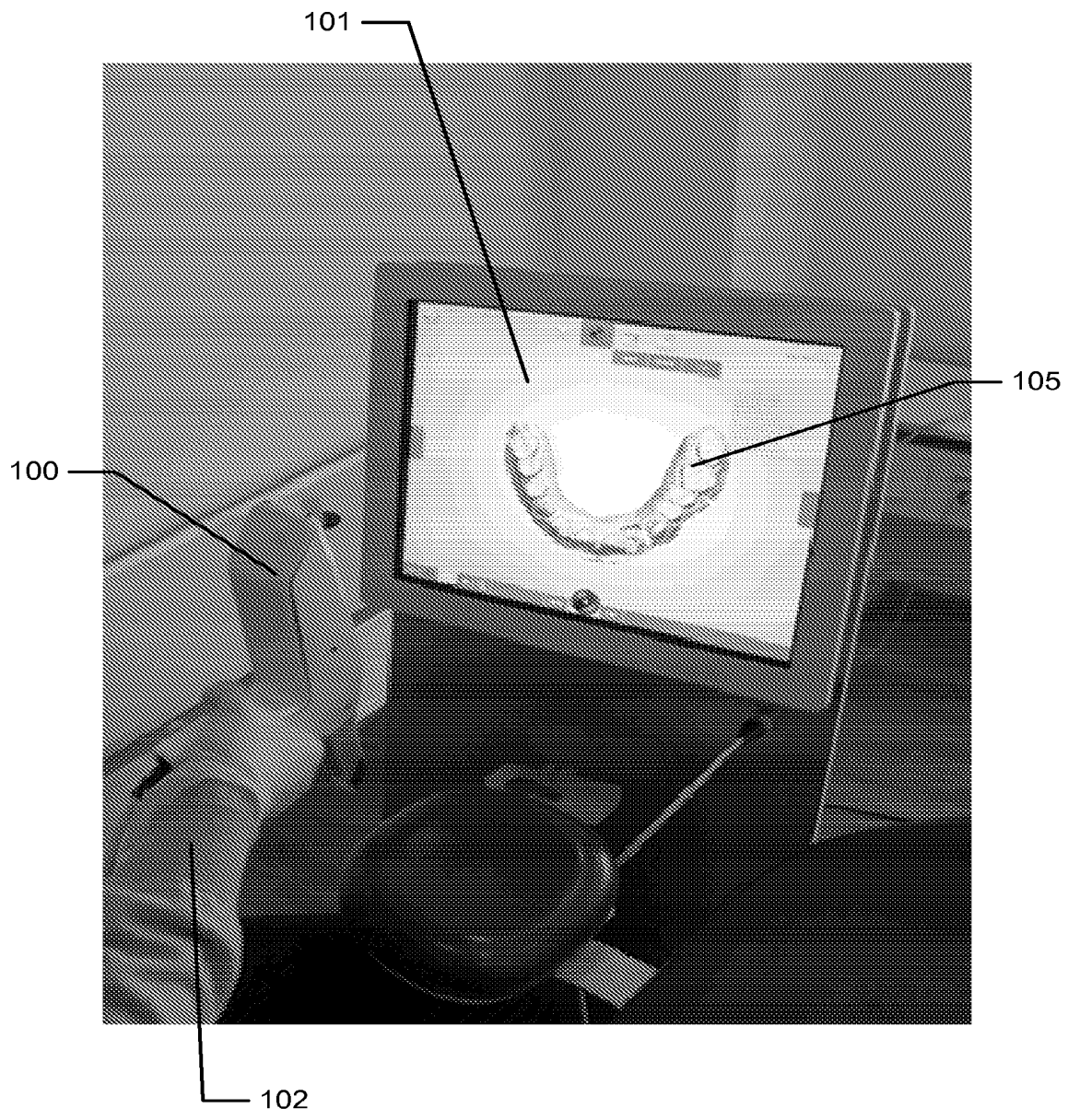


Fig. 2a)

3/5

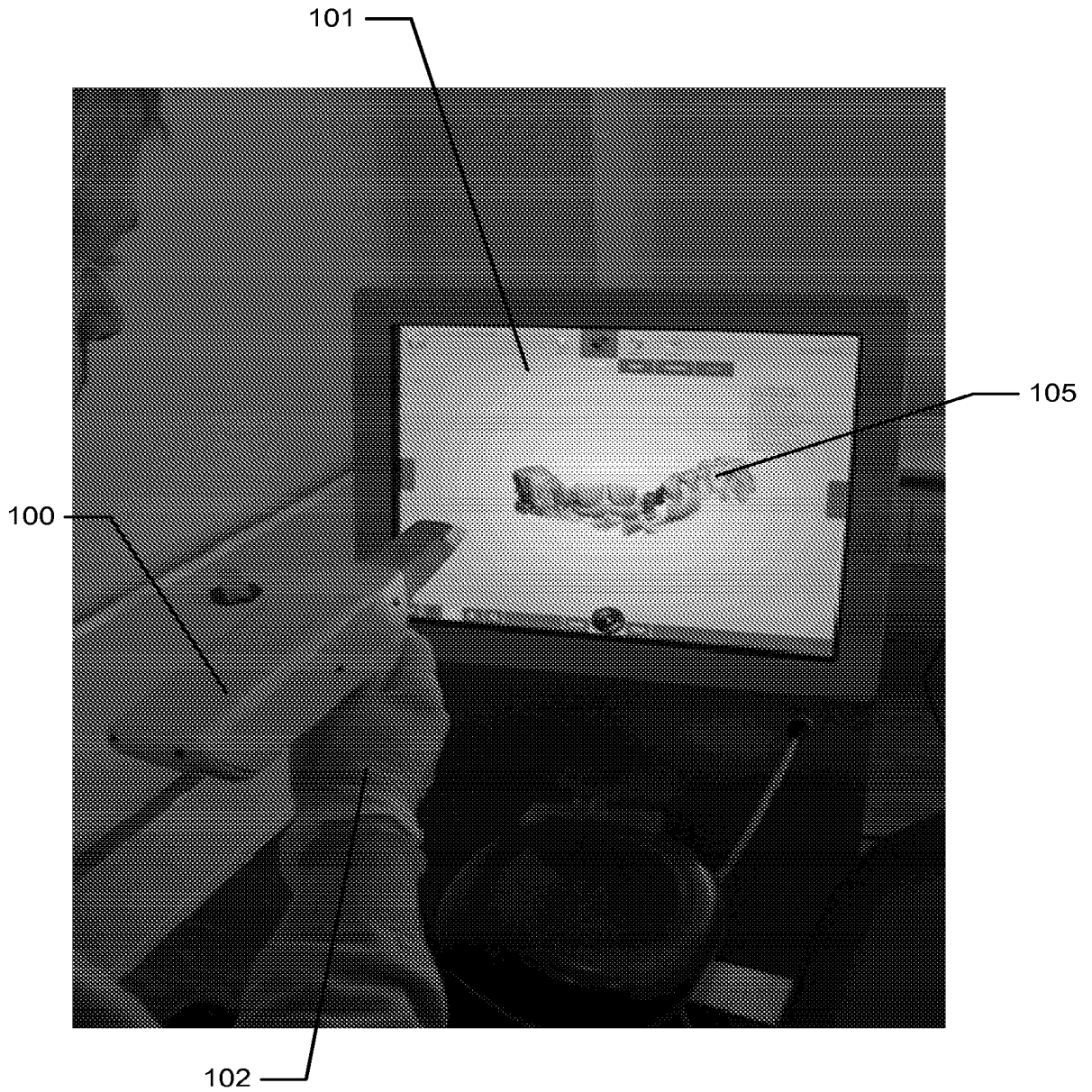


Fig. 2b)

