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(54) **AUGMENTING REAL-TIME VIEWS OF A PATIENT WITH THREE-DIMENSIONAL DATA**

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(63) Continuation of application No. 15/894,595, filed on Feb. 12, 2018, now Pat. No. 10,475,244, which is a (Continued)

(51) **Int. Cl.**
G06T 19/00 (2011.01)
A61B 5/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **G06T 19/006** (2013.01); **A61B 5/0015** (2013.01); **A61B 5/0071** (2013.01);
(Continued)

(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,657,809 B2 2/2014 Schoepp
8,830,263 B2 9/2014 Kohara et al.
(Continued)

FOREIGN PATENT DOCUMENTS

DE 102012025374 A1 7/2014
JP 2005-500096 A2 1/2001
(Continued)

OTHER PUBLICATIONS

United States Patent and Trademark Office; International Search Report and Written Opinion issued in PCT Application No. PCT/US2018/022921, dated Jul. 5, 2018; 11 pages.
(Continued)

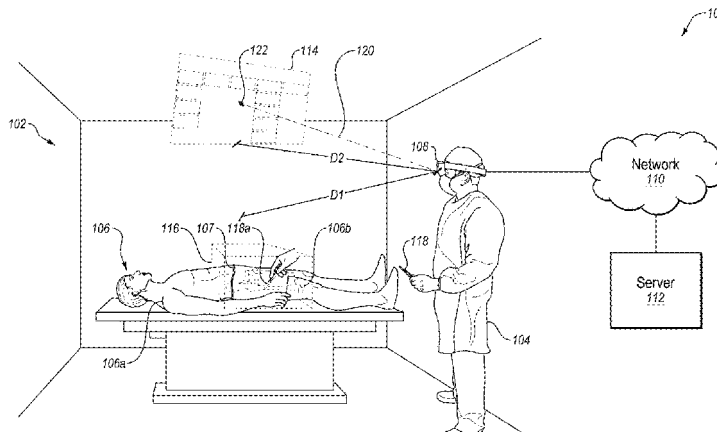
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(57) **ABSTRACT**

Augmenting real-time views of a patient with three-dimensional (3D) data. In one embodiment, a method may include identifying 3D data for a patient with the 3D data including an outer layer and multiple inner layers, determining virtual morphometric measurements of the outer layer from the 3D data, registering a real-time position of the outer layer of the patient in a 3D space, determining real-time morphometric measurements of the outer layer of the patient, automatically registering the position of the outer layer from the 3D data to align with the registered real-time position of the outer layer of the patient in the 3D space using the virtual morphometric measurements and using the real-time morphometric measurements, and displaying, in an augmented reality (AR) headset, one of the inner layers from the 3D data projected onto real-time views of the outer layer of the patient.

20 Claims, 11 Drawing Sheets



Related U.S. Application Data

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- A61B 5/107** (2006.01)
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- G06T 15/04** (2011.01)
- G06T 7/246** (2017.01)
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- G16H 30/40** (2018.01)
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(56)

References Cited

U.S. PATENT DOCUMENTS

9,248,000	B2	2/2016	Sarvestani et al.
9,436,993	B1	9/2016	Stolka et al.
9,538,962	B1	1/2017	Hannaford et al.
9,675,319	B1	6/2017	Razzaque et al.
9,861,446	B2	1/2018	Lang
9,892,564	B1	2/2018	Cvetko et al.
9,980,780	B2	5/2018	Lang
10,010,379	B1	7/2018	Gibby et al.
10,028,727	B2 *	7/2018	Inoue A61B 8/469
10,052,170	B2 *	8/2018	Saget G02B 27/0172
10,154,239	B2	12/2018	Casas
10,159,530	B2	12/2018	Lang
10,194,131	B2	1/2019	Casas
10,278,777	B1	5/2019	Lang
10,292,768	B2	5/2019	Lang
10,326,975	B2	6/2019	Casas
10,368,947	B2	8/2019	Lang
10,405,927	B1	9/2019	Lang
10,511,822	B2	12/2019	Casas
10,531,852	B2 *	1/2020	Kwon G16H 30/40
10,594,998	B1	3/2020	Casas
10,602,114	B2	3/2020	Casas
10,603,113	B2	3/2020	Lang
10,742,949	B2	8/2020	Casas
10,743,939	B1	8/2020	Lang
10,799,296	B2	10/2020	Lang
10,841,556	B2	11/2020	Casas
10,849,693	B2	12/2020	Lang
2004/0070611	A1	4/2004	Tanaka et al.
2004/0254456	A1	12/2004	Ritter
2005/0203367	A1	9/2005	Ahmed et al.

