IN THE

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

LG ELECTRONICS INC.,

Petitioner

v.

CyWee Group Ltd.,

Patent Owner

U.S. Patent No. 8,441,438
Issued: May 14, 2013
Inventor(s): Zhou Ye; Chin-Lung Li; Shun-Nan Liou

Title: 3D POINTING DEVICE AND METHOD FOR COMPENSATING MOVEMENT THEREOF

Inter Partes Review No. IPR2019-01203

PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 8,441,438 PURSUANT TO 35 U.S.C. §§ 311-319 AND 37 C.F.R. § 42

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I. INTRODUCTION

Petitioner LG Electronics Inc. requests institution of *Inter Partes* Review, and cancellation of claims 1, 4-5, 14-17, and 19 of U.S. Patent No. 8,441,438 ("the '438 Patent"). (Ex.1001). This Petition is being submitted concurrently with a Motion for Joinder. Specifically, Petitioner requests institution and joinder with *ZTE (USA), Inc. v. Cywee Group Ltd.*, IPR2019-00143 (the "ZTE IPR"), which the Board instituted on May 17, 2019. This Petition is substantially identical to the Petition in the ZTE IPR.

II. MANDATORY NOTICES UNDER 37 C.F.R. § 42.8(a)(1)

A. Real Party-In-Interest Under 37 C.F.R. § 42.8(b)(1)

The real-parties-in-interest for this Petition are LG Electronics Inc. and LG Electronics U.S.A., Inc.[1] Petitioner further identifies as real-parties-in-interest the parties identified in IPR2019-00143 (to which this petition seeks joinder): ZTE (USA), Inc. and ZTE Corporation.

B. Related Matters Under 37 C.F.R. § 42.8(b)(2)

The '438 Patent is asserted in the following matters:

- *CyWee Group Ltd.* v. *Google, Inc.*, Case No. 1-18-cv-00571, (D. Del.);

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[1] LG Electronics MobileComm U.S.A., Inc. merged into and is now part of LG Electronics U.S.A., Inc.

- *CyWee Group Ltd., v. ZTE (USA) Inc.*, Case No. 3:17-cv-02130, (S.D. Cal.);
- *CyWee Group Ltd.* v. *HTC Corporation et al.,* Case No. 2-17-cv-00932, (W.D. Wash.);
- *CyWee Group Ltd.* v. *Motorola Mobility LLC,* Case No. 1-17-cv-00780, (D. Del.);
- *CyWee Group Ltd.* v. *Huawei Technologies Co., Inc. et al.,* Case No. 2-17-cv-00495, (E.D. Tex.);
- *CyWee Group Ltd.* v. *LG Electronics, Inc. et al.,* Case No. 3-17-cv-01102, (S.D. Cal.);
- *CyWee Group Ltd.* v. *Samsung Electronics Co. Ltd. et al.,* Case No. 2-17-cv-00140, (E.D. Tex.);
- *CyWee Group Ltd.* v. *Apple Inc.,* Case No. 4-14-cv-01853, (N.D. Cal.).

Also, as noted above, the '438 Patent has been challenged in the ZTE IPR. Additionally, there is a petition of *Inter Partes Review* (IPR2018-01258) filed by Google LLC regarding the same '438 Patent that has been instituted by the Board ("the Google IPR"), as well as the following petitions for *Inter Partes* Review seeking joinder to the Google IPR (collectively with the Google IPR, "Prior Petitions"):

- *Samsung Electronics Co., Ltd. et al. v. Cywee Group Ltd.*, IPR2019-00535, filed January 8, 2019;
- *ZTE (USA), Inc. et al. v. Cywee Group Ltd.*, IPR2019-00526, filed January 10, 2019;
- *LG Electronics Inc. et al. v. Cywee Group Ltd.*, IPR2019-00559, filed January 10, 2019; and
- *Huawei Device USA, Inc., et al. v. Cywee Group Ltd.*, IPR2019-00562, filed January 11, 2019.

However, Petitioner notes that the present petition and the ZTE IPR, to which this petition seeks joinder, are different from the Prior Petitions. Indeed, between the present petition and the ZTE IPR on one hand and the Prior Petitions on the other, the challenged claims are different, the asserted prior art is different with only one overlapping reference, and there are no overlapping grounds of unpatentability.

C. Lead and Back-Up Counsel Under 37 C.F.R. § 42.8(b)(3)

Petitioner provides the following designation of counsel.

Lead Counsel: Collin W. Park (Reg. No. 43,378); Tel: 202.739.3000; Facsimile: 202.739.3001.

Backup Counsel: Andrew V. Devkar (Reg. No. 76,671); Tel: 310.255.9070

Backup Counsel: Adam D. Brooke (Reg. No. 58,922); Tel: 202.739.3000

Backup Counsel: Jeremy Peterson (Reg. No. 52,115); Tel: 202.739.3000.

Address of lead counsel: Morgan, Lewis & Bockius, LLP, 1111 Pennsylvania Ave., N.W., Washington, D.C. 20004-2541. Facsimile: 202.739.3001.

D. Service Information Under 37 C.F.R. § 42.8(b)(4)

Please address all correspondence to the lead counsel at the address shown above. Petitioner consents to electronic service by email at:

- collin.park@morganlewis.com;
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- adam.brooke@morganlewis.com;
- jeremy.peterson@morganlewis.com; and
- MLB_CyWeevsLGE@morganlewis.com.

III. PAYMENT OF FEES UNDER 37 C.F.R. § 42.103

Petitioner authorizes the Office to charge Account No. 50-0310 for fees set forth in 37.C.F.R. § 42.15(a), and for additional fees.

A. REQUIREMENTS FOR *INTER PARTES* REVIEW UNDER 37 C.F.R. §§ 42.104

As set forth below and pursuant to 37 C.F.R. § 42.104, each requirement for *Inter Partes* review of the '438 Patent is satisfied.

B. Grounds for Standing Under 37 C.F.R. § 42.104(a)

Petitioner certifies that the '438 Patent is available for *Inter Partes* Review, and that Petitioner is not barred or estopped from requesting *Inter Partes* Review challenging the claims of the '438 Patent on the grounds identified herein. In particular, *inter partes* review IPR2019-00143 was instituted on May 17, 2019, and this petition is accompanied by a timely request for joinder in that review, pursuant to 37 CFR § 42.122(b).

C. Identification of Challenge Under 37 C.F.R. § 42.104(b)

1. Claims for Which *Inter Partes* Review Is Requested (37 C.F.R. § 42.104(b)(1))

Inter Partes review of claims 1, 4-5, 14-17, and 19 of the '438 Patent is requested.

2. The Specific Statutory Ground on Which the Challenge is Based Under 37 C.F.R. § 42.104(b)(2)

Inter Partes review is requested in view of the following references:

Exhibit No.	Reference
Ex.1006	U.S. Patent No. 8,267,785 ("Yamashita")
Ex.1007	U.S. Patent No. 7,089,148 ("Bachmann")
Ex.1008	U.S. Patent No. 8,462,109 ("Nasiri")
Ex.1009	U.S. Patent Publication No. 2009/0265671 ("Sachs")
Ex.1010	U.S. Patent Publication No. 2007/0299626 ("Song")

D. How the Challenged Claim(s) Are to Be Construed (37 C.F.R. §42.104(b)(3))

A claim in *inter partes* review is given the "broadest reasonable construction in light of the specification." See 37 C.F.R. § 42.100(b), *In re ICON Health and Fitness, Inc.*, 496 F.3d 1374, 1379 (Fed. Cir. 2007) ("[T]he PTO must give claims their broadest reasonable construction consistent with the specification. Therefore, we look to the specification to see if it provides a definition for claim terms, but otherwise apply a broad interpretation."). For the purpose of this proceeding, claim terms are presumed to take on their broadest reasonable interpretation.

E. How the Construed Claim(s) Are Unpatentable (37 C.F.R. § 42.104(b)(4))

An explanation of why the Challenged Claims are invalid is discussed below in section X, including grounds stated in the supporting declaration by Mr. Andrews.

IV. STATEMENT OF PRECISE RELIEF REQUESTED

The Petitioner respectfully requests the Board initiate an *Inter Partes* Review and cancel claims 1, 4-5, 14-17, and 19 of the '438 Patent as unpatentable pursuant to 35 U.S.C.§ 311(b) based on the following Two grounds:[2]

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[2] Petitioner requests institution and joinder with respect to only the ground for which the ZTE IPR has been instituted. Both ZTE grounds are presented in order

Ground A: Yamashita in view of Bachmann renders claims 1, 4-5, 14-17, and 19 obvious. *See infra* Section X.A.

Ground B: Nasiri in view of Song renders claims 1, 4-5, 14-17, and 19 obvious. *See infra* Section X.B.

V. THRESHOLD REQUIREMENT FOR *INTER PARTES* REVIEW

A petition for *Inter Partes* Review must demonstrate "a reasonable likelihood that the Petitioner would prevail with respect to at least one of the claims challenged in the petition." 35 U.S.C. § 314(a). The Petition meets this threshold. The prior art teaches each of the elements of claims 1, 4-5, 14-17, and 19 of the '438 Patent as explained below in the proposed grounds of unpatentability. Also, the Petition establishes reasons and motivations to combine prior art for each ground under 35 U.S.C. § 103(a).

VI. OVERVIEW OF THE '438 Patent

A. Background of the '438 Patent

The '438 Patent is directed to a 3D pointing device using a six-axis motion sensor to calculate deviation angles, such as yaw, pitch, and roll. Ex.1001 at abstract, 1:21-26. Figure 1 of the '438 Patent shows "a handheld 3D pointing device 110 to point at a point on the screen 122 of a 2D display device 120." *Id.*,

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to remain substantially identical to the ZTE IPR Petition.

1:28-30. The 3D pointing device could be "a video game console" that detects movements and rotations of the console in three dimensions and transfer detected movements and rotations to a computer. *Id.*, 1:32-34.

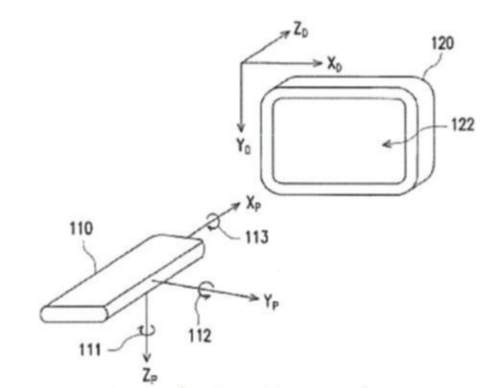

FIG. 1 (RELATED ART)

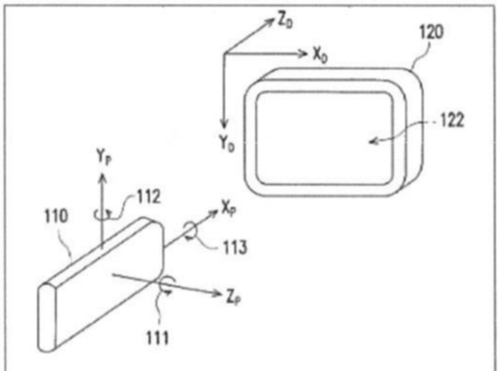

FIG. 2 (RELATED ART)

Figure 4 of the '438 Patent shows that the device includes a six-axis motion sensor containing a rotation sensor 342 and an accelerometer 344. Ex.1001, 7:59-61. The rotational sensor generates a rotational signal set and the accelerometer generates an axial acceleration signal set. Ex.1001, 7:64-8:10.

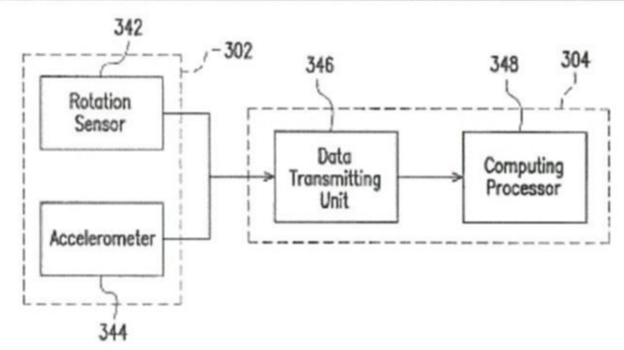

FIG. 4

The '438 Patent discloses that in order to calculate deviation angles of the device, the rotation sensor (e.g., gyroscope) generates a set of angular velocity readings and the accelerometer generates a set of acceleration readings. *Id.*, 7:64-8:17. These sensor readings are sent to the computer processor that calculates deviation angles including yaw, pitch and roll angles in a spatial pointer frame. *Id.*, 3:62-66, 8:18-58.

The '438 Patent discloses using quaternions to calculate orientation. As shown in Figure 7 of the '438 Patent, the updated state or the improved orientation, called 3rd quaternion, is obtained by comparing the current state with the measure state of the axial acceleration. *Id.*, 13:25-49.

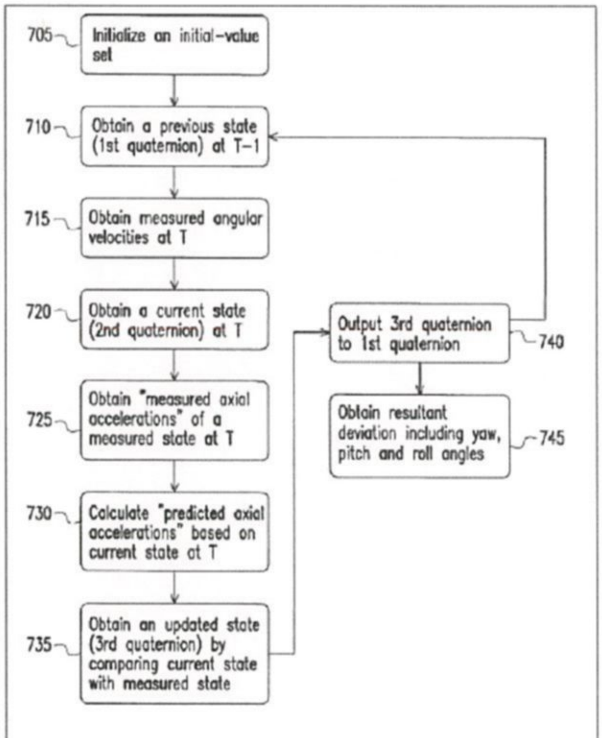

FIG. 7

B. Prosecution History of the '438 Patent

The '438 Patent encountered two office actions. Ex.1002, pp.77-91; 127-52. In the second office action, claims were rejected under 35 U.S.C. 102(a) as being anticipated by U.S. Publication 2009/0262074 ("Nasiri") and were rejected under 35 U.S.C. 103(a) as being unpatentable over Nasiri in view of a publication ("Azuma".) *Id.*, pp.127-52. This application was allowed by the examiner after amendments to independent claims 1, 11 and 16. *Id.*, pp.192-210. Particularly, examiner added limitations "without using any derivatives of the…" which is drawn from the newly added claim 21 to the independent claims 1, 11 and 16 respectively. *Id.*, pp.199-210.

VII. LEVEL OF ORDINARY SKILL IN THE ART

Petitioner asserts a person of ordinary skill in the art ("POSITA") at the time, would have been familiar with motion sensors (such as gyroscopes, accelerometers, and magnetometers) and mobile device technology. Ex.1003, ¶22. Such POSITA would have, at minimum, a bachelor's degree in computer science, computer engineering, electrical engineering, or a related field, with at least two years of experiences in research, design, or development of pointing devices utilizing motion sensors. *Id.* Extensive experience and technical training may substitute for educational requirements, while advanced education such as a relevant MS or PhD might substitute for experience. *Id.*

VIII. CLAIM CONSTRUCTION (37 C.F.R. § 42.104(b)(3))

To file a substantially identical petition to that of IPR2019-00143 (to which this petition seeks joinder), Petitioner proposes identical constructions to those proposed by original Petitioner ZTE. However, recognizing that the Board has construed the terms in instituting IPR2019-00143, Petitioner consents to the Board's constructions therein.

Moreover, while the claim construction standard changed from BRI to *Phillips* for petitions filed after November 13, 2018, the Board should apply BRI to the instant petition because Petitioner is simply seeking joinder as a passive co-petitioner to the ZTE IPR. If the Board deems that its rule(s) require application of *Phillips* , Petitioner seeks waiver of such rule(s) pursuant to 37 C.F.R. § 42.5(b). Alternatively, even if *Phillips* is deemed to apply, the Board's constructions should be the same and would apply in the same manner in all aspects of the petition and decision instituting IPR2019-00143.