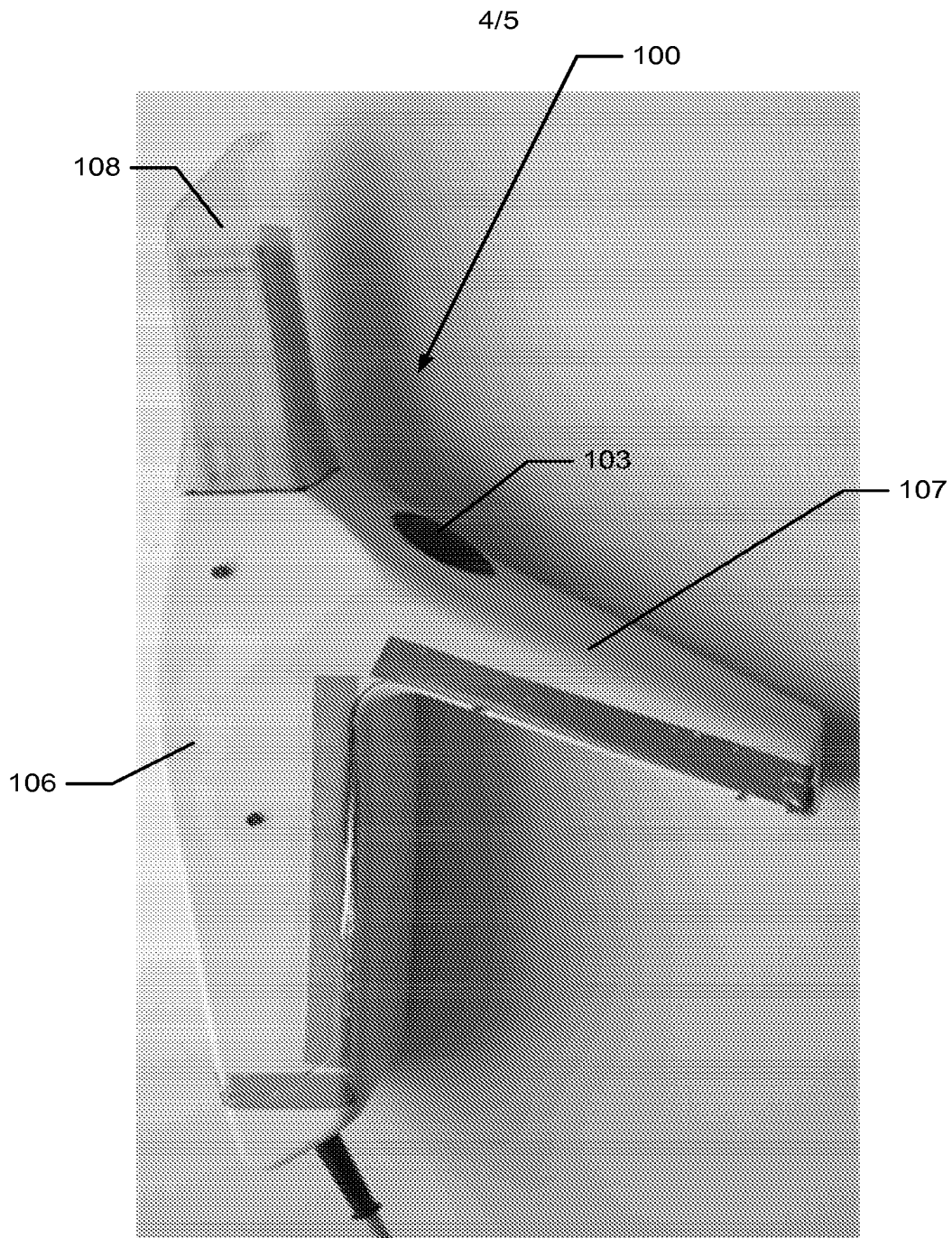


Fig. 3

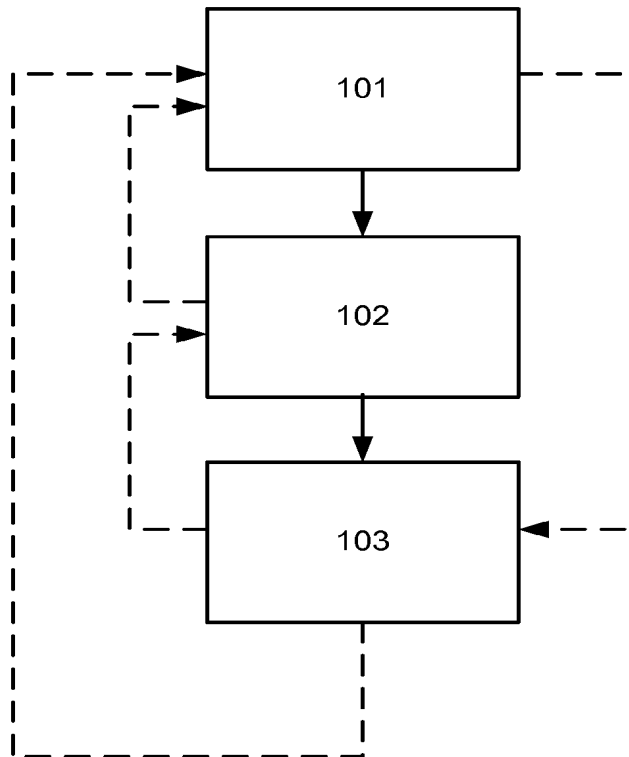


Fig. 4

Electronic Acknowledgement Receipt

EFS ID:	8975128
Application Number:	61420138
International Application Number:	
Confirmation Number:	8620
Title of Invention:	System with 3D user interface integration
First Named Inventor/Applicant Name:	Karl J. Hollenbeck
Customer Number:	64974
Filer:	Fredrik Mollborn
Filer Authorized By:	
Attorney Docket Number:	3SHAPEP015P
Receipt Date:	06-DEC-2010
Filing Date:	
Time Stamp:	17:19:15
Application Type:	Provisional

Payment information:

Submitted with Payment	yes
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RAM confirmation Number	3782
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1		Provisional_Spec_Claims_Abstr act.pdf	118805 <small>3b6661869a91e1d5baeb7fcb86eac12bccd 20ec5</small>	yes	32
Multipart Description/PDF files in .zip description					
		Document Description	Start	End	
		Specification	1	24	
		Claims	25	31	
		Abstract	32	32	
Warnings:					
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2	Drawings-other than black and white line drawings	Provisional_Drawings.pdf	6403892 <small>76daf566f15872257e61acf9d45402da2e56 8b29</small>	no	5
Warnings:					
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3	Provisional Cover Sheet (SB16)	ProvisionalSB.pdf	1000153 <small>b54b90b648e81878cb89156f3bfcc3de593 a6f58</small>	no	3
Warnings:					
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4	Fee Worksheet (PTO-875)	fee-info.pdf	29024 <small>6a/b02ff60cd856231a4029/281a45c/a694 9fd6</small>	no	2
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New International Application Filed with the USPTO as a Receiving Office

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DOCUMENT MADE AVAILABLE UNDER THE PATENT COOPERATION TREATY (PCT)

International application number:	PCT/DK2011/050461
International filing date:	05 December 2011 (05.12.2011)
Document type:	Certified copy of priority document
Document details:	Country/Office: US
	Number: 61/420,138
	Filing date: 06 December 2010 (06.12.2010)
Date of receipt at the International Bureau:	19 December 2011 (19.12.2011)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a),(b) or (b-bis)

PCT REQUEST

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0	For receiving Office use only	
0-1	International Application No.	PCT/DK2011/050461
0-2	International Filing Date	05 December 2011 (05.12.2011)
0-3	Name of receiving Office and "PCT International Application"	RO/DK
0-4	Form PCT/RO/101 PCT Request	
0-4-1	Prepared Using	PCT Online Filing Version 3.5.000.225 MT/FOP 20020701/0.20.5.20
0-5	Petition The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	Receiving Office (specified by the applicant)	Danish Patent and Trademark Office (RO/DK)
0-7	Applicant's or agent's file reference	P2635PC00
I	Title of Invention	System with 3D user interface integration
II	Applicant	
II-1	This person is	Applicant only
II-2	Applicant for	All designated States except US
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II-6	State of nationality	DK
II-7	State of residence	DK
II-8	Telephone No.	-
II-9	Facsimile No.	-
III-1	Applicant and/or inventor	
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III-1-2	Applicant for	US only
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III-1-7	State of residence	DK

PCT REQUEST

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III-2-1	This person is	Applicant and inventor
III-2-2	Applicant for	US only
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III-2-6	State of nationality	SE
III-2-7	State of residence	DK
III-3	Applicant and/or inventor	
III-3-1	This person is	Applicant and inventor
III-3-2	Applicant for	US only
III-3-4	Name (LAST, First)	FISCHER, David
III-3-5	Address	Rådyrleddet 16 3660 Stenløse Denmark
III-3-6	State of nationality	DK
III-3-7	State of residence	DK
IV-1	Agent or common representative; or address for correspondence	
	The person identified below is hereby/ has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	Agent
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IV-1-2	Address	St. Kongensgade 59 A 1264 Copenhagen K Denmark
IV-1-3	Telephone No.	+4533320337
IV-1-4	Facsimile No.	+4533320384
IV-1-5	e-mail	hoiberg@hoiberg.com
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IV-1-6	Agent's registration No.	100061385
V	DESIGNATIONS	
V-1	The filing of this request constitutes under Rule 4.9(a), the designation of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.	

PCT REQUEST

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VI-1	Priority claim of earlier national application	
VI-1-1	Filing date	06 December 2010 (06.12.2010)
VI-1-2	Number	PA 2010 01104
VI-1-3	Country	DK
VI-2	Priority claim of earlier national application	
VI-2-1	Filing date	06 December 2010 (06.12.2010)
VI-2-2	Number	61/420,138
VI-2-3	Country	US
VI-3	Priority document request The International Bureau is requested to obtain from a digital library a certified copy of the earlier application(s) identified above as item(s):	VI-2
VI-4	Priority document request The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s):	VI-1
VI-5	Incorporation by reference : where an element of the international application referred to in Article 11(1)(iii)(d) or (e) or a part of the description, claims or drawings referred to in Rule 20.5(a) is not otherwise contained in this international application but is completely contained in an earlier application whose priority is claimed on the date on which one or more elements referred to in Article 11(1)(iii) were first received by the receiving Office, that element or part is, subject to confirmation under Rule 20.6, incorporated by reference in this international application for the purposes of Rule 20.6.	
VII-1	International Searching Authority Chosen	Nordic Patent Institute (ISA/XN)
VII-2	Request to use results of earlier search; reference to that search	
VII-2-1	Filing date	06 December 2010 (06.12.2010)
VII-2-2	Application Number	PA 2010 01104
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PCT REQUEST

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VIII		Declarations		Number of declarations			
VIII-1	Declaration as to the identity of the inventor	-					
VIII-2	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent	-					
VIII-3	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application	-					
VIII-4	Declaration of inventorship (only for the purposes of the designation of the United States of America)	-					
VIII-5	Declaration as to non-prejudicial disclosures or exceptions to lack of novelty	-					
IX		Check list		Number of sheets		Electronic file(s) attached	
IX-1	Request (including declaration sheets)		5				✓
IX-2	Description		33				✓
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IX-5	Drawings		5				✓
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IX-8	Fee calculation sheet		-				✓
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X-1-2	Name of signatory	DK, Hoiberg A/S, P. Gaarde 19388					
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10-6	Transmittal of search copy delayed until search fee is paid	

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11-1	Date of receipt of the record copy by the International Bureau	
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From the INTERNATIONAL BUREAU

PCTNOTIFICATION OF THE RECORDING
OF A CHANGE(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

To:

MÜNZER, Marc
Guardian IP Consulting I/S
Diplomvej, Building 381
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Date of mailing (day/month/year) 24 May 2012 (24.05.2012)	
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1. The following indications appeared on record concerning:

the applicant the inventor the agent the common representative

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2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

the person the name the address the nationality the residence

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3. Further observations, if necessary:

4. A copy of this notification has been sent to:

the receiving Office the International Preliminary Examining Authority
 the International Searching Authority the designated Offices concerned
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[Continued on next page]

(54) **Title:** SYSTEM WITH 3D USER INTERFACE INTEGRATION

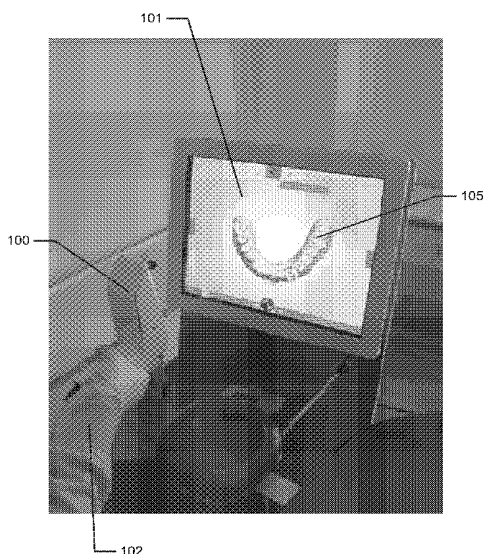


Fig. 2a)

(57) **Abstract:** Disclosed is a system comprising a handheld device (100) and at least one display (101), where the handheld device (100) is adapted for performing at least one action in a physical 3D environment. The actions include measuring, modifying, manipulating, recording, touching, sensing, scanning, moving, transforming, cutting, welding, chemically treating, cleaning. The display (101) is adapted for visually representing the physical 3D environment, and where the handheld device (100) is adapted for remotely controlling the view with which the 3D environment is represented on the display (101).