2005/0215879	A1	9/2005	Chuanggui
2006/0173290	A1	8/2006	Lavallee et al.
2007/0236514	A1	10/2007	Agusanto et al.
2010/0100081	A1	4/2010	Tuma et al.
2010/0266171	A1	10/2010	Wendler et al.
2011/0046483	A1	2/2011	Fuchs et al.
2011/0102549	A1	5/2011	Takahashi
2012/0127200	A1	5/2012	Kohara et al.
2013/0060146	A1	3/2013	Yang et al.
2013/0177229	A1 *	7/2013	Inoue A61B 8/483 382/131
2013/0245461	A1 *	9/2013	Maier-Hein A61B 5/742 600/476
2014/0132605	A1 *	5/2014	Tsukagoshi G06T 19/20 345/424
2014/0142426	A1	5/2014	Razzaque et al.
2014/0222462	A1	8/2014	Shakil et al.
2014/0243614	A1	8/2014	Rothberg et al.
2014/0275760	A1	9/2014	Lee et al.
2014/0276001	A1	9/2014	Ungi et al.
2014/0300632	A1	10/2014	Laor
2015/0049083	A1	2/2015	Bidne et al.
2016/0078669	A1	3/2016	Lin
2016/0148052	A1	5/2016	Tsuda et al.
2016/0154620	A1	6/2016	Tsuda et al.
2016/0225192	A1	8/2016	Jones et al.
2016/0235402	A1	8/2016	Chowaniec et al.
2016/0302747	A1	10/2016	Averbuch
2017/0231714	A1	8/2017	Kosmecki et al.
2017/0281297	A1	10/2017	Tuma et al.
2018/0020992	A1 *	1/2018	Guo A61B 6/032 600/424
2018/0137690	A1	5/2018	Coffey et al.
2018/0286132	A1	10/2018	Cvetko et al.
2018/0289344	A1 *	10/2018	Green A61B 18/1815
2018/0303558	A1 *	10/2018	Thomas A61B 34/20
2018/0338814	A1 *	11/2018	Saget G06T 19/006
2019/0246088	A1	8/2019	Casas
2021/0022808	A1	1/2021	Lang
2021/0037224	A1	2/2021	Casas

FOREIGN PATENT DOCUMENTS

JP	2004-178554	A	6/2004
JP	2015-019678		2/2015
WO	2002/100284	A	12/2002
WO	2009/116663		9/2009
WO	WO 2011/010644		1/2011
WO	2015/008470	A2	1/2015
WO	2017/160651		9/2017
WO	2018183001	A1	10/2018

OTHER PUBLICATIONS

U.S. Appl. No. 62/097,771, filed Dec. 20, 2014, titled "Intraoperative Image-guided Surgery with Surface Reconstruction and Augmented Reality Visualization".

U.S. Appl. No. 62/307,476, filed Mar. 12, 2016, titled "Devices and Methods for Surgery".

U.S. Appl. No. 17/111,643, filed Dec. 4, 2020.

Justin Barad "Controlling Augmented Reality in the Operating Room, a Surgeon's Perspective", medgadget, Oct. 30, 2015; XP055754822; Webpage; located at: <https://www.medgadget.com/2015/10/controlling-augmented-reality-operating-room-surgeons-perspective.html>.

European Patent Office; Extended European Search Report issued in Application No. 18775013.8 dated Mar. 17, 2021, 12 pages.

Japanese Office Action issued in Application No. 2020-503249 dated Jan. 5, 2021, 7 pages.