A claim in *inter partes* review is given the "broadest reasonable construction in light of the specification." See 37 C.F.R. § 42.100(b), *In re ICON Health and Fitness, Inc.*, 496 F.3d 1374, 1379 (Fed. Cir. 2007) ("[T]he PTO must give claims their broadest reasonable construction consistent with the specification. Therefore, we look to the specification to see if it provides a definition for claim terms, but otherwise apply a broad interpretation.").

For the purpose of this proceeding, claim terms are presumed to take on their broadest reasonable interpretation. The constructions below are for the purpose of this petition only, and Petitioner reserves the right to change these constructions as appropriate in future proceedings. Petitioner also does not concede, by seeking this petition, that the challenged claims are of definite scope or properly described under 35 U.S.C. §112.

Petitioner submits that all terms in the challenged claims should be given their plain meaning to a POSITA at the time the patent application was filed.[3]

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[3] Patent Owner agreed to the construction of certain claim terms based on the Courts' claim construction order in its prior litigations concerning the same '438 patent. *CyWee Group Ltd.* v. *Google, Inc.*, Case No. 1-18-cv-00571, (D. Del.); *CyWee Group Ltd.* v. *Apple Inc.,* Case No. 4-14-cv-01853, (N.D. Cal.); (Exs, 1012, 1013). However, the Court for the litigation involving Patent Owner and the Petitioner has not yet issued its claim construction order. *CyWee Group Ltd.* v. *LG Electronics, Inc. et al.,* Case No. 3-17-cv-01102, (S.D. Cal.). In instances where the challenged claim terms for this petition differ from Courts' claim construction order in the prior related litigations, the Petitioner provides additional analysis below distinguishing the claim constructions.

A. "three-dimensional (3D) pointing device"

The independent claims 1, 14 and 19 contain the preamble "three-dimensional (3D) pointing device." In the context of '438 Patent, the preambles should be limiting. Ex.1003, ¶55.

The 3D pointing device limitations provide antecedent basis for "*the* 3D pointing device" recited throughout the body of every independent claim. *See* Ex.1001, claims 1, 14, 19. Furthermore, "a preamble limits the [claimed] invention if it recites essential structure." *Catalina Mktg. Int'l, Inc. v. Coolsavings.com, Inc.*, 289 F.3d 801, 808 (Fed. Cir. 2002). The 3D pointing device limitations do just that here by providing the critical "spatial . . . reference frame" recited in the body of the claims. *Id.*

Thus, term "three-dimensional (3D) pointing device" or "3D pointing device" should be given its plain and ordinary meaning. Ex.1003, ¶¶55-57.

B. "six-axis motion sensor module"

In the context of the '438 patent, the appropriate construction of the term "six-axis motion sensor module" should be construed as "a sensor module that detects movement in terms of three angular velocities ω_x, ω_y, ω_z, and the three axial accelerations Ax, Ay, Az." Ex.1003, ¶58.

Indeed, even the specification recites that "the term 'six-axis' means the three angular velocities ωx, ωy, ωz and the three axial accelerations Ax, Ay, Az."

Ex.1001, 8:10-12. In a related litigation, CyWee agreed that "motion sensor module" "need not be construed." Ex.1004, 10.

The construction, therefore, is consistent with how a POSITA would understand the broadest reasonable interpretation in view of the specification. Ex.1003, ¶¶58-60.

C. "receiving and calculating said first and second signal sets"

The term "calculating" should be given its plain and ordinary meaning because the patentee did not specifically define this term differently from what the ordinary meaning would be. *Thorner v. Sony Computer Entm't Am. LLC*, 669 F.3d 1362, 1367-68, 101 USPQ2d 1457, 1460 (Fed. Cir. 2012). Ex.1003, ¶61. The plain and ordinary meaning of "calculating" or "calculate" is to "determine the value of something . . . by a mathematical process." Ex.1005.

D. "utilizing a comparison to compare the first signal set with the second signal set" / "comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax′, Ay′, Az′ also at current time T"

Prior petitioner ZTE has noted that the mapping from 3-dimensional measured sets into 4-dimensional quaternion sets are not defined in the specification (Ex.1004, 15-18), but arguments under Section 112 are not appropriately addressed in an IPR request. Thus, assuming that the real component of the quaternion is set to zero like it is explicitly done in the prior art, the term "comparison"/"comparing" should be given its plain and ordinary meaning. While it does not rise to the standard of lexicography that would allow for departure from the plain meaning, the "background of the invention" section of the '438 patent states that the comparison "may generally refer to the calculating and obtaining of the actual deviation angles of the 3D pointing device 110 …." Ex.1001, 2:26-32. However, this statement designates only the overall general purpose and does not explicitly define the meaning of "comparison". While this is inconsistent with the plain and ordinary meaning, the broadest reasonable interpretation of comparison, if it is definite should include "performing calculations based on first and second sensor signals to obtain the deviation angles of the device with respect to the spatial pointing frame." Ex.1003, ¶¶62-65. With respect to the spatial reference frame means the orientation of the device and the corresponding spatial reference frame relative to the world reference frame. *Id.*

The gyroscope generates the first signal set of angular velocities and the accelerometer generates the second signal set of acceleration measurements. Ex.1001, 7:64–8:17. The '438 patent specification discloses converting the angular velocities and the measured axial acceleration into quaternions and comparing the quaternions. *Id.*, 12:40-44; 13:13-16; 13:25-43.

IX. BRIEF DESCRIPTION OF PRIOR ART RELIED UPON

A. Yamashita in view of Bachmann

1. <u>U.S. Patent No. 8,267,785 ("Yamashita")</u>

Yamashita discloses a game console for executing a game using motion sensors, such as gyrosensors and acceleration sensors, and using the moving velocity and/or relative positional relationship to execute game processing. Ex.1006, Abstract. The game console, also called the input device, detects and generates at least acceleration data and angular velocity data. *Id.*

FIG. 1

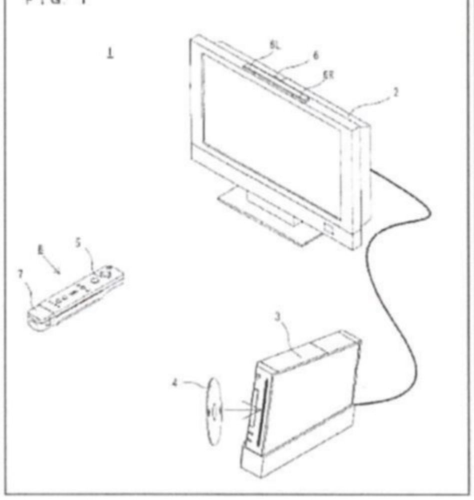
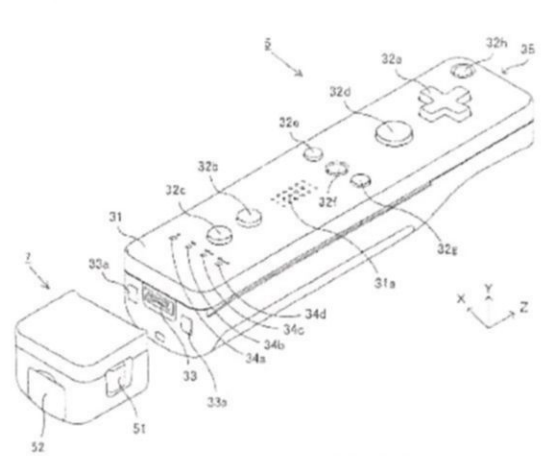


FIG. 3



Yamashita discloses in FIG. 7, that "the input device 8 includes, among other components, "a communication section 36, and the acceleration sensor 37." *Id.*, 11:52-59; FIG. 7. The communication section 36 is the data transmitting unit and is electronically connected to the six-axis motion sensor (acceleration sensor and gyrosensors). Ex.1006, FIG. 7.

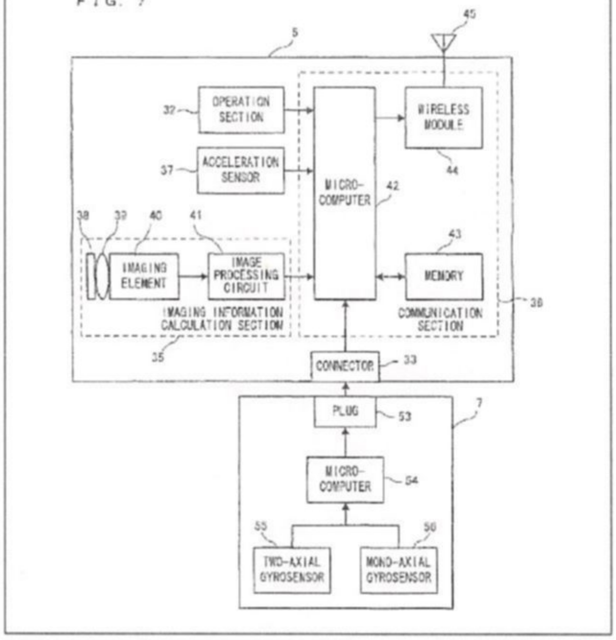
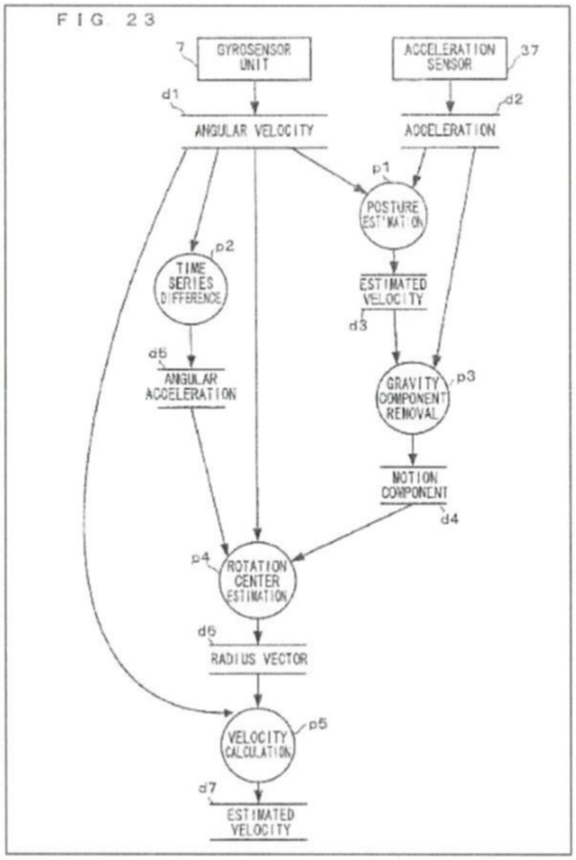


FIG. 7

Yamashita discloses that the microcomputers 42 are the computing processor of the input device 8. *Id.*, 13:25-60. The microcomputers are used for posture calculation using gyrosensor data and inclining angle determination using acceleration data. *Id.*, 12:62-13:24, 14:18-15:8. Yamashita discloses the estimated posture of the input device based on acceleration data and angular velocity data. *Id.*, 19:4-13. Yamashita discloses, in connection with Figure 23, reproduced below, that the updated posture, which is the updated state, is based on the angular velocity, the first signal set, and corrected by acceleration data, the second signal set. *Id.*, 19:29-40.



2. <u>U.S. Patent No. 7,089,148 ("Bachmann")</u>

Bachmann teaches a nine-axis sensor system that combines accelerometers, magnetometers and angular rate detectors (e.g., gyroscopes) to form MARG sensors. Ex.1007, Abstract, 7:34-40.

Bachmann teaches combining sensor data using an attitude estimation filter to produce an estimate of the orientation of a tracked object. Bachmann discloses "a three-axis angular rate sensor (p, q, r) 33" that generates the first signal set, the angular rate data, and a three-axis accelerometer 31 (h_1, h_2, h_3) that generates the second signal set, the acceleration data. Ex.1007, 9:59-10:14.

Bachmann utilizes a comparison to compare the first signal set with the second signal set to obtain the resulting deviation. Bachmann's filter, as shown in Fig. 3, receives inputs from three sets of sensors (accelerometers, magnetometers and angular-rate sensors) marked 31, 32 and 33, on the left side of Fig. 3. *Id.*, 10:10-14. The output of the angular rate sensors (33) is used to "provide angular rate information 37 to the filtering system." *Id.*, 9:59-60.

The measurements from box 31 accelerometers, the second signal set, and box 32 magnetometers, form a six-valued measurement vector (h_1 h_2 h_3 b_1 b_2 b_3) shown in box 34. *Id.*, 9:61-65. "The magnetometer returns a local magnetic field vector (the unit vector b) in sensor coordinates. The accelerometer returns a local gravity vector (the unit vector h) in sensor coordinates. These two vector quantities b and h, expressed in sensor coordinates as pure vector quaternions, are unit vectors,"

$$h=[0\ h_1\ h_2\ h_3] \qquad (2)$$

$$b=[0\ b_1\ b_2\ b_3] \qquad (3)$$

Ex.1007, 8:37-47.

Bachman then describes that "[T]he vector parts from Eqns. (2) and (3) can be combined to produce a 6xl measurement vector y_0 34 in sensor coordinates:

$$y_0=[h_1\ h_2\ h_3\ b_1\ b_2\ b_3]^T \qquad (4)$$

Id., 8:48-51.

Bachman also describes that the output orientation of the system $\hat{q}$ is re-mapped to the sensor reference frame in box 35 to produce a "computed measurement vector $y(\hat{q})$ 35a, wherein the values for h_1 h_2, h_3, b_1, b_2 ,b_3 are generated by mapping m and n through as an estimated orientation quaternion

$$y(\hat{q})=[h_1\ h_2\ h_3\ b_1\ b_2\ b_3]^T \quad (8)$$

Id., 8:52-9:8.

Bachmann describes that the output orientation of the system $\hat{q}$ that is used to generate the computed measurement vector $y(\hat{q})$ is computed by integrating the difference between the angular rate measurement (box 37) and a "criterion function." "Then the difference between the actual measurements y_0 and the computed measurement vector is defined as the error vector $\bar{\varepsilon}(\hat{q})$ 36."

$$\vec{\epsilon}\,(q)=\vec{y}_0-\vec{y}\,(\hat{q}) \quad (9)$$

Id., 9:9-13

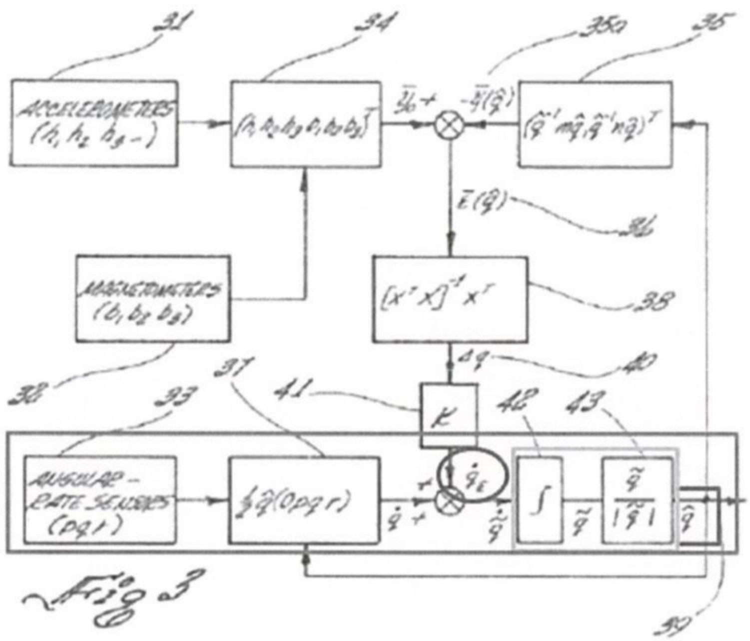
The six actual measurements are thus compared to six predicted measurements found in the vector $\bar{y}(\hat{q})$, by subtracting the predicted measurements $\bar{y}(\hat{q})$ from the actual measurements (h1 h2 h3 b1 b2 b3). *Id.*, 9:9-17, 17:12-22, This forms a six-valued error vector $\bar{\varepsilon}(\hat{q})$, numbered 36. *Id.*

The six-valued error vector $\bar{\varepsilon}(\hat{q})$ is a measure of how actual accelerometer and magnetometer measurements differ from the what the filter predicts those measurements should be, based on the angular rate sensor output. *Id.*, 17:12-22, 9:9-14.