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System with 3D user interface integration

Field of the invention

- 5 This invention generally relates to a method and a system comprising a handheld device and at least one display.

Background of the invention

- 10 3D visualization is important in many fields of industry and medicine, where 3D information is becoming more and more predominant.

Displaying and inspecting 3D information is inherently difficult. To fully understand a 3D object or entire environment on a screen, the user should generally be able to rotate the object or scene, such that many or preferentially all surfaces are displayed. This is true even for 3D displays, e.g. stereoscopic or holographic, where from a given viewing position and with a given viewing angle, the user will only see some surfaces of an arbitrary 3D environment. Often, the user will also want to zoom into details or zoom out for an overview.

20 Various user interaction devices are in use for software that displays 3D data; these devices are: 3D mice, space balls, and touch screens. The operation of these current interaction devices requires physically touching them.

25 Physically touching a user-interaction device can be a disadvantage in medical applications due to risks of cross-contamination between patients or between patient and operator, or in industrial applications in dirty environments.

30

Several non-touch user interfaces for 3D data viewing in medical applications have been described in the literature. Vogt et al (2004) describe a touchless interactive system for in-situ visualization of 3D medical imaging data. The user interface is based on tracking of reflective markers, where a camera is mounted on the physician's head. Graetzel et al (2004) describe a touchless system that interprets hand gestures as mouse actions. It is based on stereo vision and intended for use in minimally invasive surgery.

It remains a problem to improve systems that require user interfaces for view control, which for example can be used for clinical purposes.

Summary

Disclosed is a system comprising a handheld device and at least one display, where the handheld device is adapted for performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment, and where the handheld device is adapted for remotely controlling the view with which said 3D environment is represented on the display.

The system may be adapted for switching between performing the at least one action in the physical 3D environment, and remotely controlling the view with which the 3D environment is represented on the display.

The system disclosed here performs the integration of 3D user interface functionality with any other handheld device with other operating functionality, such that the operator ideally only touches this latter device that is intended to be touched. A particular example of such a handheld device is one that records some 3D geometry, for example a handheld 3D scanner.

30

The handheld device is a multi-purpose device, such as a dual-purpose or two-purpose device, i.e. a device both for performing actions in the physical 3D environment, such as measuring and manipulating, and for remotely controlling the view of the 3D environment on the display.

5

Geometrically, a view is determined by the virtual observer's/camera's position and orientation relative to the 3D environment or its visual representation. If the display is two-dimensional, the view is also determined by the type of projection. A view may also be determined by a magnification

10 factor.

The virtual observer's and the 3D environment's position and orientation are always relative to each other. In terms of user experience in software systems with 3D input devices, the user may feel that for example, he/she is

15 moving the 3D environment while remaining stationary himself/herself, but there is always an equivalent movement of the virtual observer/camera that gives the same results on the display. Often, descriptions of 3D software systems use the expression "pan" to indicate an apparent translational movement of the 3D environment, "rotate" to indicate a rotational movement

20 of the 3D environment, and "zoom" to indicate a change in magnification factor.

Graphically, a view can represent a 3D environment by means of photographs or as some kind of virtual representation such as a computer

25 graphic, or similar. A computer graphic can be rendered for example with texture and/or shading and/or virtual light sources and/or light models for surface properties. A computer graphic can also be a simplified representation of the 3D environment, for example a mesh, an outline, or an otherwise simplified representation. All or parts of the 3D environment can

30 also be rendered with some degree of transparency. A view may represent the 3D environment in total or only parts thereof.

All of the touch-less prior art systems are 3D user interface devices only. In many prior art applications, the operator using such user interface device will also hold and work with another device that really is the central device in the overall application, e.g. a medical instrument.

It is thus an advantage of the present system that the 3D user-interface functionality is integrated in the central device, which is used for performing some kind of action.

In some embodiments the handheld device is adapted for remotely controlling the magnification with which the 3D environment is represented on the display.

In some embodiments the handheld device is adapted for changing the rendering of the 3D environment on the display.

In some embodiments the view is defined as viewing angle and/or viewing position.

In some embodiments the at least one action comprises one or more of the actions of:

- measuring,
- recording,
- scanning,
- manipulating,
- modifying.

In some embodiments the 3D environment comprises one or more 3D objects.

In some embodiments the handheld device is adapted to be held in one hand by an operator.

5 In some embodiments the display is adapted to represent the 3D environment from multiple views.

In some embodiments the display is adapted to represent the 3D environment from different viewing angles and/or viewing positions.

10 In some embodiments the view of the 3D environment in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

15 In some embodiments the magnification represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

In some embodiments the handheld device is adapted to record the 3D geometry of the 3D environment.

20

Thus the handheld device may be an intraoral dental scanner, which records the 3D geometry of a patient's teeth. The operator may move the scanner along the teeth of the patient for capturing the 3D geometry of the relevant teeth, e.g. all teeth. The scanner may comprise motion sensors for taking the movement of the scanner into account while creating the 3D model of the scanned teeth.

25

The 3D model of the teeth may be shown on a display, and the display may for example be a PC screen and/or the like.

30

The user interface functionality may comprise incorporating motion sensors in the scanner to provide that the user can determine the view on the screen by moving the scanner. Pointing the scanner down can provide that the scanned teeth are shown given a downward viewing angle. Holding the scanner in a horizontal position can provide that the viewing angle is likewise horizontal.

In some embodiments the handheld device comprises at least one user-interface element. A user-interface element is an element which the user may manipulate in order to activate a function on the user interface of the software. Typically the use interface is graphically presented on the display of the system.

The handheld device may furthermore be provided with an actuator, which switches the handheld device between performing the at least one action and remotely controlling the view. By providing such a manual switching function that enables the operator to switch between performing the at least one action and remotely controlling the view, the operator may easily control what is performed.

Such an actuator can for example be in the form of a button, switch or contact. In other embodiments it could be a touch sensitive surface or element.

In another embodiment the actuator could be a motion sensor provided in the handheld device that function as the actuator when it registers a specific type of movement, for example if the operator shakes the handheld device. Examples of such motion sensors will be described herein with respect to the user-interface element, however, the person skilled in the art will based on the disclosure herein understand that such motion sensors may also be used as actuators as discussed.

For example, the handheld device can in one embodiment be an intra-oral 3D scanner used by a dentist. The scanner is set to be performing the action of scanning a dental area when the actuator is in one position. When the
5 actuator is switched into a second position the handheld is set to control the view with which the 3D environment is represented on the display. This could for example be that when the dentist have scanned a part of or the complete desired area of an dental arch he can activate the actuator which then allows the dentist to remotely control the view of the 3D representation of the
10 scanned area on the display by using the handheld device.

For example, the actuator could be a button. When the button is pressed quickly the handheld device is prepared for scanning, i.e. it is set for performing at least one action, the scanning procedure, in the physical 3D
15 environment. The scanning is stopped when the button is pressed quickly a second time.

While the scanning is performed a virtual 3D representation is visually built on the display.
20

The user can now press and hold the button. This will put the handheld in a controller mode, where the handheld device is adapted for remotely controlling the view with which the 3D environment, such as scanned teeth, is represented on the display. While holding the button pressed the system will
25 use signals from a motion sensor in the handheld device to determine how to present the view of the virtual 3D environment. Thus, if the user turns or otherwise moves the hand that holds the handheld device the view of the virtual 3D environment on the display will change accordingly.

30 Thus, the dentist may use the same handheld device for both scanning an area and subsequently verifying that the scan has been executed correctly

without having to move away from the patient or touching any other equipment than already present in his hands.

5 In one embodiment the user-interface element is the same as the actuator, or where several user-interface elements are present at least one also functions as an actuator.

The system may be equipped with a button as an additional element providing the user-interface functionality.

10 In an example the handheld device is a handheld intraoral scanner, and the display is a computer screen. The operator or user may be a dentist, an assistant and/or the like. The operation functionality of the device may be to record some intraoral 3D geometry, and the user interface functionality may be to rotate, pan, and zoom the scanned data on the computer screen.

15

In some embodiments the at least one user-interface element is at least one motion sensor.

20 Thus the integration of the user interface functionality in the device may be provided by motion sensors, which can be accelerometers inside the scanner, whose readings determine the orientation of the display on the screen of the 3D model of the teeth acquired by the scanner. Additional functionality, e.g. to start/stop scanning, may be provided by a button. The button may be located where the operator's or user's index finger can reach it
25 conveniently.

Prior art intraoral scanners use a touch screen, a trackball, or a mouse to determine the view in the display. These prior art user interface devices can be inconvenient, awkward and difficult to use, and they can be labor-
30 intensive, and thus costly to sterilize or disinfect. An intraoral scanner should always be disinfected between scanning different patients, because the

scanner is in and may come in contact with the mouth or other parts of the patient being scanned.

5 The operator or user, e.g. dentist, may use one hand or both hands to hold the intraoral scanner while scanning, and the scanner may be light enough and comfortable to be held with just one hand for a longer time while scanning.

10 The device can also be held with one or two hands, while using the device as remote control for e.g. changing the view in the display. It is an advantage of the touchless user interface functionality that in clinical situations, the operator can maintain both hands clean, disinfected, or even sterile.