* cited by examiner

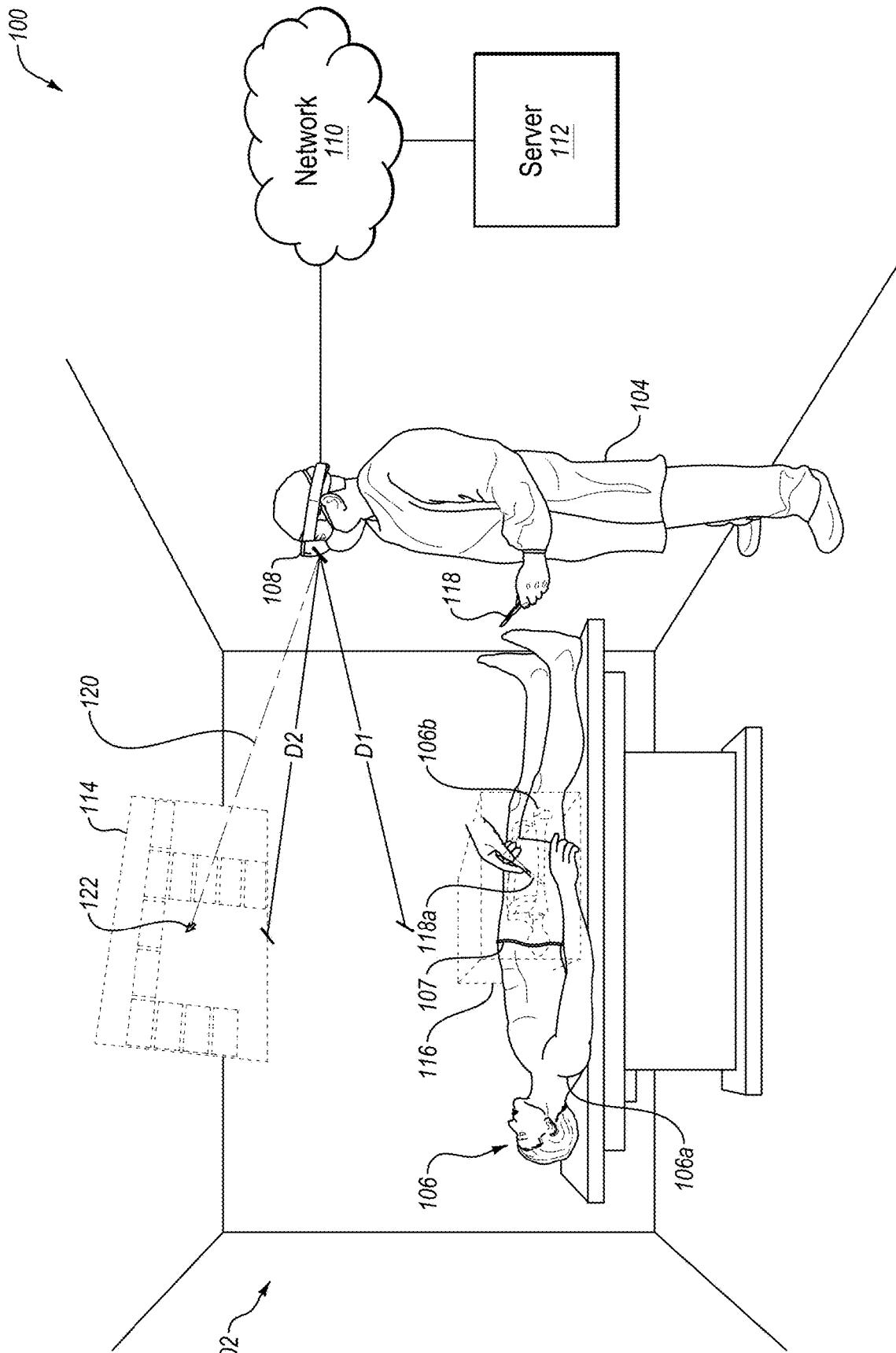


FIG. 1



FIG. 2A

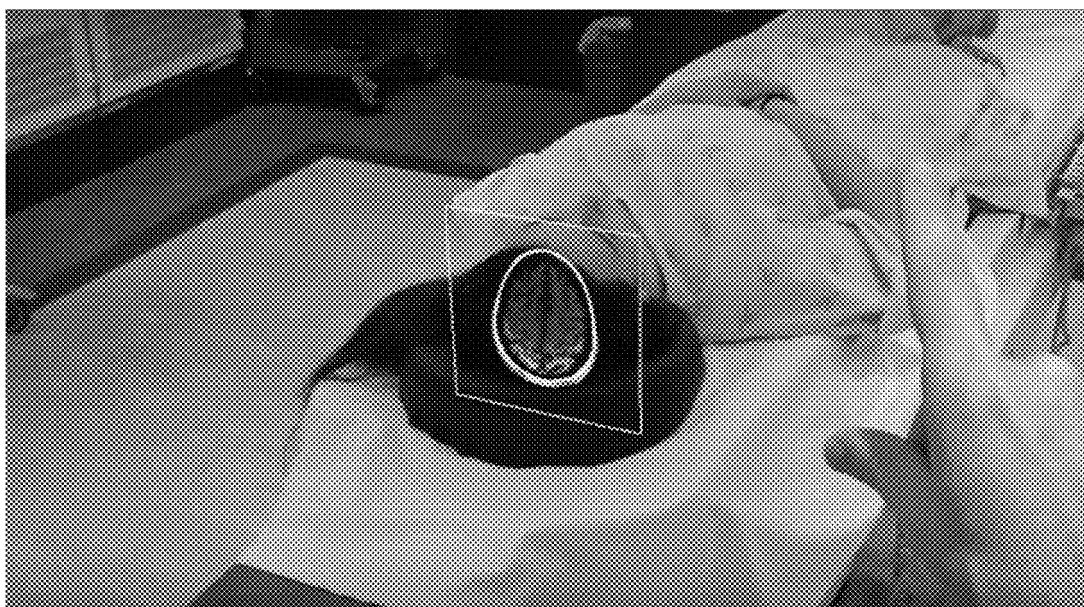


FIG. 2B