Bachmann describes that the error function is squared to form the criterion function that will subsequently be minimized. "As previously described, the difference between the measurement vector y_0 and the computed measurement vector $y(\hat{q})$ is the error vector $\vec{\varepsilon}(\hat{q})$ 36 and the square of the filter modeling error is termed the criterion function." *Id.*, 10:2-7.

Bachman describes this difference between the angular rate measurement (box 37) and the criterion function (boxes 38 and 40) is then used to determine the orientation of the device, i.e. the output orientation. "The output of the filters can be integrated 42 and normalized 43 to provide an estimated orientation quaternion 39." *Id.*, 9:43-45.

Bachman describes that the filter shown in FIG. 3, calculates the predicted value of $\hat{q}$, which is the deviation derived from the integration and normalization boxes 42 and 43. *Id.*, FIG. 3. Box 42 is the integral of $\dot{q}$, which is the measured angular velocity corrected by the criterion function described above.



Bachmann describes that when the computations are done in a discrete time system, the predicted value of q is given by equation 16, which clearly shows that the next discrete value of q is determined by the least squares filtered difference "*Δq* (full)" times the time interval between the samples plus the measured angular rate time the time interval. Ex.1007, 11:12-20.

$$\hat{q}_{n+1} = \hat{q}_n + \frac{1}{2}\hat{q}^{B}\omega\Delta t + \alpha[X^T X]^{-1}X^T\varepsilon(\hat{q}_n) \qquad (16)$$
$$= \hat{q}_n + k\Delta t\Delta q_{full} + \dot{q}_{measured}\Delta t$$

The q rate (q̇ measured) is simply the measured angular velocity rate, therefore, while the rate is measured, it is not a "derivative". Ex.1003, ¶89. The computation is simply done q domain, not in the q̇ domain because the time samples are uniform. *Id.*,

3. <u>The Combination of Yamashita and Bechmann</u>

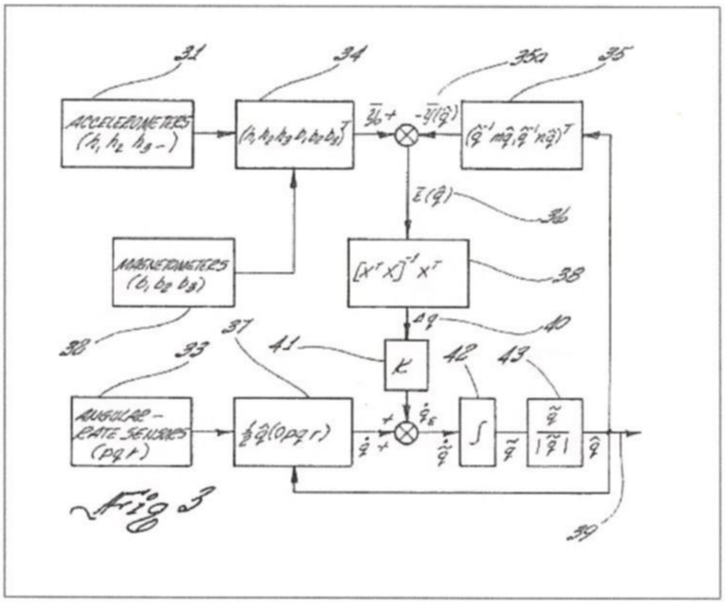
It would have been obvious to a POSITA in the relevant timeframe to use Yamashita's game console device with Bachmann's sensors and filter calculations. A POSITA would have understood that additional sensors, and additional types of sensors, would have yielded at least better error and noise control. Ex.1003, ¶84. Yamashita describes that a key reason for using the combined acceleration and angular velocity sensors is to compensate for errors. Ex.1006, 1:49-60, Ex.1003, ¶84.

Yamashita admits that the described solution still exhibits errors when the device is moving. Ex.1003, ¶85. Yamashita states "[b]y performing such a correction, the posture is calculated more accurately based on the acceleration when there is little motion of the input device 8, and the posture can be always estimated with a certain degree of appropriateness even when the input device 8 is moving." Ex.1006, 19:29-40.

Bachmann's filtered approach using a nine axis sensor set compensates for error whether the device is moving or not, and thus a POSITA implementing Yamashita would have been motivated to adopt the filtered nine axis sensor solution of Bachman in order to further reduce these errors. Ex.1003, ¶86.

Bachmann's nine-axis sensors were also well-known in the art in the relevant timeframe. Ex.1003, ¶87. Specifically, magnetic, angular rate and gravitational (acceleration) sensors, known in the art as MARG sensors, were already commercially available, and could be integrated in a known fashion. Ex.1007, 14:37-57, Ex.1003, ¶87. Bachmann further states that its sensors and filter are applicable to hand-held devices "[b]y mounting a plurality of sensors on a body... Examples include, but are not limited to hand-held devices, swords, pistols, or simulated weapons." Ex.1007, 13:42-48, Ex.1003, ¶87.

In using Bachmann's suggested MARG sensors, it would have been obvious to use Bachmann's quaternion-based filter techniques (as illustrated, for example, in Fig. 3 of Bachmann) because those filter techniques were adapted directly to MARG sensors. Ex.1007, 7:18-45; Ex.1003, ¶88. In particular, Bachmann teaches that its filter techniques using quaternion calculations are superior to filters that (internally) use spatial (e.g. Euler) angle calculations, because the quaternion-based techniques are computationally more efficient and avoid singularities that might otherwise occur at certain sensor orientations. Ex.1007, 5:33-7:31; Ex.1003, ¶88.



As discussed above, sensors of the type described by Bachmann were widely available on the commercial market. Ex.1007, 14:37-57, Ex.1003, ¶89. A POSITA would have been able to integrate these sensors into Yamashita's device using standard conditioning circuits, samplers and analog-to-digital converters, making adjustments as necessary. Ex.1003, ¶89.

Both Yamashita and Bachmann teach implementing orientation calculations on computer chips, for example Yamashita's microcomputers 42 and 54. Ex1006., 10:38-44, or Bachmann's CPU 403, Ex.1007, 13:64-14:29. In the timeframe, microcomputers and microcontrollers with sufficient power to implement Bachmann's filter were readily available. Ex.1003, ¶90. A POSITA likewise would have expected success performing a transformation of Bachmann's orientation output into Euler angles to express a deviation, because the calculations were well-known and that was the conventional form of such output. *Id.*

Yamashita and Bachmann are analogous art, because they are in the same field and reasonably related to the problems of improving the accuracy of the orientation calculation, as shown by the discussion below. Ex.1003, ¶91. A POSITA therefore would have been able to implement the combination and would have had a reasonable expectation of success. *Id.*

B. Nasiri in view of Song

1. U.S. Patent No. 8,462,109 ("Nasiri")

Nasiri teaches handheld electronic devices based on sensing rotational rate around at least three axes and linear acceleration along at least three axes. Ex.1008, Abstract. Nasiri discloses that the device is capable of facilitate user interaction. *Id.*, Abstract

Nasiri provides an example of tilt controls on a handheld device *Id.*, 7:56-58. "For example, such a handheld device can be a mobile device ..." *Id.*, 8:26-35.

Nasiri discloses that the handheld device "includes an application processor 12, memory 14, interface devices 16, a motion processing unit 20, analog sensors 22, and digital sensors 24." *Id.*, 8:50-52. The sensors include gyroscopes 26 that measure the angular velocity, the first signal set, of the device 10 and accelerometers 28 that measure the linear acceleration, the second signal set, of the device 10. *Id.*, 9:64-10:11.

Nasiri discloses having processor 12 that receives rotation rate data, first signal set, and acceleration data, second signal set, from the sensors and performs further calculations, such as the gesture processing and recognition, using that data. *Id.*, 8:52-9:20.

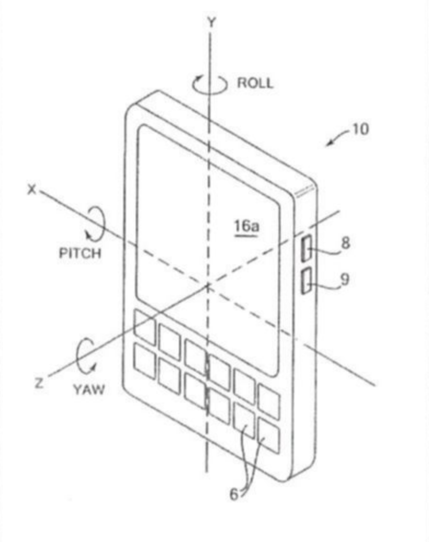


FIG. 1

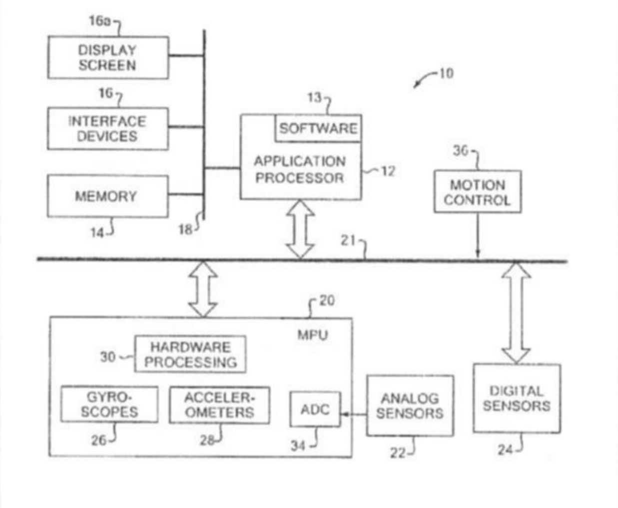


FIG. 2

a. U.S. Patent Publication No. 2009/0265671 ("Sachs") (EX.)

Sachs was incorporated by reference in Nasiri as a method for recognition of gestures and motions of a device, such as "an algorithm combining inputs from multiple sensors to provide more robust sensing..." Ex.1008, 14:49-57.

Sachs and Nasiri share some of the same figures. For example, Sachs discloses the same FIG. 1 as Nasiri, which shows that the Application processor 12 communicates with the six-axis motion sensor, gyroscopes 26 and accelerometers 28. Ex.1009, ¶0037. Sachs FIG. 9 shows that the processor can receive raw data from the sensors. *Id.*, ¶0037, FIG. 9.

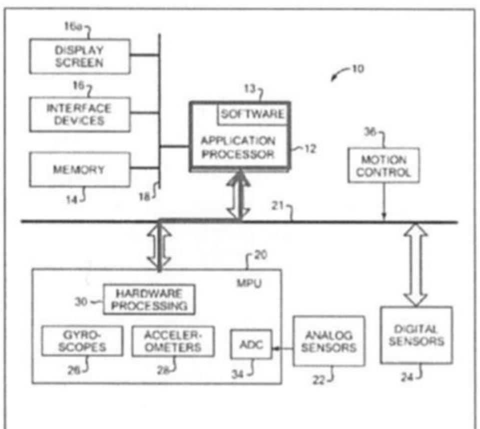


FIG. 1

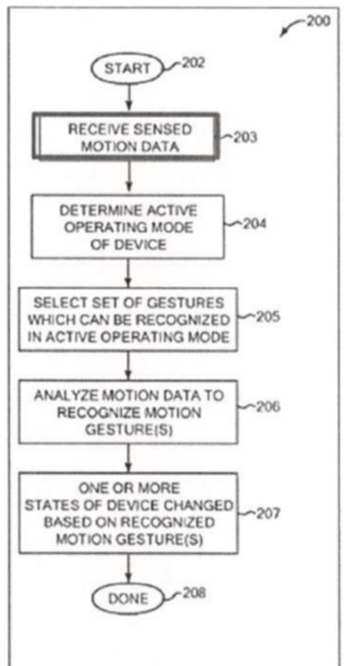


FIG. 9

Sachs teaches using coordinate transforms when operating handheld devices. Sachs teaches the use of motion gestures using a handheld device. Recognizing that a person may make the gestures in a variety of different postures, Sachs teaches the use of coordinate transforms to account for the different postures. *Id.*, Figs. 5-7, ¶¶ 13, 53, 57-77.

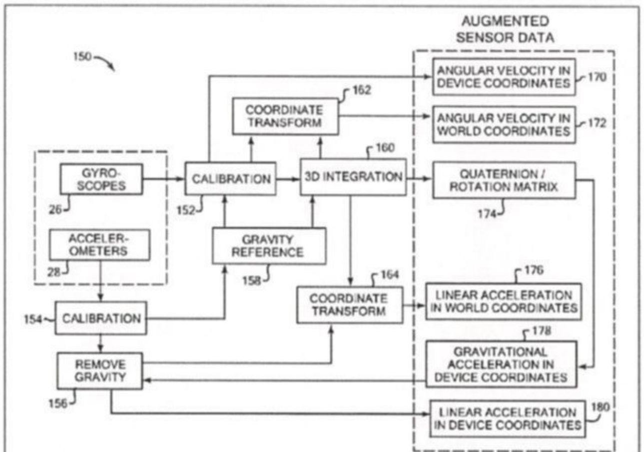


FIG. 7

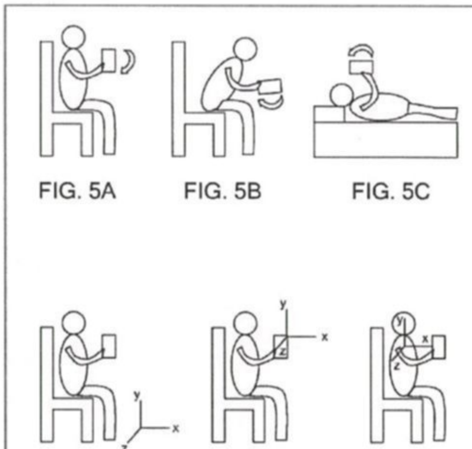


FIG. 5A FIG. 5B FIG. 5C

FIG. 6A FIG. 6B FIG. 6C

Sachs discloses a system for producing augmented data for recognizing motion gestures using both the first (gyroscopes data) and the second (acceleration data) signal sets, as shown FIG. 7. *Id.*, ¶0062, FIG. 7. Sachs discloses the determination of the resultant angle by showing the rotation matrix and quaternion as representing the orientation of the device.

Sachs discloses the updated state of the device is based on a previous state associated with said first signal set (angular velocities), $q_{gyroscope}$ and the updated state is also based on a measured state associated with the second signal set (axial accelerations). *Id.*, ¶¶0069-0072,

Sachs discloses "a predicted measurement obtained based on the first signal set without using any derivatives of the first signal set." With discrete time processing, the time increment is known and fixed. The device 10 computes the changes directly using only delta rotations, not rotation rates. *Id.*

2. <u>U.S. Patent Publication No. 2007/0299626 ("Song") (EX.)</u>

Song teaches "a method of recognizing space according to the movement of an input device." Ex.1010, Abstract. Song discloses "measuring angular velocity data using an angular velocity sensor; measuring acceleration data using an accelerometer; estimating a bias of the angular velocity sensor using the acceleration data; calculating Euler angles between a reference navigational frame and a body frame using the angular velocity data and the acceleration data; and identifying position information of the input device according to the movement of the input device by using the calculated Euler angles." *Id.*, Abstract.

Song discloses the transmitter 310 to transmit position information of the input device to the receiver 320. *Id.*, ¶0038. Song discloses "the transmitter 310 measures angular velocity data and acceleration data as the input device moves … identifies position information of the input device recognized as the input device moves, and transmits the identified position information to the receiver 320 using the wireless communication method." *Id.*, ¶0038.