15 An advantage of the system is that it allows an iterative process of working in a 3D environment without releasing the handheld device during said process. For the above intraoral scanning system example, the operator, e.g. dentist, can record some teeth surface geometry with a handheld device that is an intraoral scanner, inspect coverage of the surface recording by using that same handheld device to move, e.g. rotate, the recorded surface on the display, e.g. a computer screen, detect possible gaps or holes in the coverage of the scanned teeth, and then for example arrange the scanner in the region where the gaps were located and continue recording teeth surface geometry there. Over this entire iterative cycle, which can be repeated more than once, such as as many times as required for obtaining a desired scan coverage of the teeth, the dentist does not have to lay the handheld intraoral scanner out of his or her hands.

20

25

30 In some embodiments, the 3D user interface functionality is exploited in a separate location than the operation functionality. For the above intraoral scanning system example, the scanning operation is performed in the oral cavity of the patient, while the user interface functionality is more flexibly

exploited when the scanner is outside the patient's mouth. The key characteristic and advantage of the system, again, is that the dentist can exploit the dual and integrated functionality, that is operation and user interface, of the scanner without laying it out of his or her hands.

5

The above intraoral scanning system is an example of an embodiment. Other examples for operation functionality or performing actions could be drilling, welding, grinding, cutting, soldering, photographing, filming, measuring, executing some surgical procedure etc..

10

The display of the system can be a 2D computer screen, a 3D display that projects stereoscopic image pairs, a volumetric display creating a 3D effect, such as a swept-volume display, a static volume display, a parallax barrier display, a holographic display etc.. Even with a 3D display, the operator has only one viewing position and viewing angle relative to the 3D environment at a time. The operator can move his/her head to assume another viewing position and/or viewing angle physically, but generally, it may be more convenient to use the handheld device with its built-in user interface functionality, e.g. the remote controlling, to change the viewing position and/or viewing angle represented in the display.

15

20

In some embodiments the system comprises multiple displays, or one or more displays that are divided into regions. For example, several sub-windows on a PC screen can represent different views of the 3D environment. The handheld device can be used to change the view in all of them, or only some of them.

25

In some embodiments the user interface functionality comprises the use of gestures.

Gestures made by e.g. the operator can be used to change, shift or toggle between sub-windows, and the user-interface functionality can be limited to an active sub-window or one of several displays.

- 5 In some embodiments the gestures are adapted to be detected by the at least one motion sensor. Gestures can alternatively and/or additionally be detected by range sensors or other sensors that record body motion.

10 The operator does not have to constantly watch the at least one display of the system. In many applications, the operator will shift between viewing and possible manipulating the display and performing another operation with the handheld device. Thus it is an advantage that the operator does not have to touch other user interface devices. However, in some cases it may not be possible for the operator to fully avoid touching other devices, and in these
15 cases it is an advantage that fewer touches are required compared to a system where a handheld device does not provide any user interface functionality at all.

20 In some embodiments the at least one display is arranged separate from the handheld device.

In some embodiments the at least one display is defined as a first display, and where the system further comprises a second display.

- 25 In some embodiments the second display is arranged on the handheld device.

30 In some embodiments the second display is arranged on the handheld device in a position such that the display is adapted to be viewed by the operator, while the operator is operating the handheld device.

In some embodiments the second display indicates where the handheld device is positioned relative to the 3D environment.

5 In some embodiments the first display and/or the second display provides instructions for the operator.

The display(s) can be arranged in multiple ways. For example, they can be mounted on a wall, placed on some sort of stand or a cart, placed on a rack or desk, or other.

10

In some embodiments at least one display is mounted on the device itself. It can be advantageous to have a display on the device itself because with such an arrangement, the operator's eyes need not focus alternatingly between different distances. In some cases, the operating functionality may require a close look at the device and the vicinity of the 3D environment it operates in, and this may be at a distance at most as far away as the operator's hand. Especially in crowded environments such as dentist's clinics, surgical operation theatres, or industrial workplaces, it may be difficult to place an external display closely to the device.

20

In some embodiments visual information is provided to the operator on one or more means other than the first display.

25 In some embodiments audible information to the operator is provided to the operator.

30 Thus in some embodiments, the system provides additional information to the operator. In some embodiments, the system includes other visual clues shown on means other than the display(s), such as LEDs on the device. In some embodiments, the system provides audible information to the operator, for example by different sounds and/or by speech.

Said information provided to the operator can comprise instructions for use, warnings, and the like.

5 The information can aid with improving the action performance or operation functionality of the device, for example by indicating how well an action or operation is being performed, and/or instructions to the operator aimed at improving the ease of the action or operation and/or the quality of the action or operation's results. For example, a LED can change in color and/or flashing frequency. In a scanner, the information can relate to how well the scanned 3D environment is in focus and/or to scan quality and/or to scan coverage. The information can comprise instructions on how best to position the scanner such as to attain good scan quality and/or scan coverage. The instructions can be used for planning and/or performing bracket placement. The instructions can be in the form of a messenger system to the operator.

15

In some embodiments, some 3D user interface functionality is provided by at least one motion sensor built into the device. Examples of motion sensors are accelerometers, gyros, and magnetometers and/or the like. These sensors can sense rotations, lateral motion, and/or combinations thereof. Other motion sensors use infrared sensing. For example, at least one infrared sensor can be mounted on the device and at least one infrared emitter can be mounted in the surroundings of the device. Conversely, the at least one emitter can be mounted on the device, and the at least one sensors in the surroundings. Yet another possibility is to use infrared reflector(s) on the device and both sensor(s) and emitter(s) on the surroundings, or again conversely. Thus motion can be sensed by a variety of principles.

20
25

Through proper signal processing, some sensors can recognize additional operator actions; for example gestures such as taps, waving, or shaking of the handheld device. Thus, these gestures can also be exploited in the 3D user interface functionality.

30

In some embodiments the handheld device comprises at least two motion sensors providing sensor fusion. Sensor fusion can be used to achieve a better motion signal from for example raw gyro, accelerometer, and/or magnetometer data. Sensor fusion can be implemented in ICs such as the InvenSense MPU 3000.

In some embodiments the handheld device comprises at least one user-interface element other than the at least one motion sensor.

In some embodiments the at least one other user-interface element is a touch-sensitive element.

In some embodiments the at least one other user-interface element is a button.

In some embodiments the at least one other user-interface element is a scroll-wheel.

In some embodiments, user interface functionality is provided through additional elements on the device. Thus these additional elements can for example be buttons, scroll wheels, touch-sensitive fields, proximity sensors and/or the like.

The additional user interface elements can be exploited or utilized in a workflow suitable for the field of application of the device. The workflow may be implemented in some user software application that may also control the display and thus the view represented thereon. A given interface element can supply multiple user inputs to the software. For example, a button can provide both a single click and a double click. For example, a double click can mean to advance to a subsequent step in a workflow. For the example of

intraoral scanning, three steps within the workflow can be to scan the lower mouth, the upper mouth, and the bite. A touch-sensitive field can provide strokes in multiple directions each with a different effect, etc. Providing multiple user inputs from a user interface elements is advantageous because
5 the number of user interface elements on the device can be reduced relative to a situation where each user interface element only provides one user input.

The motion sensors can also be exploited in a workflow. For example, lifting
10 the device, which can be sensed by an accelerometer, can represent some type of user input, for example to start some action. In a device that is a scanner, it may start scanning. Conversely, placing the device back in some sort of holder, which can be sensed by an accelerometer as no acceleration occur over some period of time, can stop said action.

15

If the action performed by the device is some kind of recording, for example scanning, for example 3D scanning, the results of the recording can also be exploited as user inputs, possibly along with user inputs from other user interface elements. For example, with a 3D scanner with a limited depth of
20 field, it may be possible to detect whether any objects within the 3D environments are present in the volume corresponding to this depth of field by detecting whether any 3D points are recorded. User inputs can depend on such detected presence. For example, a button click on an intraoral scanner can provide a different user input depending on whether the scanner is in the
25 mouth, where teeth are detectable, or significantly away from and outside the mouth. Also the effect of motion sensor signals can be interpreted differently for either situation. For example, the scanner may only change the view represented on the display when it is outside the mouth.

In some embodiments the handheld device is adapted to change a viewing angle with which the 3D environment is represented on the at least one display.

- 5 In some embodiments the handheld device is adapted to change a magnification factor with which the 3D environment is represented on the at least one display.

- 10 In some embodiments the handheld device is adapted to change a viewing position with which the 3D environment is represented on the at least one display.

In some embodiments the view of the 3D environment comprises a viewing angle, a magnification factor, and/or a viewing position.

15

In some embodiments the view of the 3D environment comprises rendering of texture and/or shading.

- 20 In some embodiments the at least one display is divided into multiple regions, each showing the 3D environment with a different view.

- 25 Thus in some embodiments the user interface functionality comprises changing the view with which the 3D environment is displayed. Changes in view can comprise changes in viewing angle, viewing position, magnification and/or the like. A change in viewing angle can naturally be effected by rotating the device. Rotation is naturally sensed by the aid of gyros and/or relative to gravity sensed by an accelerometer. Zooming, i.e. a change in magnification, can for example be achieved by pushing the handheld device forward and backward, respectively. A translational change of the viewing
30 position, i.e., panning, can for example be achieved by pushing the handheld device up/down and/or sideways.

In some embodiments the user interface functionality comprises selecting or choosing items on a display or any other functionality provided by graphical user interfaces in computers known in the art. The operator may perform the selection. The Lava C.O.S scanner marketed by 3M ESPE has additional buttons on the handheld device, but it is not possible to manipulate the view by these. Their only purpose is to allow navigation through a menu system, and to start/stop scanning.

10 In some embodiments the user interface functionality comprises manipulating the 3D environment displayed on the screen. For example, the operator may effect deformations or change the position or orientation of objects in the 3D environment. Thus, in some embodiments the user interface functionality comprises virtual user interface functionality, which can be that the 3D data are manipulated, but the physical 3D environment in which the device operates may not be manipulated.

In some embodiments the handheld device is an intraoral scanner and/or an in-the-ear scanner. If the scanner comprises a tip, this tip may be exchanged whereby the scanner can become suitable for scanning in the mouth or in the ear. Since the ear is a smaller cavity than the mouth, the tip for fitting into an ear may be smaller than a tip for fitting in the mouth.