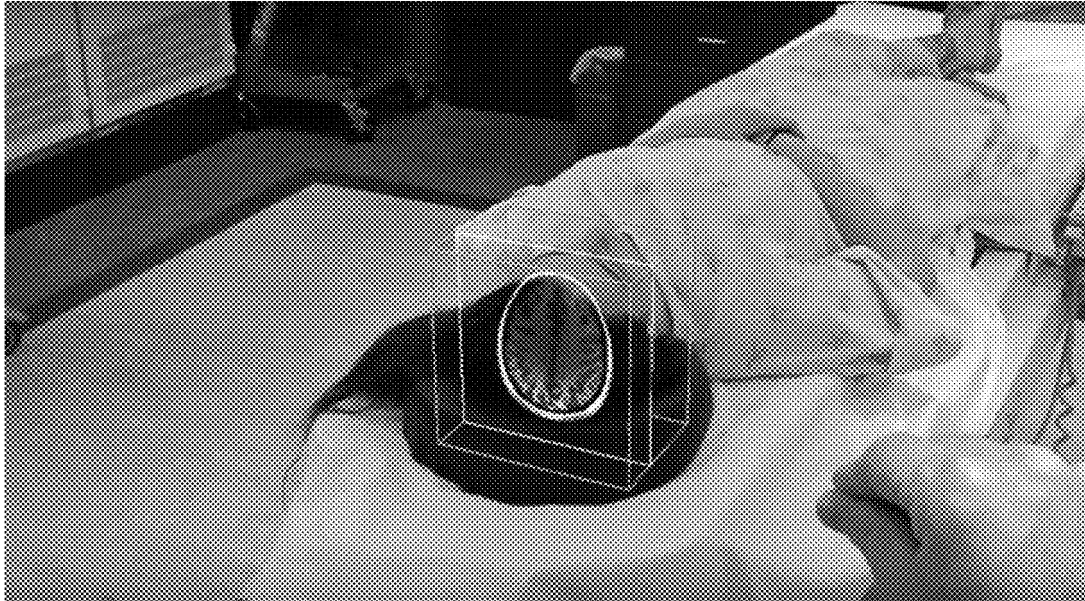


FIG. 2C

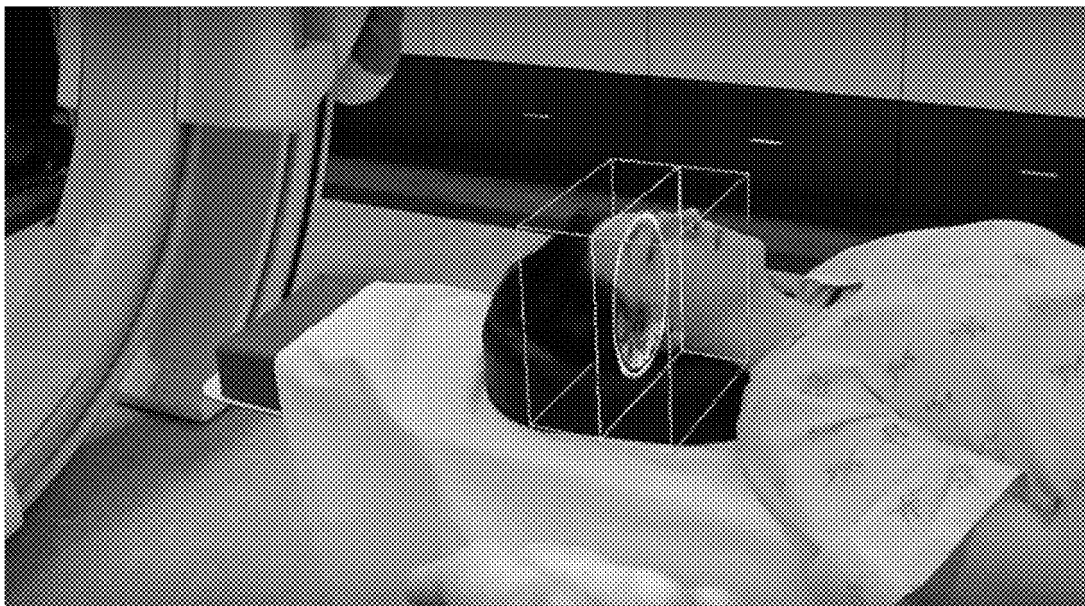


FIG. 2D

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