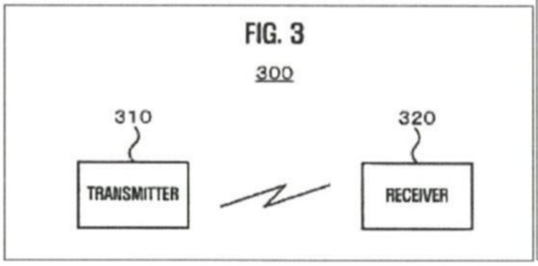


FIG. 3

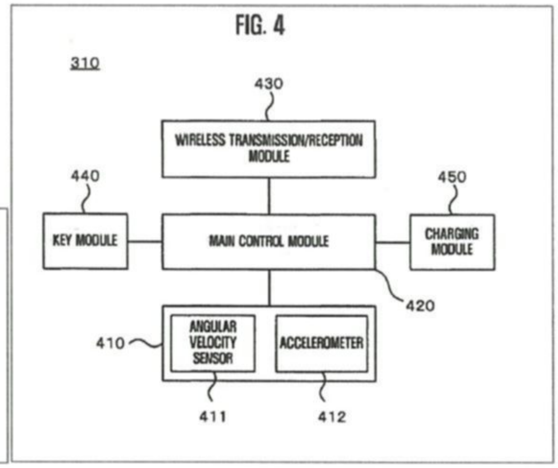


FIG. 4

Song discloses that angular velocity sensor 11 measures the angular velocity data, the first data set, and accelerometer 412 measures the acceleration data, the second data set. *Id.*, ¶¶0042-43.

3. <u>The Combination of Nasiri and Song</u>

It would have been obvious to a POSITA in the relevant timeframe to combine Nasiri and Song. Nasiri and Song are analogous art, because they are in the same field and reasonably related to the problems of improving the accuracy of the orientation calculation, as shown by the discussion below. As to Sachs, there was an explicit teaching, suggestion, and motivation to combine because Sachs was incorporated by reference in Nasiri. Ex.1008, 14:49-57.

A POSITA therefore would have been able to implement the combination and would have had a reasonable expectation of success. Ex.1003, ¶107.

Further, a POSITA would have understood that the I2C bus is a well-known serial chip-to-chip interconnect standard for placing data onto the bus (i.e.

transmitting data), and for obtaining data from the bus (i.e. receiving data). Ex.1003, ¶108.

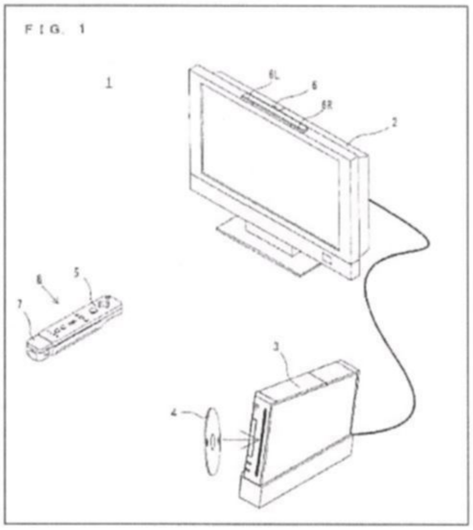
A POSITA would also have the desire to physically separate the sensor module from the application processor in order to of reduce the size weight and power consumption of the handheld unit. In this combination, the systems (the sensor module and application processor of Nasiri, and the wireless interface bus of Song) would be performing the same functions it had been known to perform, and the combination of these familiar elements would produce the predictable result of allowing the system described by Nasiri to perform as described by Nasiri, while enjoying the wireless connection described by Song. Ex.1003, ¶¶109, 210.

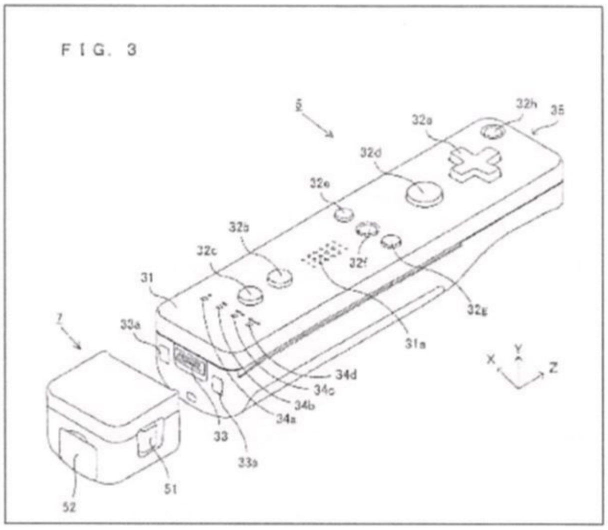
X. CLAIM-BY-CLAIM EXPLANATION OF GROUNDS OF UNPATENTABILITY

A. Ground A: Under 35 U.S.C. § 103, U.S. Patent No. 8,267,785 ("Yamashita") in view U.S. Patent No. 7,089,148 ("Bachmann") renders claims 1, 4-5, 14-17, and 19 obvious.

1. <u>**1(pre)** "*A three-dimensional (3D) pointing device subject to movements and rotations in dynamic environments, comprising*"</u>

Yamashita discloses a pointing device. As shown in FIGs. 1 and 3, Yamashita teaches a game console that a player can hold by hand and point to the display screen to perform a game operation. Ex.1006, 9:42-50; FIGs. 1 and 3.





Yamashita discloses that the pointing device, which is the input device 8 (the controller 5 and the gyrosensor unit 7) in FIGs. 1 and 3, detects movements and rotations in a three-dimensional coordinate system. For examples, the pointing devices includes gyrosensors to detect angular velocity, in the rotation directions of the "pitch direction", the "yaw direction" and "roll direction", respectively." Ex.1006, 12:47-13:10; 14:35-48, FIG.8, Ex.1003, ¶112. The pointing device also includes acceleration sensors to detect accelerations, including gravitational accelerations, of the controller. 8. Ex.1006, 12:47-13:10. The acceleration sensor detects linear accelerations in up-down, left-right, and front-rear directions. Ex.1006, 12:47-13:10, FIG. 3. Ex.1003, ¶113.

FIG. 8

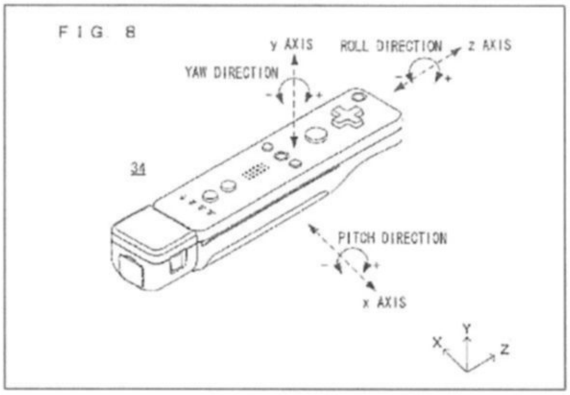
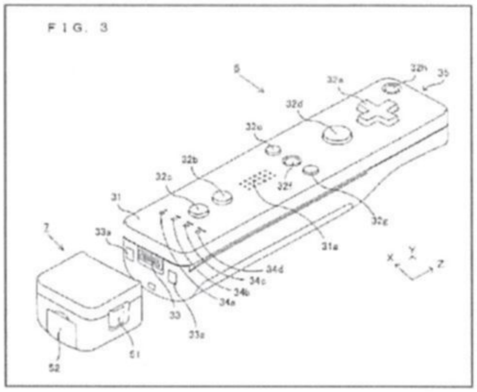


FIG. 3



Yamashita discloses that the input device obtains movement and rotational data in dynamic environments. Yamashita discloses when "the controller 5 is in a dynamic state (in the state where the controller 5 is being moved), the acceleration sensor 37 detects an acceleration in accordance with the motion of the controller 5 in addition to the gravitational acceleration." Ex.1006, 13:61-65.

2. <u>**1(a)** "*a housing associated with said movements and rotations of the 3D pointing device in a spatial pointer reference frame*"</u>

Yamashita discloses that the pointing device, the input device, has a housing. The housing is the plastic molding, of the controller as shown in FIGs. 3 and 4, and the size of the input device is small enough to be held by hand.

FIG. 3

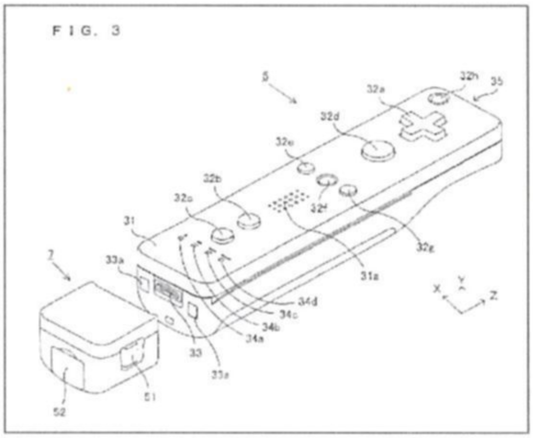
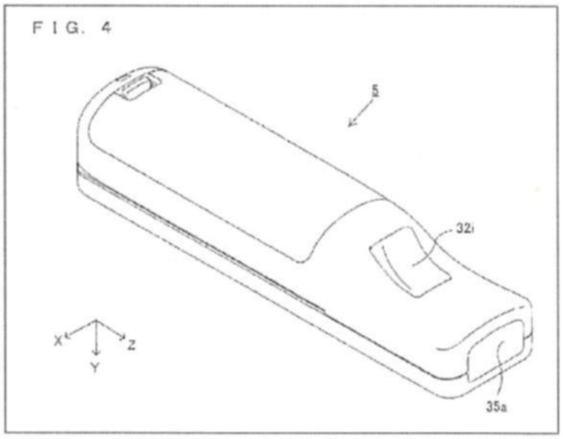
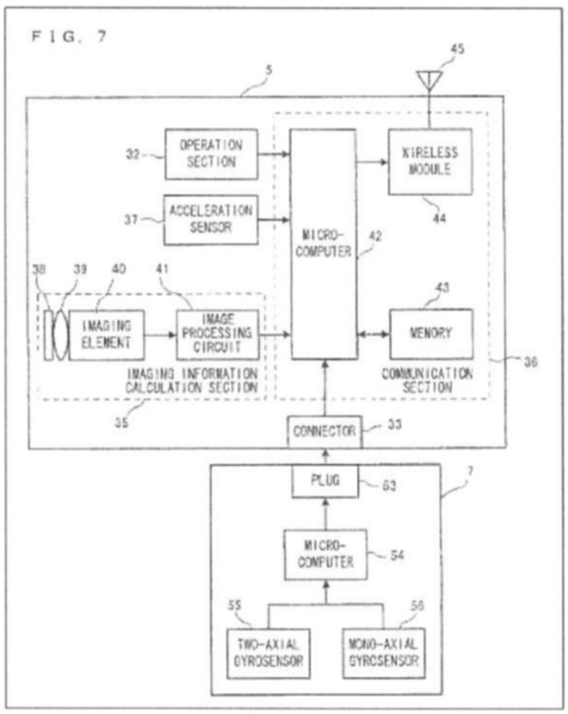


FIG. 4

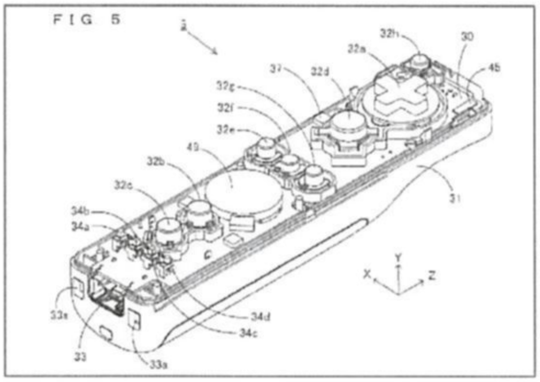


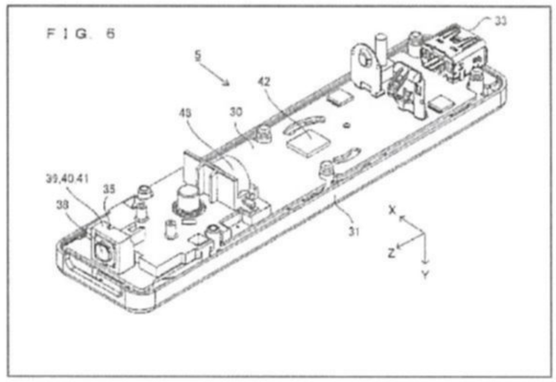
The housing is associated with movements and rotations of the 3D pointing device in a spatial pointer reference frame because the game player moves the input device, including its housing, to perform a game operation, including playing the game. Ex1003. ¶116. Yamashita also discloses a block diagram showing a structure of the input device where gyrosensors 55, 56 and acceleration sensors 37 that detect movements and rotations can be found inside the controller. Ex.1006, 9:42-10:7; FIG. 7. Ex1003. ¶116. The spatial pointer reference frame moves with the controller, and is shown, for example, by the X, Y and Z axes in Fig. 3 and 4.



3. <u>1(b) "*a printed circuit board (PCB) enclosed by the housing*"</u>

Yamashita discloses a printed circuit board (PCB) enclosed by the housing. For example, as shown in FIGs 5 and 6, the substrate 30, which is a PCB, is fixed inside the housing 31. FIGs 5 and 6 indicate that other components are affixed to the substract 30. Ex.1006, 10:38-44. A POSITA would have understood that the substrate to which components can be mounted as a "printed circuit board" or "PCB". Ex.1003, ¶117.





The Patent Office expressly noted that printed circuit boards were commonplace features of electronic devices during the prosecution of the patents-in-suit: "Examiner takes Official Notice that it is well known in the art to employ the use of a PCB to mechanically support and electrically connect electronic components using conductive pathways." Ex.1002, 80.

4. <u>1(c) "*a six-axis motion sensor module attached to the PCB, comprising*"</u>

Yamashita discloses a six-axis motion sensor module attached to the PCB. FIGs. 5-7 show that the acceleration sensor 37 is attached to the substrate, which is the PCB, and gyrosensors 55 and 56 reside in the gyrosensor unit 7, which can be attached to the PCB. Ex.1006, 10:36-11:32, FIGs. 5-7, Ex.1003, ¶120. Figures 5-7 further show that once the gyrosensor unit is plugged to the controller, the gyrosensor unit is attached to the PCB directly. Ex.1003, ¶120.

The acceleration sensor 37 is a three-axis sensor that detects acceleration from up-down, left-right, and front-rear directions. Ex.1006, 12:47-13:10, Ex.1003, ¶121. Gyrosensors 55 and 56 detects angular velocities from X, Y, Z axes, in the rotation directions of the "pitch direction", the "yaw direction" and "roll direction", respectively." Ex.1006, 12:47-13:10; 14:35-48, FIG.8, Ex.1003, ¶121. Thus, in total, Yamashita discloses a six-axis motion sensor.

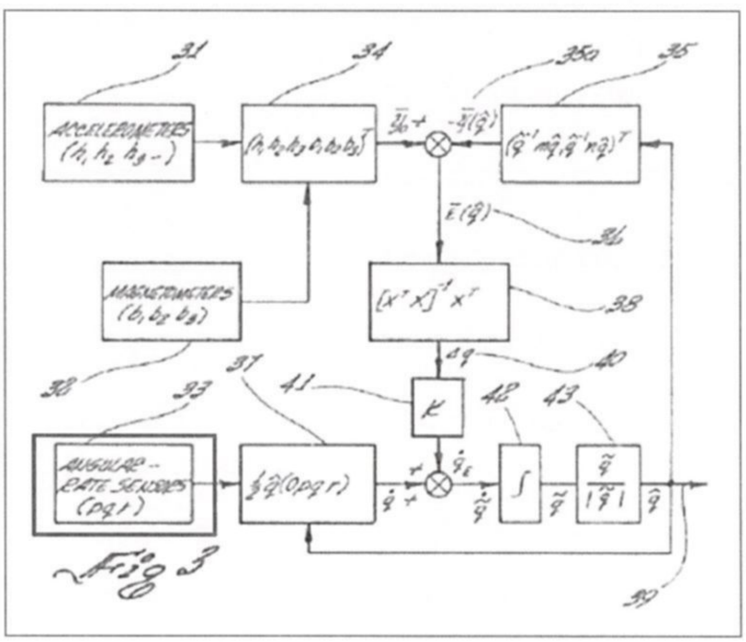
5. **1(d) "*a rotation sensor for detecting and generating a first signal set comprising angular velocities ωx, ωy, ωz associated with said movements and rotations of the 3D pointing device in the spatial pointer reference frame*"**

Yamashita discloses having gyrosensors for detecting and generating a first signal set comprising angular velocities ωx, ωy, ωz. Yamashita discloses, "ω means a value of the angular velocity which is represented as the angular velocity data and is formed of three axis components of X, Y and Z axes" and angular velocity data can be obtained or generated from the input device, the controller, including at least a gyrosensor. Ex.1006, 3:53-4:7, 4:10-25, Ex.1003, ¶¶122-23.