25 In some embodiments the handheld device is a surgical instrument. In some embodiments, the surgical instrument comprises at least one motion sensor, which is built-in in the instrument.

In some embodiments the handheld device is a mechanical tool. In some embodiments, the tool has at least one motion sensor built in. In other embodiments, other user-interface elements are built in as well, for example buttons, scroll wheels, touch-sensitive fields, or proximity sensors.

In some embodiment the 3D geometry of the 3D environment is known a-priori or a 3D representation of the environment is known a priori, i.e. before the actions (s) are performed. For example in surgery, a CT scan may have
5 been taken before the surgical procedure. The handheld device in this example could be a surgical instrument that a physician needs to apply in the proper 3D position. To make sure this proper position is reached, it could be beneficial to view the 3D environment from multiple perspectives interactively, i.e. without having to release the surgical instrument.

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An advantage of the system, also in the above surgery example, is the ability of the handheld device to record the 3D environment at least partially, typically in a 3D field-of-view that is smaller than the volume represented in the a-priori data. The 3D data recorded by the handheld device can be
15 registered in real time with the a-priori data, such that the position and orientation of the device can be detected.

In some embodiments the 3D geometry comprises a 3D surface of the environment.

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In some embodiments the 3D geometry comprises a 3D volumetric representation of the environment.

Thus the 3D environment can be displayed as volumetric data, or as surface,
25 or a combination thereof. Volumetric data are typically represented by voxels. Voxels can comprise multiple scalar values. Surface data are typically represented as meshed, such as triangulated meshes, or point clouds.

The scanning may be performed by means of LED scanning, laser light
30 scanning, white light scanning, X-ray scanning, and/or CT scanning.

The present invention relates to different aspects including the system described above and in the following, and corresponding systems, methods, devices, uses, and/or product means, each yielding one or more of the benefits and advantages described in connection with the first mentioned aspect, and each having one or more embodiments corresponding to the
5 embodiments described in connection with the first mentioned aspect and/or disclosed in the appended claims.

In particular, disclosed herein is a method of interaction between a handheld
10 device and at least one display, where the method comprises the steps of:

- performing at least one action in a physical 3D environment by means of the handheld device;
- visually representing the physical 3D environment by the at least one display; and
- 15 - remotely controlling the view of the represented 3D environment on the display by means of the handheld device.

Furthermore, the invention relates to a computer program product comprising program code means for causing a data processing system to perform the
20 method according to any of the embodiments, when said program code means are executed on the data processing system, and a computer program product, comprising a computer-readable medium having stored there on the program code means.

25 According to another aspect, disclosed is a system comprising a handheld device for operating in a 3D environment and at least one display for visualizing said environment, where the display is adapted to represent said environment from multiple perspectives,
where said device is adapted to be held in one hand by an operator, and
30 where the perspective represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

According to another aspect, disclosed is a system comprising a handheld device for operating in a 3D environment and at least one display for visualizing said environment, where the display is adapted to represent said environment in multiple views,

where said device is adapted to be held in one hand by an operator, where the view represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device, and where the device has at least one touch-sensitive user interface element.

10

The motion of the operator's hand is typically determined by a motion sensor arranged in the handheld device.

15 **Definitions**

3D geometry: A constellation of matter or its virtual representation in a three-dimensional space.

20 3D environment: A constellation of physical objects each having a 3D geometry in a three-dimensional space.

View: The way a 3D environment is represented on a display. Geometrically, a view is determined by the virtual observer's/camera's position and orientation. If the display is two-dimensional, the view is also determined by the type of projection. A view may also be determined by a magnification factor. Graphically, a view can show the 3D environment by means of photographs or as some kind of virtual representation such as a computer graphic, or similar. A computer graphic can be rendered for example with texture and/or shading and/or virtual light sources and/or light models for surface properties. A computer graphic can also be a simplified

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representation of the 3D environment, for example a mesh, an outline, or an otherwise simplified representation. All or parts of the 3D environment can also be rendered with some degree of transparency. A view may represent the 3D environment in total or only parts thereof.

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Functionality: A purpose or intended use.

Performing action(s) or operating functionality: Actions or functionality that includes some type of interaction with a 3D environment, such as measuring, 10 modifying, manipulating, recording, touching, sensing, scanning, moving, transforming, cutting, welding, chemically treating, cleaning, etc. The term "operating" is thus not directed to surgical procedures, but operating may comprise surgical procedures.

15 User Interface Functionality: Functionality for interaction between a human user and a machine with a display.

Handheld device: An object that has at least one functionality and that is held by a human operator's hand or both hands while performing this at least one 20 functionality.

3D scanner: A device that analyzes a real-world object or 3D environment to collect data on its shape and possibly its appearance.

25 Coverage of scan: The degree to which a physical surface is represented by recorded data after a scanning operation.

Motion sensor: A sensor detecting motion. Motion can be detected by: sound (acoustic sensors), opacity (optical and infrared sensors and video image 30 processors), geomagnetism (magnetic sensors, magnetometers), reflection of transmitted energy (infrared laser radar, ultrasonic sensors, and

microwave radar sensors), electromagnetic induction (inductive-loop detectors), and vibration (triboelectric, seismic, and inertia-switch sensors). MEMS accelerometers, gyros, and magnetometers are examples of motions sensors.

5

Workflow: a sequence of tasks implemented in software.

Brief description of the drawings

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The above and/or additional objects, features and advantages of the present invention, will be further elucidated by the following illustrative and non-limiting detailed description of embodiments of the present invention, with reference to the appended drawings, wherein:

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Fig. 1 shows an example of the system comprising a handheld device and a display.

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Fig. 2 shows an example of user interface functionality in the form of remote controlling using the handheld device.

Fig. 3 shows an example of the handheld device.

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Fig. 4 shows an example of a flow-chart of a method of interaction between a handheld device and a display.

Detailed description

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In the following description, reference is made to the accompanying figures, which show by way of illustration how the invention may be practiced.

Fig. 1 shows an example of the system comprising a handheld device and a display. The handheld device 100 is in this example an intraoral dental scanner, which records the 3D geometry of the patient's teeth. The operator
5 102 moves the scanner along the teeth of the patient 104 for capturing the 3D geometry of the relevant teeth, e.g. all teeth. The scanner comprises motion sensors (not visible) for taken the movement of the scanner into account while creating the 3D model 105 of the scanned teeth. The display
10 101 is in this example a PC screen displaying the data recorded by the scanner.

Fig. 2 shows an example of user interface functionality in the form of remote controlling using the handheld device. The motion sensors (not shown) in the handheld device 100, e.g. scanner, provide that the user 102 can determine
15 the view shown on the display 101, e.g. screen, by moving the handheld device 100.

Fig. 2a) shows that pointing the device 100 down can provide that the 3D model 105 of the scanned teeth is shown from a downward viewing angle.

Fig. 2b) shows that holding the scanner in a horizontal position can provide
20 that the viewing angle is likewise horizontally from the front, such that the 3D model 105 of the scanned teeth is shown from the front.

Fig. 3 shows an example of the handheld device.

The handheld device 100 is in this example an intraoral scanner with a pistol-grip.
25 The scanner comprises a housing 106 comprising the pistol-grip part 107, and a tip 108 adapted for insertion in the mouth of the patient. In this example the scanner also is equipped with a button 103 which is an additional element providing user-interface functionality.

30 The example system as shown in fig. 1, fig. 2 and fig. 3 comprises a device 100 which is a handheld intraoral scanner and a display 101 which is a

computer screen. The operator 102 may be a dentist, an assistant and/or the like. In an example, the action performance or operation functionality of the device 100 is to record some intraoral 3D geometry, and the user interface functionality is to rotate, pan, and zoom the 3D model 105 of the scanned data on the computer screen 101. The integration of the user interface
5 functionality in the device 100 is provided by motion sensors (not visible), which can be accelerometers inside the scanner 100, whose readings determine the orientation, as seen in Figs 2a and 2b, of the display on the screen of the 3D model 105 of the teeth acquired by the scanner 100.
10 Additional functionality, e.g. to start/stop scanning, may be provided by the button 103 as seen in fig. 3. In the example system, the button 103 is located where the user's index finger can reach it conveniently.

In fig. 1 the dentist 102 uses two hands to hold the intraoral scanner 100 while scanning, but it is understood that the scanner 100 can also be held
15 with one hand while scanning. The device 100 can also be held with one or two hands, while changing the perspective of the 3D model 105 in the display 101. The example shown in Figure 1 thus illustrates the advantage of the touchless user interface functionality, because in many clinical situations, the
20 operator 102 should maintain both hands clean, disinfected, or even sterile.

The 3D user interface functionality may be exploited in a separate location than the operation functionality. For the above intraoral scanning system example, the scanning operation is performed in the oral cavity of the patient,
25 see fig. 1, while the user interface functionality is more flexibly exploited when the scanner is outside the patient's mouth, see figs 2 and 3.

Fig. 4 shows an example of a flow-chart of a method of interaction between a handheld device and a display.

In step 101 at least one action in a physical 3D environment is performed by means of the handheld device. This action may be the scanning of teeth as shown in fig. 1.

5 In step 102 the physical 3D environment is visually represented by the at least one display. This may be the display of the 3D model of the scanned teeth as seen in fig 1.

In step 103 the view of the represented 3D environment shown on the display is remotely controlled on the display by means of the handheld device. This may be the control of the viewing angle of the 3D model as seen in fig. 2.

10 All the steps of the method may be repeated one or more times. The order in which the steps are performed may be different than the order described above, which is indicated by the dotted lines in the figure. If one or more of the steps are performed more times, the order of the steps may also be different.

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Although some embodiments have been described and shown in detail, the invention is not restricted to them, but may also be embodied in other ways within the scope of the subject matter defined in the following claims. In particular, it is to be understood that other embodiments may be utilised and structural and functional modifications may be made without departing from the scope of the present invention.

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In device claims enumerating several means, several of these means can be embodied by one and the same item of hardware. The mere fact that certain measures are recited in mutually different dependent claims or described in different embodiments does not indicate that a combination of these measures cannot be used to advantage.