Yamashita discloses "a rotational sensor … associated with movements and rotations of the 3D pointing device in a spatial pointer reference frame." *See supra* Section X.A.2.

As discussed above, a POSITA would have been motivated to use Bachmann's sensor with Yamashita's handheld game console. *See supra* Section IX.A.3. A POSITA would have known that components were typically mounted to circuit boards in the relevant time frame, and would have found it obvious to mount Bachmann's sensors on Yamashita's PCB. Ex.1003, ¶127.

Bachmann discloses "a three-axis angular rate sensor (p, q, r) 33." Ex.1007, 10:10-14; FIG. 3. The angular rate sensor generates angular rate data, the first signal set, and provide such information to the filtering system. *Id.*, 9:59-10:14. As shown in FIG. 3, the angular rate sensor 33 is "associated with movements and rotations of the 3D pointing device in a spatial pointer reference frame." Ex.1003, ¶126. As Bachmann states, referring to equation (11), the angular rates are "measured in the sensor reference frame." Ex.1007, 10:17-30; Ex.1003, ¶126.



6. 1(e) "*an accelerometer for detecting and generating a second signal set comprising axial accelerations Ax, Ay, Az associated with said movements and rotations of the 3D pointing device in the spatial pointer reference frame; and*"

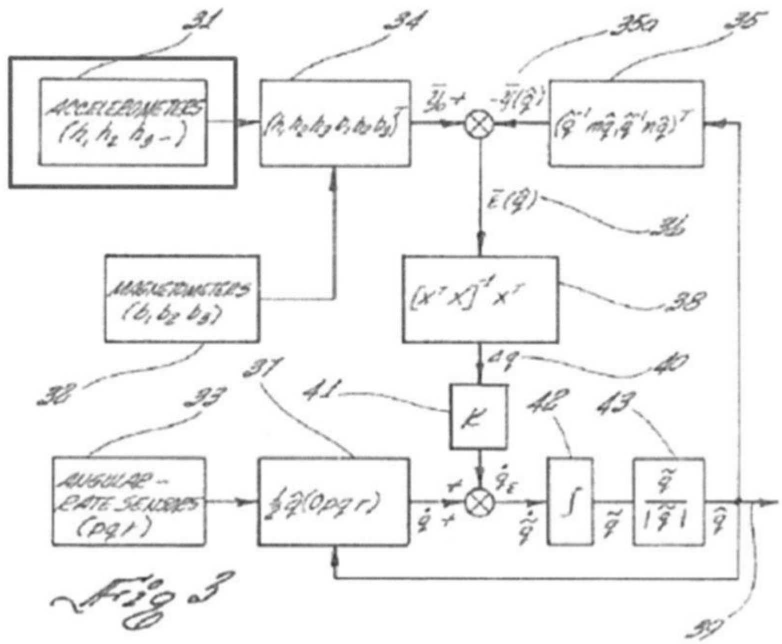
Yamashita discloses having acceleration sensors for detecting and generating a second signal set comprising axial accelerations Ax, Ay, Az. Yamashita discloses, "'A' can be specified by an acceleration component (hereinafter, referred to as the "motion component") obtained by removing a gravity component from the acceleration obtained from the acceleration sensor." Ex.1006, 17:52-18:2. The acceleration sensors detect accelerations, including gravitational accelerations, of the controller. 8. *Id.*, 12:47-13:10. The acceleration sensor detects linear accelerations in up-down, left-right, and front-rear directions. Ex.1006, 12:47-13:10, FIG. 3.

As discussed above, Yamashita discloses "an accelerometer … associated with movements and rotations of the 3D pointing device in a spatial pointer reference frame." *See supra* Section X.A.2.

As discussed above, a POSITA would have been motivated to use Bachmann's acceleration sensor with Yamashita's handheld game console. *See supra* Section IX.A.3.

Bachmann discloses a three-axis accelerometer 31 (h_1, h_2, h_3). Ex.1007, 8:12-15, 10:10-14, FIG. 3. The accelerometer 31 generates acceleration data and provide linear acceleration information to the filtering system. Ex.1007, 10:10-14.

"In one embodiment, a three-axis accelerometer can be used to measure total acceleration (forced linear acceleration and gravitational reaction force) $\vec{a}_{\text{measured}}$ as over a fixed time period." Ex.1007, 8:12-15. As shown in FIG. 3, the angular rate accelerometer 31 is "associated with movements and rotations of the 3D pointing device in a spatial pointer reference frame." Ex.1003, ¶130. The total acceleration is expressed in equation (1): $\vec{a}_{\text{measured}} = \vec{a} + \vec{g}$. Ex.1007, 8:13-42; Ex.1003, ¶130.



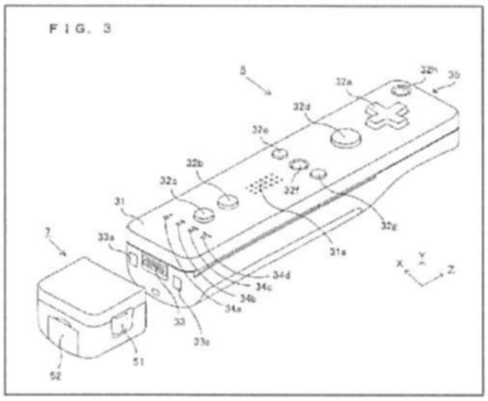
7. <u>1(f) "*a processing and transmitting module, comprising*"</u>

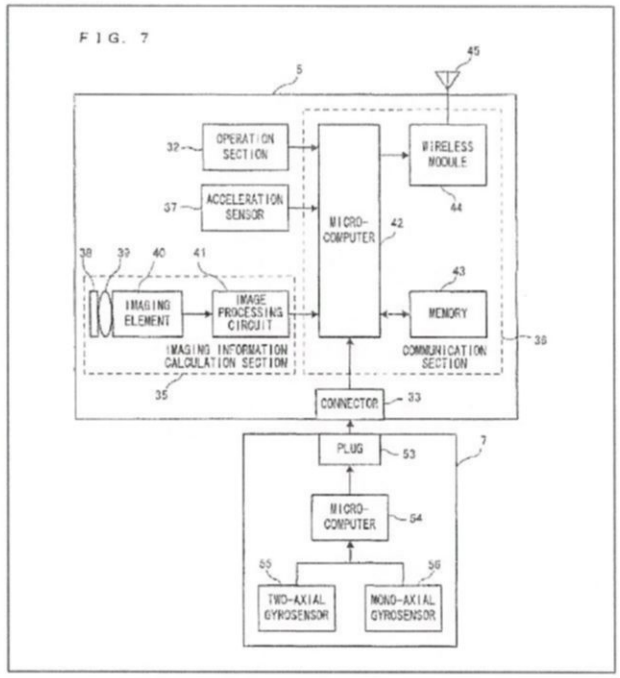
Yamashita discloses "a processing and transmitting module." *See infra* Sections X.A.8-15.

8. 1(g) *"a data transmitting unit electrically connected to the six-axis motion sensor module for transmitting said first and second signal sets thereof and"*

Yamashita discloses this limitation. As FIG. 7 discloses, "the input device 8 (the controller 5 and the gyrosensor unit 7)" includes, among other components, "the operation section 32 (operation buttons 32 a through 32 i), the connector 33, the imaging information calculation section 35, a communication section 36, and the acceleration sensor 37." Ex.1006, 11:52-59; FIG. 7. The communication section 36 is the data transmitting unit. Ex.1003, ¶132. As shown in the diagram, the communication section 36 is electronically connected to the six-axis motion sensor (acceleration sensor and gyrosensors). Ex.1006, FIG. 7, Ex.1003, ¶132.

The communication section transmits said first and second signal sets. Yamashita discloses that the gyrosensors detect angular velocities, the first signal set, of the input device and the data detected is transmitted to the communication section 36 through the microcomputer 54 for posture calculation process. Ex.1006, 14:18-27, 14:28-15:8, FIG. 7. Yamashita also discloses that the acceleration data, the second signal set, of the input device detected by the acceleration sensor 37 is transmitted to the communication section 36 to determine the inclining angle of the controller 5. *Id.*, 12:62-13:24, FIG. 7.





9. <u>**1(h)** "*a computing processor for receiving and calculating said first and second signal sets from the data transmitting unit*"</u>

Yamashita discloses this limitation. Yamashita discloses that the microcomputers are the computing processor of the input device 8. Ex.1006, 13:25-60. Yamashita discloses, that the microcomputers are used for posture calculation using gyrosensor data and inclining angle determination using acceleration data. *Id.*, 12:62-13:24, 14:18-15:8, FIG. 7. Yamashita discloses that the microcomputer receives first and second signal sets: "[d]ata which is output from … the acceleration sensor 37 to the microcomputer 42, and data transmitted from the gyrosensor unit 7 to the microcomputer 42…." *Id.*, 12:62-13:24, 14:28-15:14.

10. 1(i) "*communicating with the six-axis motion sensor module to calculate a resulting deviation comprising resultant angles in said spatial pointer reference frame*"

Yamashita discloses the processing and transmitting module communicates with the six-axis motion sensor. As shown in FIG. 7, the communication section and the microcomputers receive acceleration and angular velocity data transmitted from the six-axis motion sensor, acceleration sensor and the gyrosensors, and use this data to calculate the resultant angles in the pointer (spatial) reference frame. Ex.1006, 12:62-13:24, 14:18-15:8, FIG. 7.

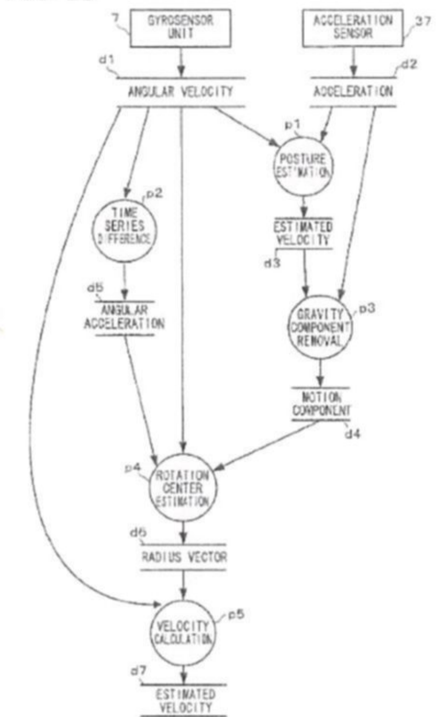
Yamashita discloses a resulting deviation comprising resultant angles. "Deviation" in the context of the '438 patent is equivalent to "orientation." Ex.1001, 1:58-61, Ex.1003, ¶137. For example, Yamashita discloses resulting deviation including resultant angles comprising yaw, pitch and roll angles. Ex.1006, 14:35-48, FIG. 8.

Yamashita discloses "a spatial pointer reference frame." *See supra* Section X.A.2.

11. 1(j) "by utilizing a comparison to compare the first signal set with the second signal set whereby"

Yamashita utilizes "a comparison to compare the first signal set with the second signal set." As shown in FIG. 23, the posture estimation p1 uses angular velocity d1 obtained from the gyrosensor unit 7, the first signal set, and acceleration d2 obtained from the acceleration sensor 37, the second signal set, and outputting the estimated posture of the input device 8 as estimated posture d3. Ex.1006, 19:1-8. The method used to calculate the estimated velocity based and acceleration and angular velocity is: "a posture vector represented by the angular velocity is corrected by a vector represented by the acceleration to calculate the posture of the input device 8." Ex.1006, 19:8-13.

FIG. 23



A POSITA would have been motivated to use Bachmann's sensor and orientation computing filter with Yamashita's handheld game console. Ex.1003, ¶¶154-55. *See supra* Section IX.A.3.

Bachmann teaches combining sensor data using an attitude estimation filter to produce an estimate of the orientation of a tracked object. Bachmann discloses "a three-axis angular rate sensor (p, q, r) 33" that generates the first signal set, the angular rate data, and a three-axis accelerometer 31 (h_1, h_2, h_3) that generates the second signal set, the acceleration data. Ex.1007, 9:59-10:14. Bachmann compares the first signal set with the second signal set to obtain the resulting deviation. Ex.1003, ¶141. Bachmann's filter as shown in Fig. 3 receives inputs from three sets of sensors (accelerometers, magnetometers and angular-rate sensors) marked 31, 32 and 33, on the left side of Fig. 3. Ex.1007, 10:10-14, Ex.1003, ¶141. The output of the angular rate sensors (33) is used to "provide angular rate information 37 to the filtering system", Ex.1007, 9:59-60.

Bachman then describes using the combine d accelerometer data and magnetometer data, the system derives an error function that is ultimately compared with the angular rate sensor data. For example:

The measurements from box 31 accelerometers, the second signal set, and box 32 magnetometers, form a six-valued measurement vector (h_1 h_2 h_3 b_1 b_2 b_3) shown in box 34. *Id.*, 9:61-65. "The magnetometer returns a local magnetic field vector (the unit vector b) in sensor coordinates. The accelerometer returns a local gravity vector (the unit vector h) in sensor coordinates. These two vector quantities b and h, expressed in sensor coordinates as pure vector quaternions, are unit vectors". *Id.*, 8:37-42, Ex.1003, ¶144.

$$h=[0\ h_1\ h_2\ h_3] \quad (2)$$

$$b=[0\ b_1\ b_2\ b_3] \quad (3)$$

Bachman describes "[t]he vector parts from Eqns. (2) and (3) can be combined to produce a 6xl measurement vector y_0 34 in sensor coordinates:

$$y_0=[h_1\ h_2\ h_3\ b_1\ b_2\ b_3]^T \qquad (4)$$

Bachman describes the output orientation of the system $\hat{q}$ is re-mapped to the sensor reference frame in box 35 to produce a "computed measurement vector $y(\hat{q})$ 35a, wherein:

$$y(\hat{q})=[h_1\ h_2\ h_3\ b_1\ b_2\ b_3]^T \qquad (8)$$

and wherein the values for h_1 h_2, h_3, b_1 , b_2 ,b_3 are generated by mapping m and n through as an estimated orientation quaternion." *Id.*, 8:63-9:48, Ex.1003, ¶¶145-47.

Bachmann describes the output orientation of the system $\hat{q}$ that is used to generate the computed measurement vector $y(\hat{q})$ is computed by integrating the difference between the angular rate measurement (box 37) and A "criterion function". "Then the difference between the actual measurements y_0 and the computed measurement vector is defined as the error vector $\bar{\varepsilon}(\hat{q})$ 36."

$$\vec{\epsilon}(q)=\vec{y}_0-\vec{y}(\hat{q}) \qquad (9)$$

Id., 9:9-13, Ex.1003, ¶148.

The six actual measurements are compared to six predicted measurements found in the vector $\overline{y}(\hat{q})$, by subtracting the predicted measurements $\overline{y}(\hat{q})$ from the actual measurements (h1 h2 h3 b1 b2 b3). Ex.1007, 9:9-17, 17:12-22, Ex.1003, ¶¶.

This forms a six-valued error vector $\overline{\varepsilon}(\hat{q})$, numbered 36. Ex.1007, 9:9-17, 17:12-22, Ex.1003, ¶149.

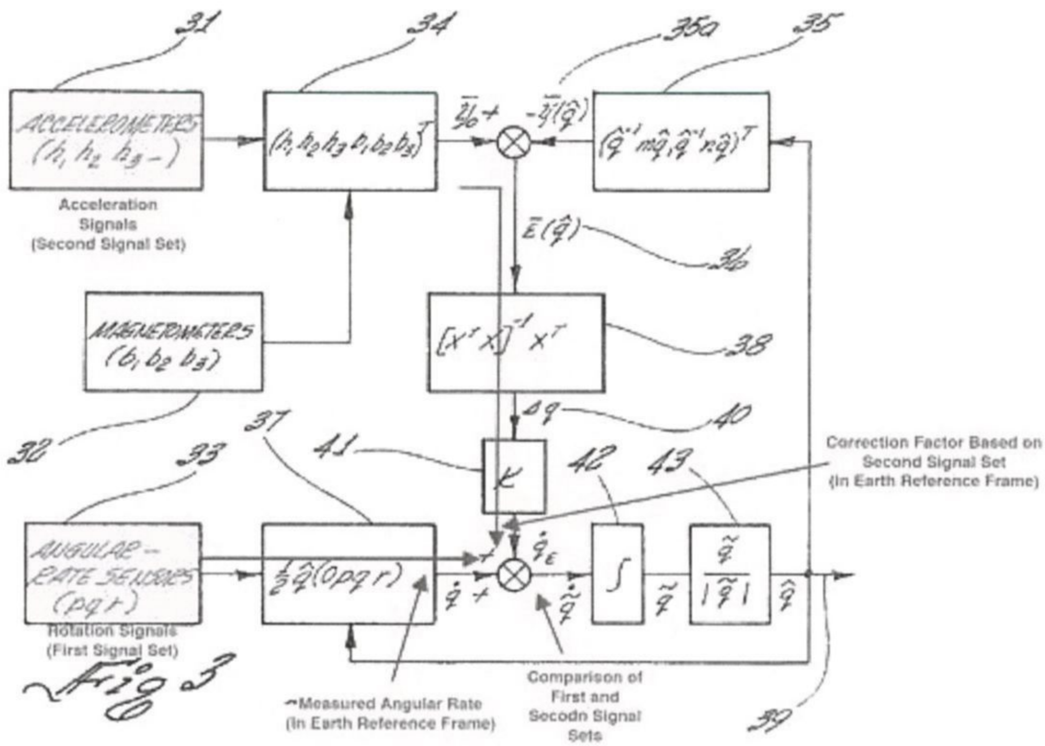
The six-valued error vector $\overline{\varepsilon}(\hat{q})$ is a measure of how actual accelerometer and magnetometer measurements differ from the what the filter predicts those measurements should be, based on the angular rate sensor output. Ex.1007, 17:12-22, 9:9-14, Ex.1003, ¶150.

Bachmann describes that this error function is squared to form the criterion function that will subsequently be minimized. "As previously described, the difference between the measurement vector y_0 and the computed measurement vector $y(\hat{q})$ is the error vector $\overline{\varepsilon}(\hat{q})$36 and the square of the filter modeling error is termed the criterion function." Ex.1007, 10:2-7, Ex.1003, ¶151.

Bachman describes this difference between the angular rate measurement (box 37) and the criterion function (boxes 38 and 40) is then used to determine the orientation of the device, i.e. the output orientation. "The output of the filters can be integrated 42 and normalized 43 to provide an estimated orientation quaternion 39." *Id.*, 9:43-45, Ex.1003, ¶152.

Bachman describes that the filter shown in FIG. 3, reproduced below, calculates the predicted value of $\hat{q}$, which is the deviation derived from the integration and normalization boxes 42 and 43. Ex.1007, FIG. 3; Ex.1003, ¶153.

Box 42 is the integral of q̇, which is the measured angular velocity corrected by the criterion function described above.



12. **<u>1(k)</u>** **"*<u>said resultant angles in the spatial pointer reference frame of the resulting deviation of the six- axis motion sensor module of the 3D pointing device are obtained under said dynamic environments</u>*"**

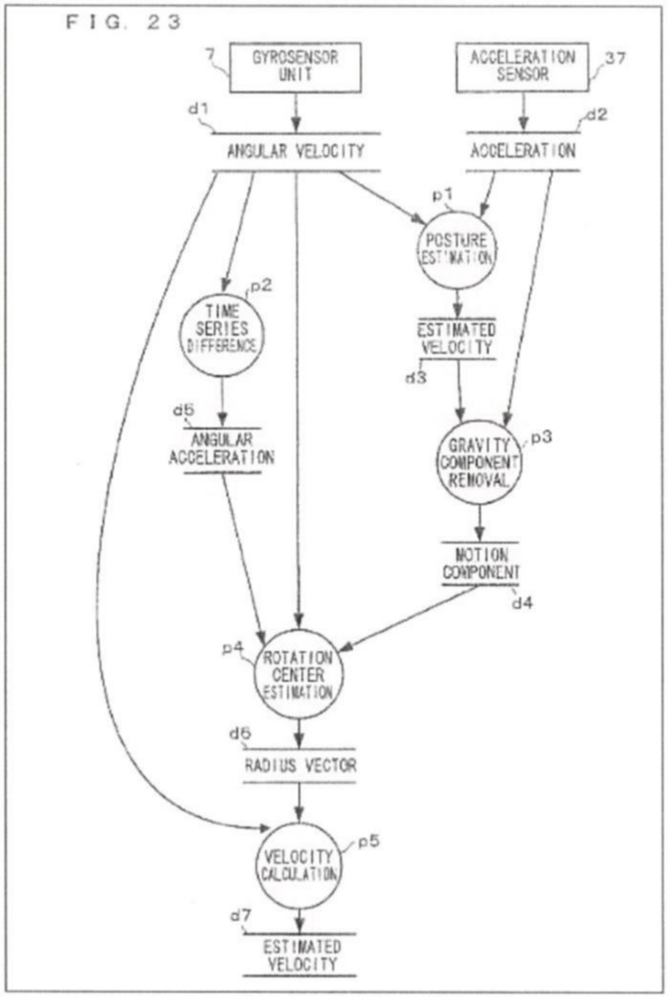
Yamashita and Bachmann disclose "resultant angles in the spatial pointer reference frame of the resulting deviation of the six- axis motion sensor module of the 3D pointing device are obtained under said dynamic environments." Bachman also discloses determining the deviations of the sensor in the world reference frame, based on the signal sets form the spatial reference frame, and as described above, this change in the sequence of operations does not have any impact on the result. Ex.1003, ¶156. *See supra* Sections X.A.1, 2, 7-10.

13. **1(l)** "*wherein the comparison utilized by the processing and transmitting module further comprises*"

Yamashita discloses "the comparison utilized by the processing and transmitting module." *See infra* Sections X.A.14-15.

14. **1(m)** "*an update program to obtain an updated state based on a previous state associated with said first signal set and a measured state associated with said second signal set*"

Yamashita discloses this limitation. Yamashita discloses that estimated posture is calculated based on acceleration and angular velocity. Ex.1006, 19:8-13. Yamashita further discloses that the updated posture, which is the updated state, is based on the angular velocity, the first signal set, and corrected by acceleration data, the second signal set. *Id.*, 19:29-40, Ex.1003, ¶158.



As discussed above, a POSITA would have been motivated to use Bachmann's sensor and orientation computing filter with Yamashita's handheld game console. *See supra* Section IX.A.3.

Bachmann describes obtaining an updated state based on a previous state associated with said first signal set and a measured state associated with said second signal set. For example:

Bachmann describes when the computations are done in a discrete time system, the predicted value of q (the updated state) is given by equation 16, which clearly shows that the next discrete value of q is determined by the least squares filtered difference "Δq (full)" times the time interval between the samples plus the measured angular rate time the time interval. Ex.1003, ¶161.

$$\hat{q}_{n+1} = \hat{q}_n + \frac{1}{2}\hat{q}^B \omega \Delta t + \alpha [X^T X]^{-1} X^T \varepsilon(\hat{q}_n) \qquad (16)$$
$$= \hat{q}_n + k \Delta t \Delta q_{full} + \dot{q}_{measured} \Delta t$$

Where the term ½ $\hat{q}^B \omega \Delta t$ represents the measured angular rate converted from the sensor reference frame to the earth reference frame, and the term Δq (full) is determined as described for the previous element, by comparing the output state $\hat{q}$ (in earth the earth reference frame), that is, $y_0(\hat{q})$, against the measured state based on the accelerometers and the magnetometers, that is, y_0. Ex.1003, ¶162.

15. <u>**1(n)** "*wherein the measured state includes a measurement of said second signal set and a predicted measurement obtained based on the first signal set without using any derivatives of the first signal set.*"</u>

Yamashita discloses this limitation. Yamashita discloses that estimated posture is calculated based on acceleration and angular velocity. Ex.1006, 19:8-13. Yamashita discloses that the updated posture, which is the updated state, is based on the angular velocity, the first signal set, and corrected by acceleration data, the second signal set. *Id.*, 19:29-40. *See supra* Section X.A.14.

Bachmann describes obtaining an updated state based on a previous state associated with said first signal set and a measured state associated with said second signal set. For example:

Bachmann describes when the computations are done in a discrete time system, the predicted value of q (the updated state) is given by equation 16, which clearly shows that the next discrete value of q is determined by the least squares filtered difference "Δq (full)" times the time interval between the samples plus the measured angular rate time the time interval. Ex.1003, ¶165.

$$\hat{q}_{n+1} = \hat{q}_n + \frac{1}{2}\hat{q}^B \omega \Delta t + \alpha [X^T X]^{-1} X^T \varepsilon(\hat{q}_n) \tag{16}$$
$$= \hat{q}_n + k \Delta t \Delta q_{full} + \dot{q}_{measured} \Delta t$$

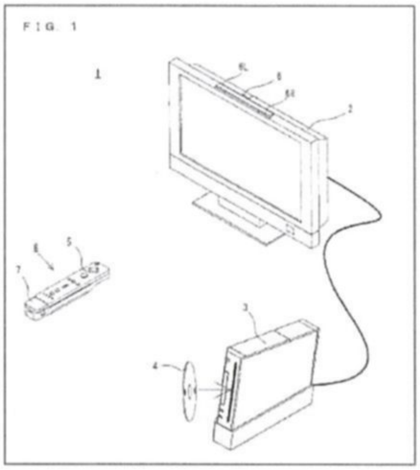
Where the term ½ $\hat{q}^B\omega\Delta t$ represents the measured angular rate converted from the sensor reference frame to the earth reference frame, and the term Δq (full) is determined as described for the previous element, by comparing the output state $\hat{q}$ (in earth the earth reference frame), that is, $y_0(\hat{q})$, against the measured state based on the accelerometers and the magnetometers, that is, y_0, by converting $y_0(\hat{q})$ from the earth reference frame to the sensor reference frame, determining the error between this value and the y_0 value generated by the accelerometers and magnetometers, and then converting this error back to the earth reference frame where it can subsequently be used in the prediction relation above. Ex.1003, ¶166.

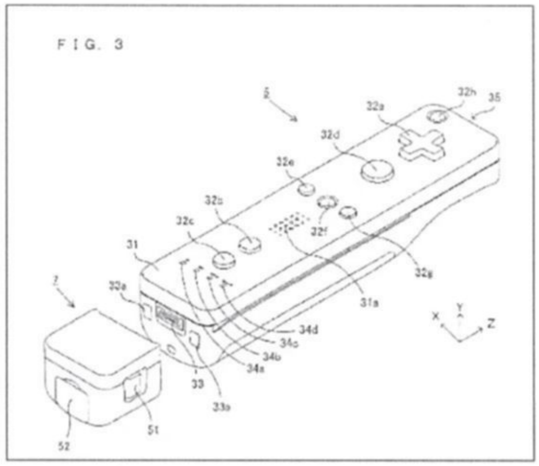
Equation 16 represents a discrete integration, where the measured angular rate value is converted to an angular offset by multiplying by the time increment Δt, and this angular offset or deviation is then corrected by the correction factor $\overline{\varepsilon}(\hat{q})$ (converted to the Earth reference frame) to generate the next predicted value. As a result, while this computation does involve a rate value, this is a measured rate, and not a computed derivative, and the entire computation is in angular space, not in rate space. Thus, this predicted orientation is determined without using any derivatives. Ex.1003, ¶167.

16. **4** "*The 3D pointing device of claim 1, wherein the spatial pointer reference frame is a reference frame in three dimensions; and wherein said resultant angles of the resulting deviation includes yaw, pitch and roll angles about each of three orthogonal coordinate axes of the spatial pointer reference frame.*"

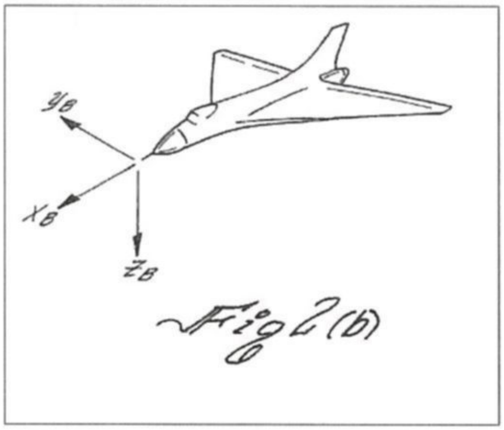
Yamashita discloses that the spatial pointer reference frame is a frame in three dimensions. Yamashita discloses that the pointing device is capable of detecting movements and rotations in a three-dimensional coordinate system. The pointing devices includes gyrosensors for angular velocity and acceleration sensors, capable of gravitational accelerations, of the controller. Ex.1006, 12:62-13:10.

Yamashita discloses the resultant angles would be yaw, pitch and roll angles. *See supra* Sections X.A.1, 4, 10, and 12.





Bachmann discloses a "body coordinate system" with orthogonal XYZ axes, equivalent to the claimed spatial pointer reference frame as shown in FIG. 2(b). Ex.1006, 5:49-6:10, Ex.1003, ¶169. Bachmann discloses "it is important to specify a body coordinate system which is attached to the body being tracked. FIG. 2(b) depicts such a system. This is an X-Y-Z system with X pointing 'out of the nose' in a positive direction, Y out the right side, and Z down. The subscript 'E' designates earth reference coordinates (XE, YE, ZE) and the subscript 'B' designates body reference coordinates (XB, YB, ZB)." Ex.1006, 5:61-67, Ex.1003, ¶169.



17. **<u>5</u>** *<u>"The 3D pointing device of claim 1, wherein the data transmitting unit of the processing and transmitting module is attached to the PCB enclosed by the housing and transmits said first and second signal of the six-axis motion sensor module to the computing processor via electronic connections on the PCB."</u>*

Yamashita disclose this limitation. Yamashita discloses a game console pointing device having a housing, the plastic molding, and the PCB resides inside the housing that having the data transmitting unit attached to the PCB. Ex.1006, FIG. 3, 4, and 7. The data transmitting unit is between the sensors and the processor, and must be electrically connected. Ex.1003, ¶172. It would have been obvious to attach the transmitting unit to the PCB and use the traces. Ex.1003, ¶172. Electronic systems contain components that communicate with one another and process data using electrical signals. Those electrical signals must travel through some medium. Often, that medium is an electronic connection, such as a wire. Ex.1003, ¶172. *See supra* Sections X.A.1-4, 8.

18. **14(pre)/19(pre)** "*A method for obtaining a resulting deviation including resultant angles in a spatial pointer reference frame of a three-dimensional (3D) pointing device utilizing a six-axis motion sensor module therein and subject to movements and rotations in dynamic environments in said spatial pointer reference frame, comprising the steps of*"

Yamashita discloses "obtaining a resulting deviation including resultant angles" in limitation 1(i). *See supra* Section XI.A.10.

Yamashita discloses combining with a pointing device and the sensor module subject to movements and rotations in dynamic environments in the spatial pointer reference frame in limitation 1(pre). *See supra* Section XI.A.1.

Yamashita discloses "a six- axis motion sensor module" in limitation 1(c). *See supra* Section XI.A.4.

19. **14(a)/19(a)** "*obtaining a previous state of the six-axis motion sensor module; wherein the previous state includes an initial-value set associated with previous angular velocities gained from the motion sensor signals of the six-axis motion sensor module at a previous time T-1*"

As discussed in in limitations (1j) and (1m), Yamashita and Bachmann disclose this limitation *See supra* Sections XI.A.11, 14.

20. **14(b)/19(b)** "*obtaining a current state of the six-axis motion sensor module by obtaining measured angular velocities ωx, ωy, ωz gained from the motion sensor signals of the six-axis motion sensor module at a current time T*"

As discussed in limitations (1d), (1j), and (1m), Yamashita and Bachmann disclose "this limitation *See supra* Sections XI.A.5, 11, and 14.

21. **<u>14(c)/19(c)</u>** *<u>"obtaining a measured state of the six-axis motion sensor module by obtaining measured axial accelerations Ax, Ay, Az gained from the motion sensor signals of the six-axis motion sensor module at the current time T and calculating predicted axial accelerations Ax', Ay', Az' based on the measured angular velocities velocities ωx, ωy, ωz of the current state of the six-axis motion sensor module without using any derivatives of the measured angular velocities velocities ωx, ωy, ωz"</u>*

As discussed in in limitations (1d), (1j), and (1m), Yamashita and Bachmann disclose this limitation. *See supra* Sections XI.A.5, 11, and 14.