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It should be emphasized that the term "comprises/comprising" when used in this specification is taken to specify the presence of stated features, integers,

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steps or components but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

5 The features of the method described above and in the following may be implemented in software and carried out on a data processing system or other processing means caused by the execution of computer-executable instructions. The instructions may be program code means loaded in a memory, such as a RAM, from a storage medium or from another computer via a computer network. Alternatively, the described features may be
10 implemented by hardwired circuitry instead of software or in combination with software.

Literature:

15

C. Graetzel, T. Fong, S. Grange, and C. Baur. A Non-Contact Mouse for Surgeon-Computer Interaction. *Technology and Health Care*, 12(3), 2004.

Vogt S., Khamene A., Niemann H., Sauer F., An AR system with intuitive
20 user interface for manipulation and visualization of 3D medical data, *Stud. Health Technol. Inform.* 2004;98, pp. 397-403.

25

Embodiments

The following embodiments relates to one aspect of the system as disclosed by the description herein.

- 5 1. A system comprising a handheld device and at least one display, where the handheld device is adapted for performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment, and where the handheld device is adapted for remotely controlling the view with which the 3D
- 10 environment is represented on the display.
2. The system according to any one or more of the preceding embodiments, wherein the view is defined as viewing angle and/or viewing position.
- 15 3. The system according to any one or more of the preceding embodiments, wherein the handheld device is adapted for remotely controlling the magnification with which the 3D environment is represented on the display.
4. The system according to any one or more of the preceding embodiments,
- 20 wherein the handheld device is adapted for changing the rendering of the 3D environment on the display.
5. The system according to any one or more of the preceding embodiments, wherein the at least one action comprises one or more of:
- 25 - measuring,
- recording,
- scanning,
- manipulating, and/or
- modifying.
- 30

6. The system according to any one or more of the preceding embodiments, wherein the 3D environment comprises one or more 3D objects.

5 7. The system according to any one or more of the preceding embodiments, wherein the handheld device is adapted to be held in one hand by an operator.

10 8. The system according to any one or more of the preceding embodiments, wherein the display is adapted to represent the 3D environment from multiple views..

15 9. The system according to any one or more of the preceding embodiments, wherein the view of the 3D environment represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

20 10. The system according to any one or more of the preceding embodiments, wherein the magnification represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

11. The system according to any one or more of the preceding embodiments, wherein the handheld device is adapted to record the 3D geometry of the 3D environment.

25 12. The system according to any one or more of the preceding embodiments, wherein the 3D geometry of the 3D environment is known a-priori.

13. The system according to any one or more of the preceding embodiments, wherein the handheld device comprises at least one user-interface element.

30

14. The system according to any one or more of the preceding embodiments, wherein the at least one user-interface element is at least one motion sensor.

5 15. The system according to any one or more of the preceding embodiments, wherein the handheld device comprises at least two motion sensors providing sensor fusion.

10 16. The system according to any one or more of the preceding embodiments, wherein the user interface functionality comprises the use of gestures.

17. The system according to any one or more of the preceding embodiments, wherein the gestures are detected by the at least one motion sensor.

15 18. The system according to any one or more of the preceding embodiments, wherein the handheld device comprises at least one user-interface element other than the at least one motion sensor.

20 19. The system according to any one or more of the preceding embodiments, wherein the at least one other user-interface element is a touch-sensitive element.

20. The system according to any one or more of the preceding embodiments, wherein the at least one other user-interface element is a button.

25 21. The system according to any one or more of the preceding embodiments, wherein the at least one other user-interface element is a scroll wheel.

30 22. The system according to any one or more of the preceding embodiments, wherein the handheld device is adapted to change a viewing angle with which the 3D environment is represented on the at least one display.

23. The system according to any of the preceding embodiments, wherein the handheld device is adapted to change a magnification factor with which the 3D environment is represented on the at least one display.

5 24. The system according to any one or more of the preceding embodiments, wherein the handheld device is adapted to change a viewing position with which the 3D environment is represented on the at least one display.

10 25. The system according to any one or more of the preceding embodiments, wherein the view of the 3D environment comprises a viewing angle, a magnification factor, and/or a viewing position.

15 26. The system according to any one or more of the preceding embodiments, wherein the view of the 3D environment comprises rendering of texture and/or shading.

20 27. The system according to any one or more of the preceding embodiments, wherein the at least one display is divided into multiple regions, each showing the 3D environment with a different view.

28. The system according to any one or more of the preceding embodiments, wherein the 3D geometry comprises a 3D surface of the environment.

25 29. The system according to any one or more of the preceding embodiments, wherein the 3D geometry comprises a 3D volumetric representation of the environment.

30. The system according to any one or more of the preceding embodiments, wherein the handheld device is an intra-oral 3D scanner.

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31. The system according to any one or more of the preceding embodiments, wherein the handheld device is a surgical instrument.
- 5 32. The system according to any one or more of the preceding embodiments, wherein the handheld device is a mechanical tool.
33. The system according to any one or more of the preceding embodiments, wherein the handheld device is an in-ear 3D scanner.
- 10 34. The system according to any one or more of the preceding embodiments, wherein the at least one display is arranged separate from the handheld device.
- 15 35. The system according to any one or more of the preceding embodiments, wherein the at least one display is arranged on a cart.
- 20 36. The system according to any one or more of the preceding embodiments, wherein the at least one display is defined as a first display, and where the system further comprises a second display.
37. The system according to any one or more of the preceding embodiments, wherein the second display is arranged on the handheld device.
- 25 38. The system according to any one or more of the preceding embodiments, wherein the second display is arranged on the handheld device in a position such that the display is adapted to be viewed by the operator, while the operator is operating the handheld device.
- 30 39. The system according to any one or more of the preceding embodiments, wherein the second display indicates where the handheld device is positioned relative to the 3D environment.

40. The system according to any one or more of the preceding embodiments, wherein the first display and/or the second display provides instructions for the operator.

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41. The system according to any one or more of the preceding embodiments, wherein visual information is provided to the operator on one or more means other than the first display.

10

42. The system according to any one or more of the preceding embodiments, wherein audible information to the operator is provided to the operator.

43. The system according to any one or more of the preceding embodiments, wherein the scanning is performed by means of LED scanning, laser light scanning, white light scanning, X-ray scanning, and/or CT scanning.

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44. A method of interaction between a handheld device and at least one display, where the method comprises the steps of:

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- performing at least one action in a physical 3D environment by means of the handheld device;
- visually representing the physical 3D environment by the at least one display; and
- remotely controlling the view of the represented 3D environment on the display by means of the handheld device.

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45. A computer program product comprising program code means for causing a data processing system to perform the method of any one or more of the preceding embodiments, when said program code means are executed on the data processing system.

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46. A computer program product according to the previous embodiment, comprising a computer-readable medium having stored there on the program code means.

Claims

1. A system comprising a handheld device and at least one display, where the handheld device is adapted for switching between
- 5 - performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment, and
- remotely controlling the view with which the 3D environment is represented on the display.
- 10
2. A system according to any one or more of the preceding claims, wherein the handheld device is adapted to record the 3D geometry of the 3D environment.
- 15
3. A system according to any one or more of the preceding claims, wherein means for manually switching between performing the at least one action and remotely controlling the view is provided on the handheld device.
4. A system according to claim 3, wherein the means for manually switching
- 20 is an actuator, such as a button, a switch or a contact.
5. The system according to any one or more of the preceding claims, wherein the view is defined as viewing angle and/or viewing position.
- 25
6. The system according to any one or more of the preceding claims, wherein the handheld device is adapted for remotely controlling the magnification with which the 3D environment is represented on the display.
7. The system according to any one or more of the preceding claims, wherein
- 30 the handheld device is adapted for changing the rendering of the 3D environment on the display.

8. The system according to any one or more of the preceding claims, wherein the at least one action comprises one or more of:
- measuring,
 - 5 - recording,
 - scanning,
 - manipulating, and/or
 - modifying.
- 10 9. The system according to any one or more of the preceding claims, wherein the 3D environment comprises one or more 3D objects.
- 15 10. The system according to any one or more of the preceding claims, wherein the handheld device is adapted to be held in one hand by an operator.
- 20 11. The system according to any one or more of the preceding claims, wherein the display is adapted to represent the 3D environment from multiple views.
12. The system according to any one or more of the preceding claims, wherein the handheld device comprises at least one motion sensor.
- 25 13. The system according to any one or more of the preceding claims, wherein the view of the 3D environment represented in the at least one display is at least partly determined by the at least one motion sensor.
- 30 14. The system according to any one or more of the preceding claims, wherein the magnification represented in the at least one display is at least partly determined by the at least one motion sensor.

15. The system according to any one or more of the preceding claims, wherein the handheld device is adapted to record the 3D geometry of the 3D environment.

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16. The system according to any one or more of the preceding claims, wherein the 3D geometry of the 3D environment is known a-priori.

17. The system according to any one or more of the preceding claims, wherein the handheld device comprises at least one user-interface element.

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18. The system according to any one or more of the preceding claims, wherein the at least one user-interface element is at least one motion sensor.

19. The system according to any one or more of the preceding claims, wherein the handheld device comprises at least two motion sensors providing sensor fusion.

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20. The system according to any one or more of the preceding claims, wherein the user interface functionality comprises the use of gestures.

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21. The system according to any one or more of the preceding claims, wherein the gestures are detected by the at least one motion sensor.

22. The system according to any one or more of the preceding claims, wherein the handheld device comprises at least one user-interface element other than the at least one motion sensor.

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23. The system according to any one or more of the preceding claims, wherein the at least one other user-interface element is a touch-sensitive element.

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24. The system according to any one or more of the preceding claims, wherein the at least one other user-interface element is a button.

5 25. The system according to any one or more of the preceding claims, wherein the at least one other user-interface element is a scroll wheel.

26. The system according to any one or more of the preceding claims, wherein the handheld device is adapted to change a viewing angle with
10 which the 3D environment is represented on the at least one display.

27. The system according to any of the preceding claims, wherein the handheld device is adapted to change a magnification factor with which the 3D environment is represented on the at least one display.

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28. The system according to any one or more of the preceding claims, wherein the handheld device is adapted to change a viewing position with which the 3D environment is represented on the at least one display.

20 29. The system according to any one or more of the preceding claims, wherein the view of the 3D environment comprises a viewing angle, a magnification factor, and/or a viewing position.

30. The system according to any one or more of the preceding claims,
25 wherein the view of the 3D environment comprises rendering of texture and/or shading.

31. The system according to any one or more of the preceding claims, wherein the at least one display is divided into multiple regions, each
30 showing the 3D environment with a different view.

32. The system according to any one or more of the preceding claims, wherein the 3D geometry comprises a 3D surface of the environment.

5 33. The system according to any one or more of the preceding claims, wherein the 3D geometry comprises a 3D volumetric representation of the environment.

10 34. The system according to any one or more of the preceding claims, wherein the handheld device is an intra-oral 3D scanner.

35. The system according to any one or more of the preceding claims, wherein the handheld device is a surgical instrument.

15 36. The system according to any one or more of the preceding claims, wherein the handheld device is a mechanical tool.

37. The system according to any one or more of the preceding claims, wherein the handheld device is an in-ear 3D scanner.

20 38. The system according to any one or more of the preceding claims, wherein the at least one display is arranged separate from the handheld device.

25 39. The system according to any one or more of the preceding claims, wherein the at least one display is arranged on a cart.

40. The system according to any one or more of the preceding claims, wherein the at least one display is defined as a first display, and where the system further comprises a second display.

30

41. The system according to any one or more of the preceding claims, wherein the second display is arranged on the handheld device.

5 42. The system according to any one or more of the preceding claims, wherein the second display is arranged on the handheld device in a position such that the display is adapted to be viewed by the operator, while the operator is operating the handheld device.

10 43. The system according to any one or more of the preceding claims, wherein the second display indicates where the handheld device is positioned relative to the 3D environment.

15 44. The system according to any one or more of the preceding claims, wherein the first display and/or the second display provides instructions for the operator.

20 45. The system according to any one or more of the preceding claims, wherein visual information is provided to the operator on one or more means other than the first display.

46. The system according to any one or more of the preceding claims, wherein audible information to the operator is provided to the operator.

25 47. The system according to any one or more of the preceding claims, wherein the scanning is performed by means of LED scanning, laser light scanning, white light scanning, X-ray scanning, and/or CT scanning.

30 48. The system according to any one or more of the preceding claims, wherein a graphical pointer is provided on the display for representing the movement of the handheld device when the handheld device is used to

remotely controlling the view with which the 3D environment is represented on the display.

5 49. The system according to any one or more of the preceding claims, wherein the handheld device is an intra-oral 3D scanner and the at least one action performed in the physical 3D environment is scanning and that the view is remotely controlled by at least one motion sensor arranged in the handheld device, and wherein an actuator provided on the handheld device switches between performing the at least one action and remotely controlling
10 the view.

50. A method of interaction between a handheld device and at least one display, where the method comprises the steps of:
- performing at least one action in a physical 3D environment by means of
15 the handheld device;
- visually representing the physical 3D environment by the at least one display; and
- remotely controlling the view of the represented 3D environment on the display by means of the handheld device.

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51. A computer program product comprising program code means for causing a data processing system to perform the method of claim 44, when said program code means are executed on the data processing system.

25 52. A computer program product according to the previous claim, comprising a computer-readable medium having stored there on the program code means.

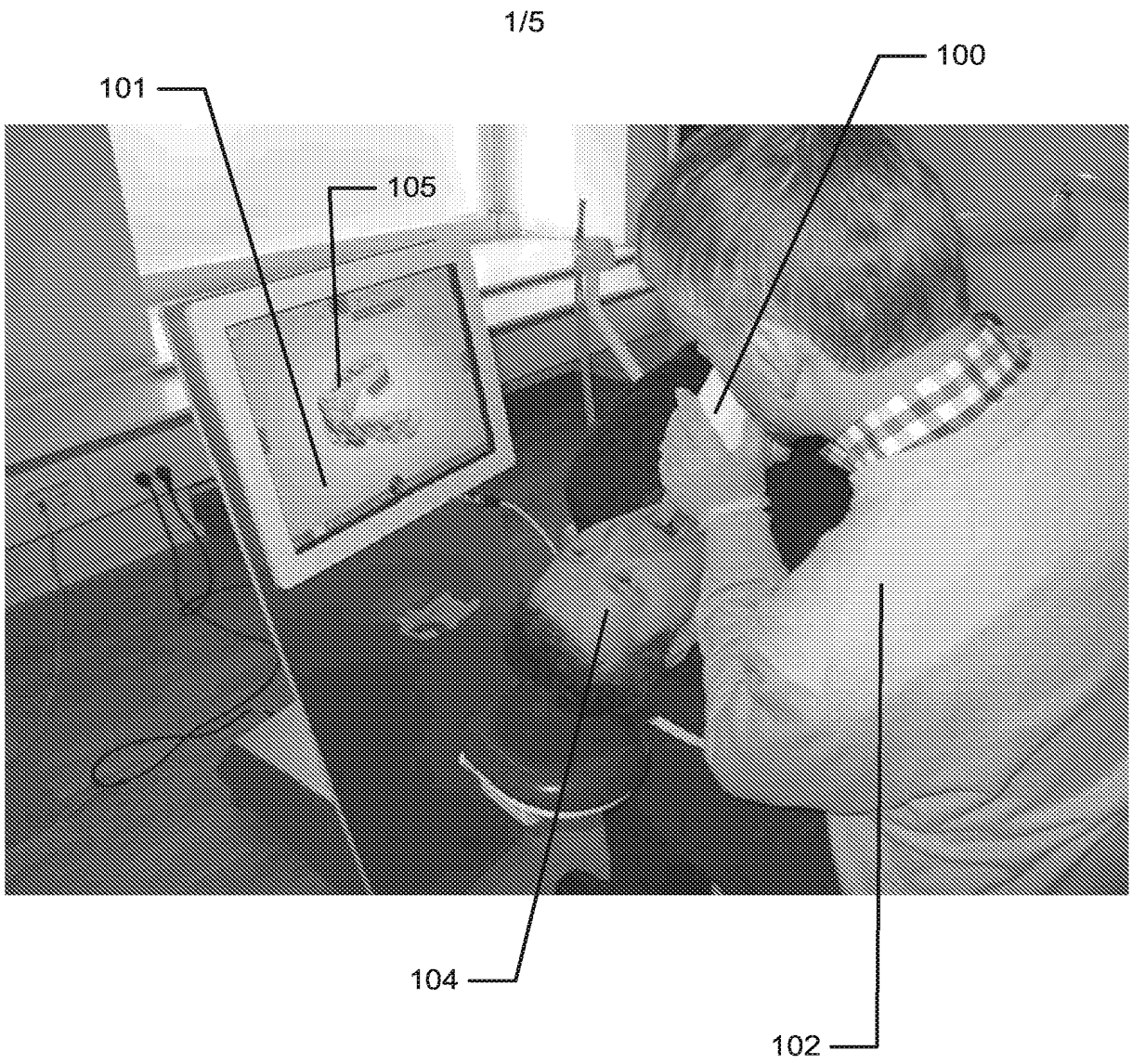


Fig. 1

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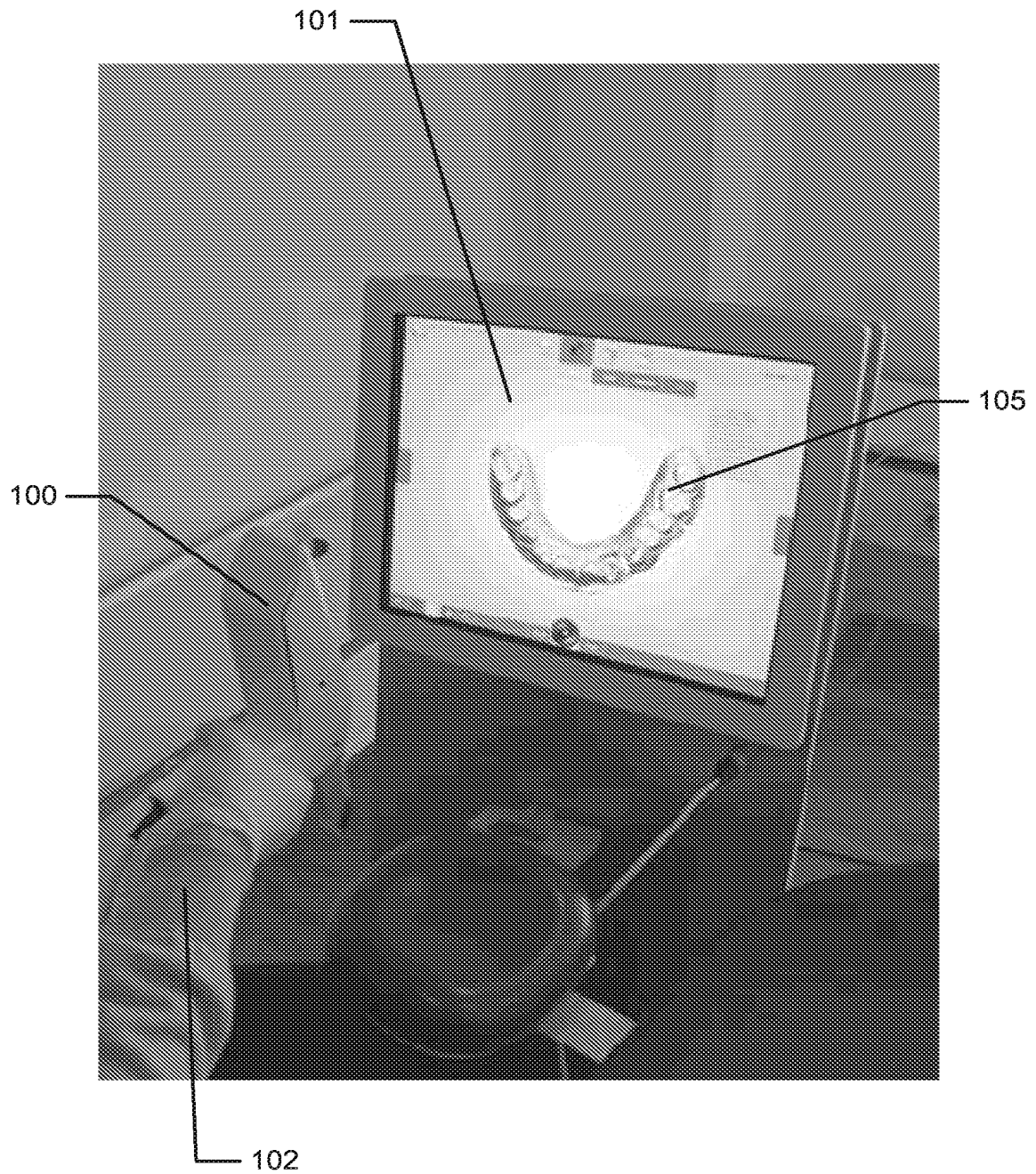