22. **<u>14(d)/19(d)</u>** *<u>"said current state of the six-axis motion sensor module is a second quaternion with respect to said current time T"</u>*

As discussed in limitations (1i) and (14b), Yamashita and Bachmann disclose this limitation. *See supra* Sections XI.A.5, 10, 11, and 14.

23. **<u>14(e)/19(e)</u>** *<u>"comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T"</u>*

As discussed in in limitations (1i), (1j), (1m), and (1n), Yamashita and Bachmann discloses this limitation. *See supra* Sections XI.A.10, 11, 14, and 15.

24. **<u>14(f)/19(f)</u>** *<u>"obtaining an updated state of the six-axis motion sensor module by comparing the current state with the measured state of the six-axis motion sensor module; and"</u>*

As discussed in in limitations (1j), (1m), and (14e), Yamashita and Bachmann disclose this limitation. *See supra* Sections XI.A.10, 11, 14, and 15.

25. **14(g)/19(g)** "*calculating and converting the updated state of the six axis motion sensor module to said resulting deviation comprising said resultant angles in said spatial pointer reference frame of the 3D pointing device.*"

As discussed in limitations (1i), (14d), and (14e), Yamashita and Bachmann disclose this limitation. *See supra* Sections XI.A.10, 11, 14, and 15.

26. **15** "*The method for obtaining a resulting deviation of a 3D pointing device of claim 14, further comprises the step of outputting the updated state of the six-axis motion sensor module to the previous state of the six-axis motion sensor module; and wherein said resultant angles of the resulting deviation includes yaw, pitch and roll angles about each of three orthogonal coordinate axes of the spatial pointer reference frame.*"

As discussed in limitations (1j) and (1m), Yamashita discloses this limitation. *See supra* Sections XI.A.11, and 14.

Yamashita disclose the use of yaw, pitch, and roll angles in (1i). *See supra* Section XI.A.10.

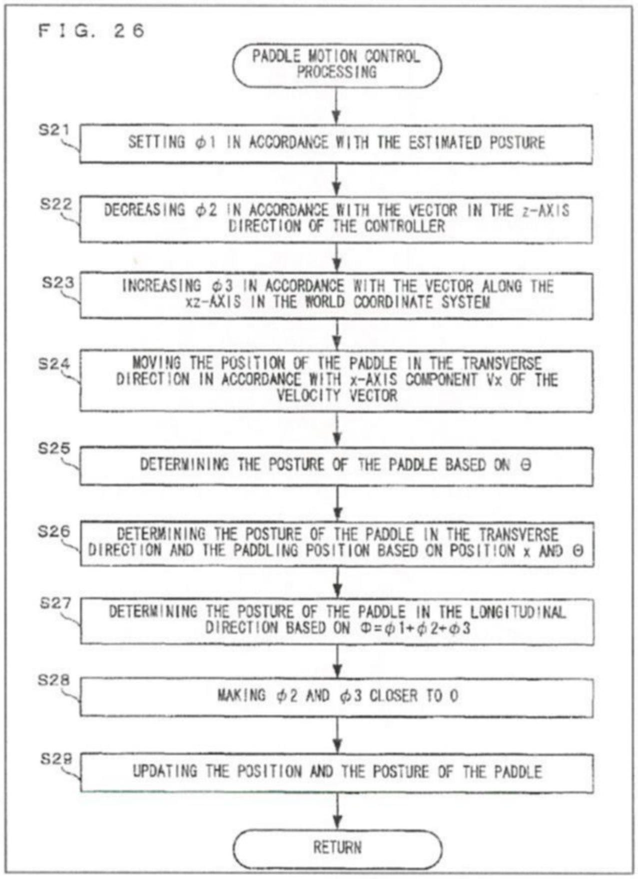
27. **16** "*The method for obtaining a resulting deviation of a 3D pointing device of claim 14, wherein said previous state of the six-axis motion sensor module is a first quaternion with respect to said previous time T-1; and said updated state of the six-axis motion sensor module is a third quaternion with respect to said current time T.*"

As discussed in in limitations (1i), (1j), and (1m), Yamashita and Bachmann disclose this limitation. *See supra* Sections XI.A.10, 11, and 14.

28. <u>17 "*The method for obtaining a resulting deviation of 3D pointing device of claim 14, wherein the obtaining of said previous state of the six-axis motion sensor module further comprises initializing said initial-value set.*"</u>

As discussed in limitations (1m) and (1n), Yamashita and Bachmann disclose this limitation. *See supra* Sections XI.A.14 and 15.

Yamashita discloses "initial-value set." Yamashita provides a game sample of paddling a canoe. FIG. 26 shows the paddle motion control process and an initial value of variable φ2 and φ3 are set to 0. Ex.1006, 22:59-23:26. "FIG. 26 is a flowchart showing the paddle motion control processing shown in step S7 in detail…Variable φ2 is used for taking "pulling" into consideration in the paddling operation…As an initial value of variable φ2, "0" is set. Variable φ3 is used for taking "translation paddling" into consideration in the paddling operation…As an initial value of variable φ3, "0" is set." *Id.*, 22:59-23:26.



B. Ground B: Under 35 U.S.C. § 103, U.S. Patent No. 8,462,109 ("Nasiri") in view of U.S. Patent Publication No. 2007/0299626 ("Song") renders claims 1, 4-5, 14-17, and 19 obvious.

1. 1(pre) "*A three-dimensional (3D) pointing device subject to movements and rotations in dynamic environments, comprising*"

Nasiri discloses a pointing device. As shown in FIGs. 1, Nasiri discloses a handheld electronic device 10 that "can be a mobile phone … video game player, video game controller ...." Ex.1008, 8:26-35. The device can be held in one or more hands of a user to be operated and can include a variety of different functions including using the device as a pointing device to facilitate user interaction with video games. *Id.*, 3:5-10, 7:56-8:6.

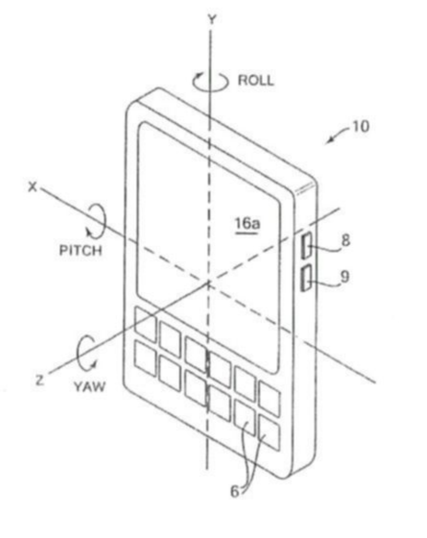


FIG. 1

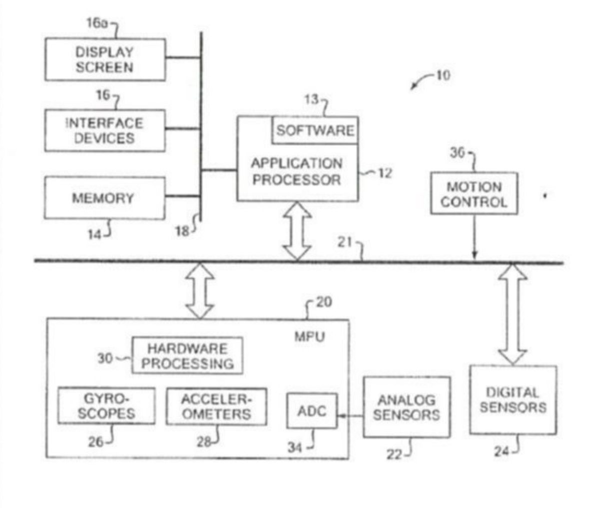


FIG. 2

Nasiri discloses that the pointing device, the handheld device, is a 3D device that is capable of facilitate interaction based on "sensing rotational rate around at least three axes and linear acceleration along at least three axes." *Id.*, Abstract, 34:58-60. FIG. 1 shows that the device 10 can rotate in the yaw, pitch and roll angles. *Id.*, FIG. 1.

Nasiri further discloses that the input device obtains movement and rotational data in dynamic environments. Nasiri discloses "[d]evice 10 can be implemented as a device or apparatus, such as a handheld device that can be moved in space by a user and its motion and/or orientation in space therefore sensed." *Id.*, 8:21-26; 33:36-52.

2. <u>**1(a)** "*a housing associated with said movements and rotations of the 3D pointing device in a spatial pointer reference frame*"</u>

Nasiri discloses "a housing associated with said movements and rotations of the 3D pointing device in a spatial pointer reference frame." For example, Nasiri discloses "in some embodiments, inertial sensors are used, where the rotational motion sensors are gyroscopes and the linear motion sensors are accelerometers. Gyroscopes 26 can measure the angular velocity of the device 10 (or portion thereof) housing the gyroscopes 26. … Accelerometers 28 can measure the linear acceleration of the device 10 (or portion thereof) housing the accelerometers 28." Ex.1008, 9:64-10:11.

A POSITA would have understood that in this configuration, the angular velocity values associated with rotations sensors and acceleration values associated with the accelerometers are relative to the reference frame of the pointing device, i.e., the "spatial reference frame". Ex.1003, ¶192.

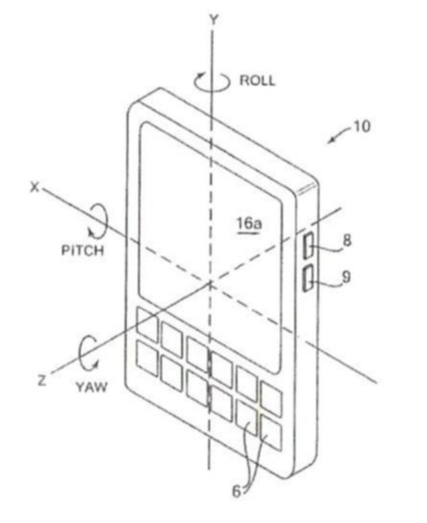


FIG. 1

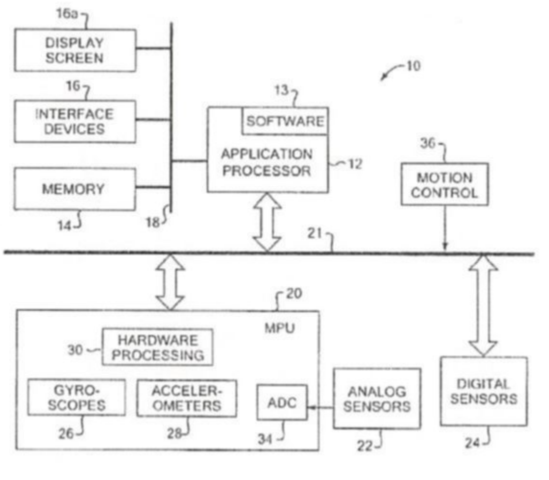


FIG. 2

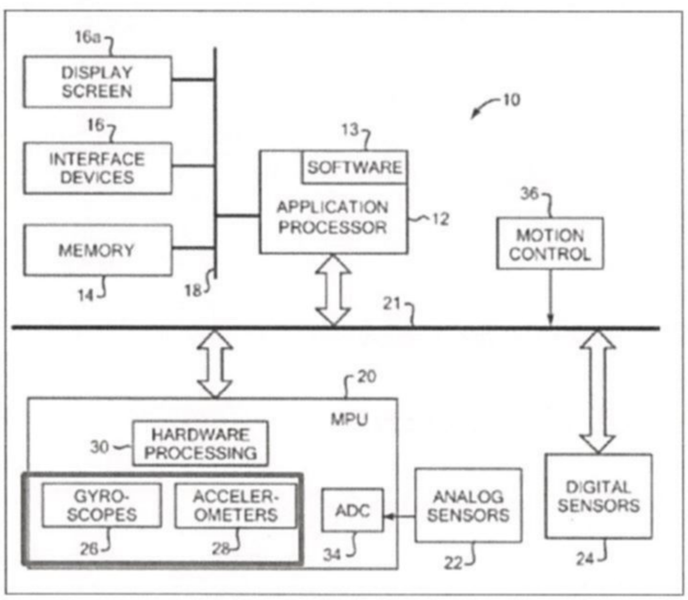
3. 1(b) "*a printed circuit board (PCB) enclosed by the housing*"

Nasiri discloses "a printed circuit board (PCB) enclosed by the housing." Nasiri discloses that the handheld electronic device 10 is the housing, the cover, which include a PCB. For example, Nasiri discloses having the three axes motion sensor and the three axes acceleration sensor be integrated into a single common package, which the common package includes "a printed circuit board (possibly including additional circuitry)." Ex.1008, 9:64-10:11, 35:19-31.

In addition, the Patent Office expressly noted that printed circuit boards were commonplace features of electronic devices during the prosecution of the patents-in-suit: "Examiner takes Official Notice that it is well known in the art to employ the use of a PCB to mechanically support and electrically connect electronic components using conductive pathways." Ex.1002, 80.

4. 1(c) "*a six-axis motion sensor module attached to the PCB, comprising*"

Nasiri discloses "a six-axis motion sensor module attached to the PCB." Nasiri discloses "[the set of motion sensors sensing rotational rate around at least three axes and linear acceleration along at least three axes are integrated in a single module. In one implementation, the module is integrated in a single package, or otherwise enclosed in a single package. The single package module could consist of a single chip, or could include multiple individual devices that are integrated together in a common package. Examples of such multiple individual devices that may be integrated together in a common package include two or more dies that are attached to each other or otherwise integrated together, a printed circuit board (possibly including additional circuitry), a system on a chip (SOC), or any other combination of devices." Ex.1008, 9:64-10:11, 35:19-31.



5. 1(d) "*a rotation sensor for detecting and generating a first signal set comprising angular velocities ωx, ωy, ωz associated with said movements and rotations of the 3D pointing device in the spatial pointer reference frame*"

Nasiri discloses having one or more rotational sensors, the gyroscopes 26, for detecting and generating a first signal set comprising angular velocities ωx, ωy, ωz. Ex.1008, 9:62-10:28. Nasiri discloses that the gyroscopes 26 senses (e.g. detects) rotational rate around at least three axes and measures (e.g. generates) the angular velocity of the device 10. *Id*., 9:62-10:28, 35:19-31. Nasiri describes that the gyroscopes are attached to a PCB that is attached to the housing of the pointing device. *Id*., 9:64-10:11, 35:19-31, Ex,1003, ¶198-99.

As discussed above, Nasiri discloses "a rotational sensor … associated with movements and rotations of the 3D pointing device in a spatial pointer reference frame." *See supra* Section X.B.2.

6. 1(e) "*an accelerometer for detecting and generating a second signal set comprising axial accelerations Ax, Ay, Az associated with said movements and rotations of the 3D pointing device in the spatial pointer reference frame; and*"

Nasiri discloses having one or more linear motion sensors, accelerometers 28, for detecting and generating a second signal set comprising axial accelerations Ax, Ay, Az. Ex.1008, 9:62-10:28. Nasiri discloses that the accelerometers 28 senses (e.g. detects) linear acceleration along at least three axes and measures (e.g. generates) the linear acceleration of the device 10. *Id*., 9:62-10:28, 35:19-31.

As discussed above, Nasiri discloses "an accelerometer … associated with movements and rotations of the 3D pointing device in a spatial pointer reference frame." *See supra* Section X.B.2.

7. 1(f) "*a processing and transmitting module, comprising*"

Nasiri and Song discloses "a processing and transmitting module." *See infra* Sections X.B.8-15.

8. 1(g) "*a data transmitting unit electrically connected to the six-axis motion sensor module for transmitting said first and second signal sets thereof and*"

Nasiri discloses a data transmitting unit to transmit signals between the sensors and the hardware processor and/or application processor. For example, Nasiri discloses a motion processing unit, MPU20, that transmit motion sensor inputs to the application processor 12, for example over bus 21. Ex.1008, 9:16-31. Nasiri discloses that the six-axis motion sensor, the gyroscopes 26 and accelerometers 28, could be "a single chip six-axis inertial measurement unit is used in the MPU 20." *Id.*, 9:62-10:28. Thus, the MPU is the data transmit unit that collects motion sensor data for transmitting the gyroscopes and accelerometers signal sets. Ex.1003, ¶203.