Fig. 2a)

3/5

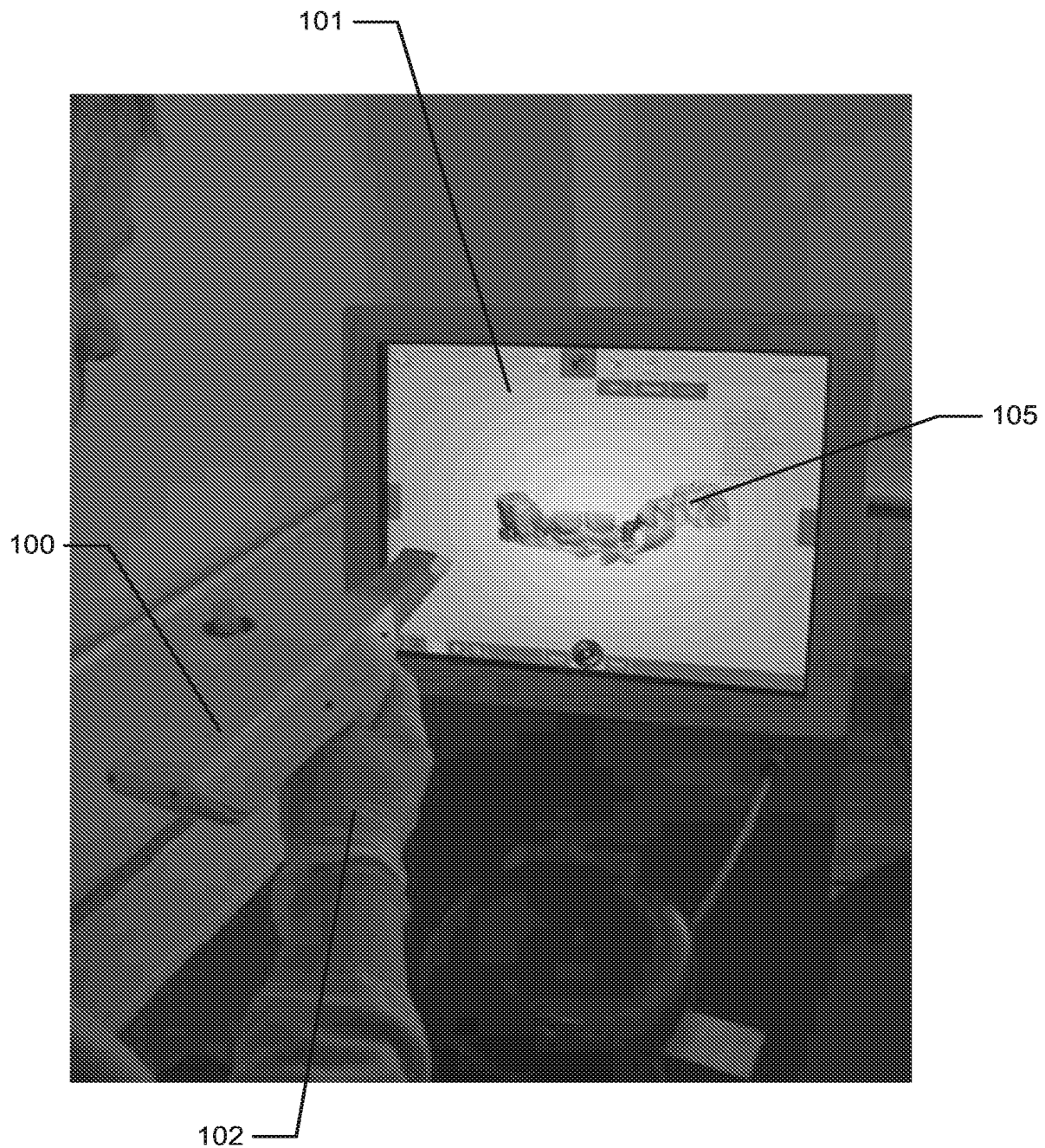


Fig. 2b)

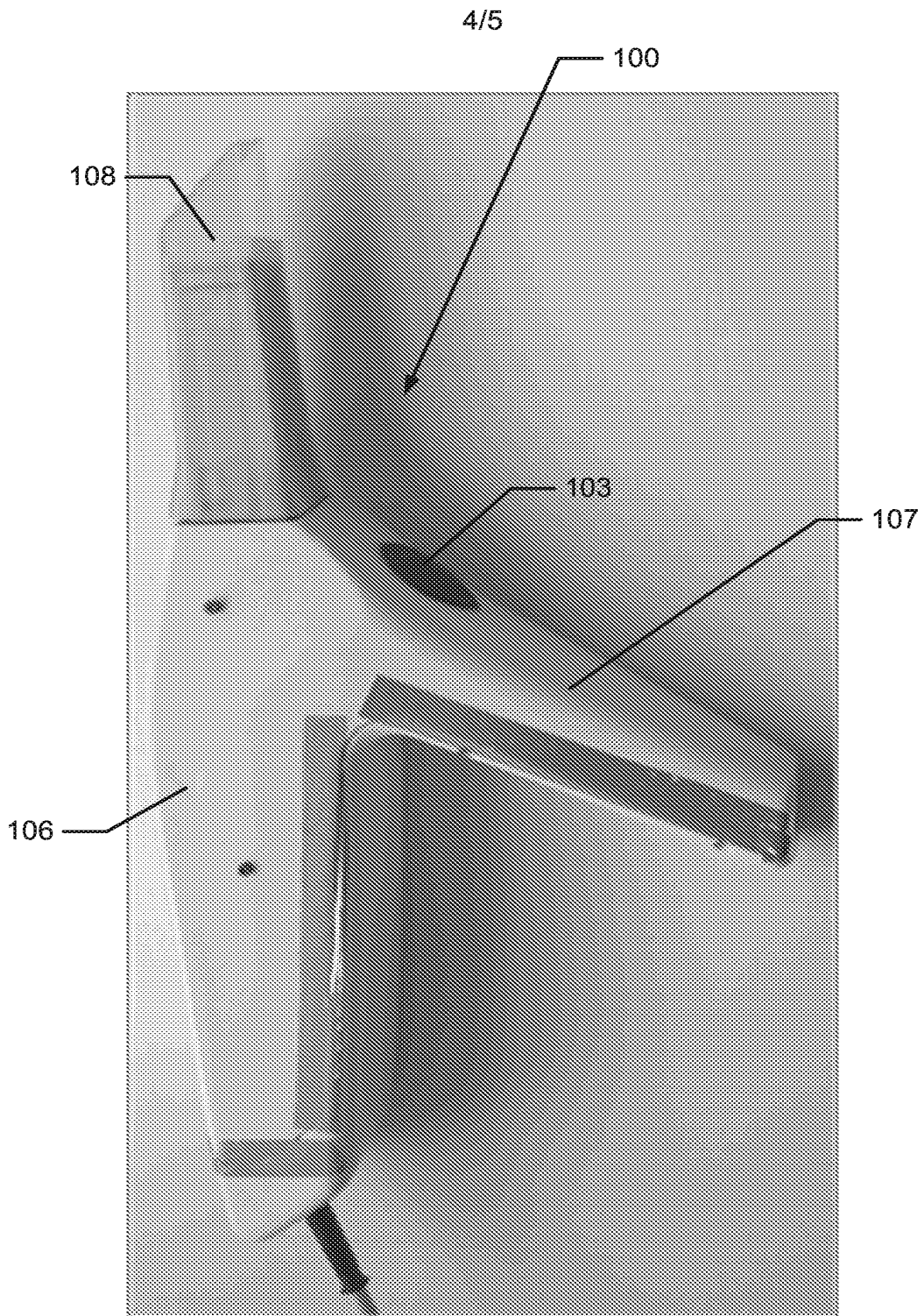


Fig. 3

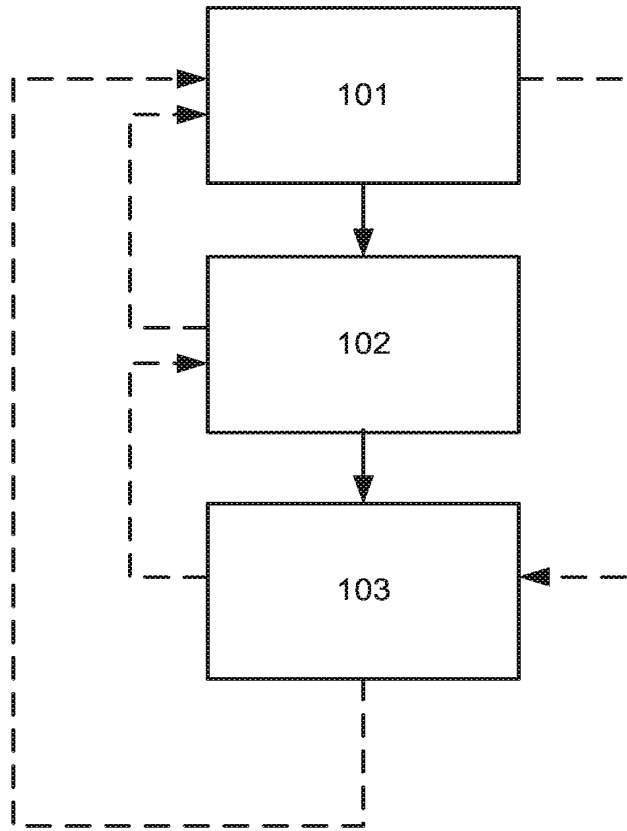


Fig. 4