Nasiri also describes that the bus connecting the processor and the sensors may be external, and may be implemented using the I2C bus standard. Ex.1008, 36:46-37:14. Ex.1003 ¶204. Nasiris also describes that in some embodiments the sensors pass their information directly to the processor over such an external (i.e. I2C) bus, as shown in Fig. 9C. Ex.1008, 37:34-38, Fig. 9C, Ex.1003, ¶205.

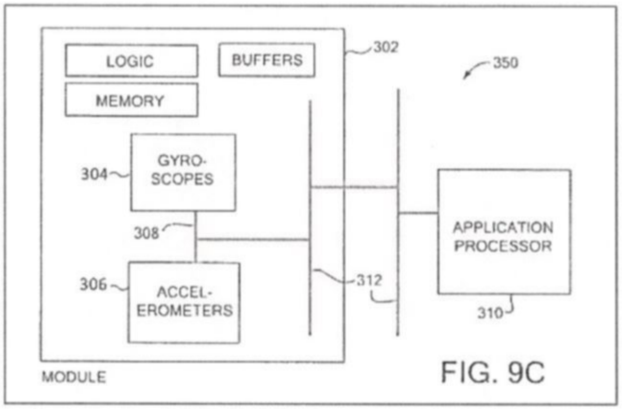


FIG. 9C

Nasiri discloses that the gyroscopes 26 detect and generate the first signal set and the accelerometers 28 detect and generate the second signal set. Ex.1008, 9:62-10:28, 35:19-31. *See supra* Sections X.B.5-6.

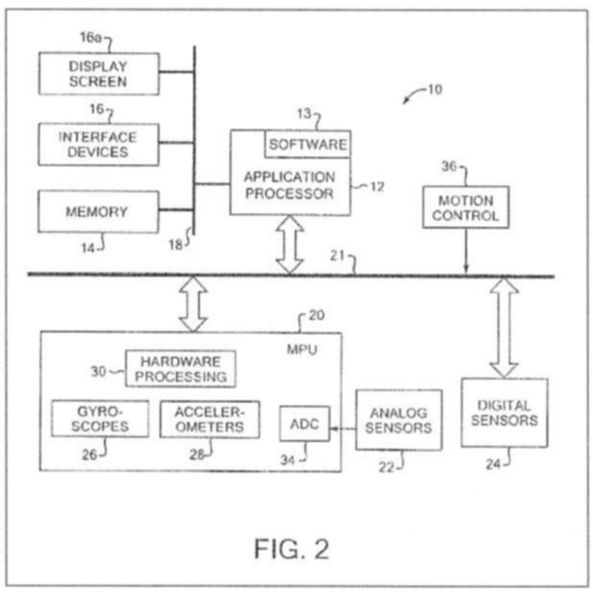


FIG. 2

A POSITA would have understood that the I2C bus is a well-known serial chip-to-chip interconnect standard for placing data onto the bus (i.e. transmitting data), and for obtaining data from the bus (i.e. receiving data), and thus the disclosure of a bus, and in particular the well-known I2C bus, inherently discloses an I2C bus interface, which meets the limitation of a "data transmitting unit". Ex.1003, ¶207.

To the extent that it is determined that Nasiri's disclosure of the I2C bus does not inherently disclose the required data transmitting unit, Song does. As discussed above, a POSITA would have been motivated to use combine Nasiri and Song in order to reduce the size, weight, and power consumption of the handheld unit. Ex.1003, ¶208. *See supra* Section IX.A.3.

Song discloses the transmitter 310 to transmit position information of the input device to the receiver 320. Ex.1010, ¶0038. Song discloses "the transmitter 310 measures angular velocity data and acceleration data as the input device moves … identifies position information of the input device recognized as the input device moves, and transmits the identified position information to the receiver 320 using the wireless communication method." *Id.*, ¶0038.

FIG. 3

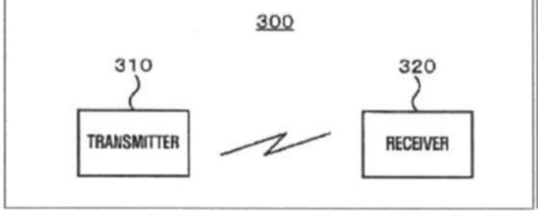
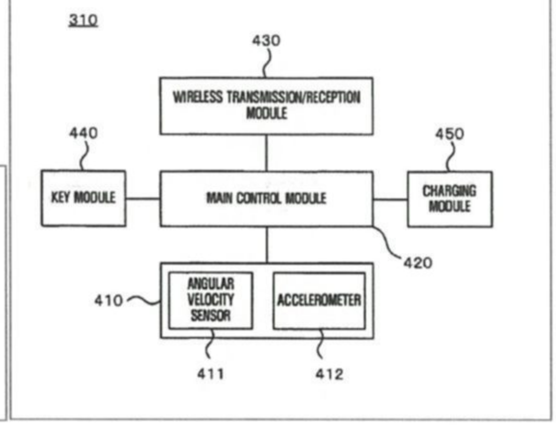


FIG. 4



Song also discloses that angular velocity sensor 11 measures the angular velocity data, the first data set, and accelerometer 412 measures the acceleration data, the second data set. *Id.*, ¶¶0042-43.

9. <u>**1(h)** *"a computing processor for receiving and calculating said first and second signal sets from the data transmitting unit"*</u>

Nasiri discloses this limitation. Nasiri includes a computing processor that receives rotation rate data, first signal set, and acceleration data, second signal set, from the sensors and performs further calculations, such as the gesture processing and recognition, using that data. For example, Nasiri discloses application processor 12 in FIG. 2 and 9C that can implement the gesture processing and recognition." Ex.1008, 8:52-9:20, 37:25-38, FIGs. 2 & 9C.

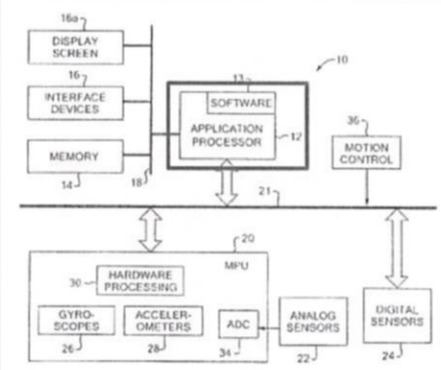


FIG. 2

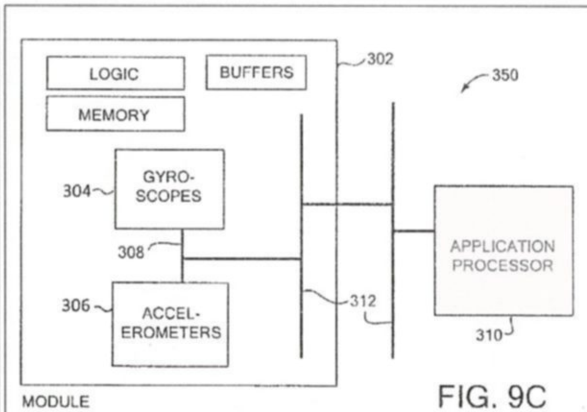


FIG. 9C

10. <u>1(i) "*communicating with the six-axis motion sensor module to calculate a resulting deviation comprising resultant angles in said spatial pointer reference frame*"</u>

Nasiri discloses this limitation. Nasiri discloses that methods for recognition of gestures and motions of a device, such as "an algorithm combining inputs from multiple sensors to provide more robust sensing, an example of which is described in copending U.S. patent application Ser. No. 12/252,322, incorporated herein by reference." Ex.1008, 14:49-57, Ex.1009.

Sachs, incorporated into Nasiri, discloses the same FIG. 1 as Nasiri, which shows that the Application processor 12 communicates with the six-axis motion sensor, gyroscopes 26 and accelerometers 28. Ex.1009, ¶0037. Sachs FIG. 9 shows that the processor can receive raw data from the sensors. *Id.*, ¶0037, FIG. 9.

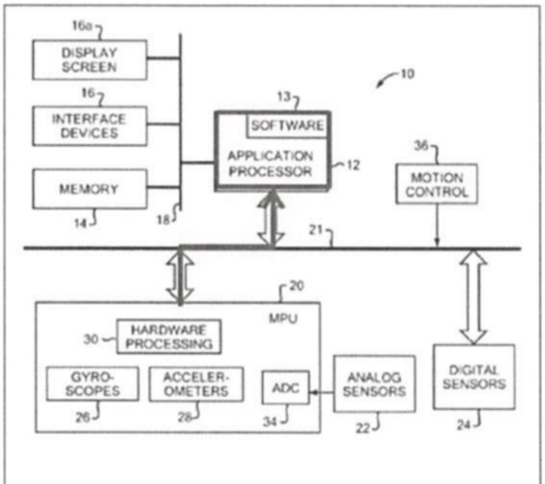


FIG. 1

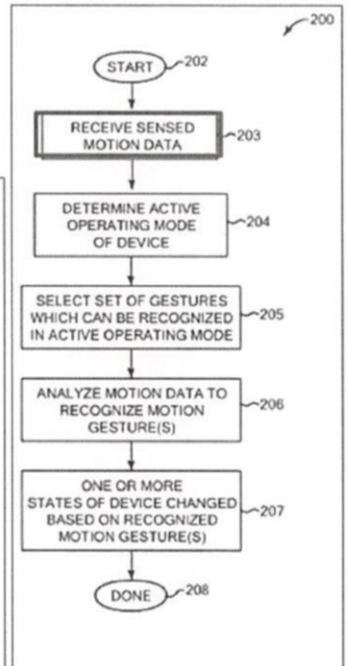


FIG. 9

Sachs, incorporated into Nasiri, discloses a system for producing augmented data for recognizing motion gestures, as shown FIG. 7. *Id.*, ¶0062, FIG. 7

Sachs, incorporated into Nasiri, discloses the determination of the resultant angle by first calibrating the angular velocity and acceleration data from the sensors, removing the gravitational component from the acceleration data and integrating the data. *Id.*, ¶0063, Ex.1003, ¶216. Sachs, incorporated into Nasiri, further discloses "[t]he 3-D integration block combines the gyroscope and accelerometer data to produce a model of the orientation of the device using world coordinates. This resulting model of device orientation is the quaternion/rotation matrix 174 and is one portion of the augmented sensor data provided by system

150. Matrix 174 can be used to provide world coordinates for sensor data from existing device coordinates." *Id.*, ¶0065.

While Sachs describes integrating the angular velocity and acceleration data using quaternion mathematics to arrive at the orientation (i.e. resultant angles) in world coordinates, a POSITA would have understood that the integration could have taken place in the spatial reference frame (i.e. to obtain the orientation or resultant angles in the spatial reference frame, and then followed by a subsequent coordinate transformation to obtain the orientation in world coordinates). *Id.*, ¶0065, Ex.1003, ¶217. A POSITA would have understood that the order of operations, that is integrating in the spatial reference frame, and then rotating the resulting orientation to the world reference frame, versus converting the angular velocity and acceleration to the world reference frame and then integrating to obtain the orientation in the world reference frame would have been nothing more than a simple design choice. Ex.1003, ¶217.

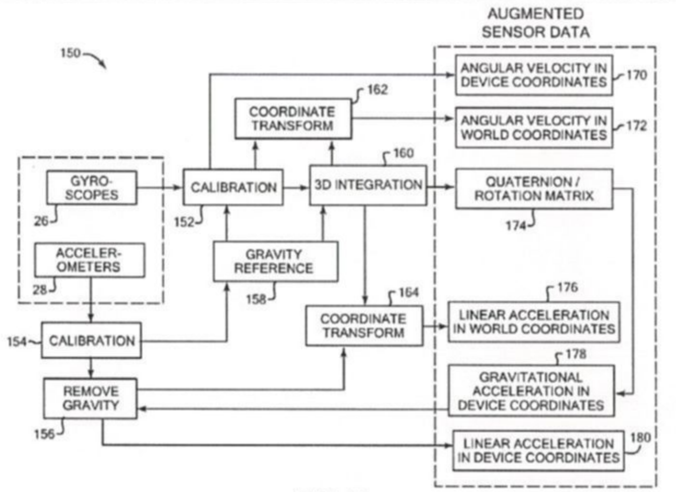


FIG. 7

Sachs, incorporated into Nasiri, discloses how acceleration and angular velocity are used to determine the rotation. Ex.1009, ¶¶0066-0074. For example, the coordinate transform block 162 receives calibrated gyroscope data from calibration block 152 and the 3D integration block 160 to produce angular velocity 172 of the device in world coordinates. *Id.*, ¶0066. The coordinate transform block 164 receives calibrated linear acceleration data from the remove gravity block 156 and the 3D integration block 160 to produce a linear acceleration 176 of the device in world coordinates. *Id.* Both are part of augmented sensor data. *Id.* Gravitational acceleration data 178 is provided by the quaternion/rotation matrix 174 and is a combination of gyroscope data and accelerometer data to obtain gravitational data. *Id.*, ¶0067.

Sachs, incorporated into Nasiri, discloses calculation of the orientation of the device by computing the quaternion using an iterative approach that first rotates the acceleration values form the spatial reference frame to the world reference frame using the rotation matrix or quaternion multiplication. *Id.*, ¶¶0069-0070, Ex.1003, ¶219.

Sachs, incorporated into Nasiri, then describes the generation of a feedback term wherein the gravitational component of acceleration is removed. *Id.*, ¶0070, Ex.1003, ¶220.

Sachs, incorporated into Nasiri, describes the generation of the acceleration component of the quaternion by multiplying this feedback term by the original quaternion. *Id.*, ¶¶0071-0072, Ex.1003, ¶221.

A POSITA would have understood that the initial value of the quaternion is unity Ex.1003, ¶222. The accelerometer and gyroscope terms represent the corrections to the initial (or prior) value of the quaternion over the time interval of the measurement. Ex.1003, ¶222. Thus, the quaternion is iteratively updated each time increment and thus over time the quaternion represents the orientation of the spatial reference frame in the world reference frame. Ex.1003, ¶222.

"The quaternion is updated as q'=normalize($q+q_{accelerometer}+q_{gyroscope}$)

This new quaternion becomes the "current quaternion," and can be converted to a rotation matrix." Ex.1009, ¶¶0073-0074

The rotation matrix that would be derived from q' and would not necessarily be unity, and thus subsequent rotations of the acceleration data as described above would cause the subsequent values of q' to first evolve to reflect the orientation of the spatial reference frame relative to the world reference frame (i.e. the resultant angles or deviation), and over the course of a single measurement cycle, the change in orientation, which would derive from the "feedback term" (*see* Sachs Ex.1009, ¶¶0069-0070), would represent the incremental change in orientation in the spatial reference frame. Ex.1003, ¶223.

As discussed above, Nasiri discloses "a spatial pointer reference frame." See supra Section X.B.2.

11. 1(j) "*by utilizing a comparison to compare the first signal set with the second signal set whereby*"

Nasiri and Sachs, incorporated into Nasiri, disclose "utilizing a comparison to compare the first signal set with the second signal set." Sachs, incorporated into Nasiri, discloses a computation using both the first (gyroscopes data) and the second (acceleration data) signal sets.

As described above, Sachs, incorporated into Nasiri, describes that the angular velocity (first signal) and acceleration (second signal) are compared to obtain the resultant deviation (i.e. the resultant angles or the orientation). For example:

> "The quaternion is updated as follows:
>
> $q' = \text{normalize}(q + q_{accelerometer} + q_{gyroscope})$"

> This new quaternion becomes the "current quaternion," and can be converted to a rotation matrix."

Ex.1009, ¶¶ 0073-74.

12. 1(k) "*said resultant angles in the spatial pointer reference frame of the resulting deviation of the six- axis motion sensor module of the 3D pointing device are obtained under said dynamic environments*"

Nasiri and Song disclose "resultant angles in the spatial pointer reference frame of the resulting deviation of the six- axis motion sensor module of the 3D pointing device are obtained under said dynamic environments." *See supra* Sections X.B.1, 2, 7-10.

13. 1(l) "*wherein the comparison utilized by the processing and transmitting module further comprises*"

Nasiri and Song discloses "the comparison utilized by the processing and transmitting module." *See infra* Sections X.B.14-15.

14. 1(m) "*an update program to obtain an updated state based on a previous state associated with said first signal set and a measured state associated with said second signal set*"

Nasiri and Sachs, incorporated into Nasiri, disclose the updated state is based on a previous state associated with said first signal set (angular velocities), $q_{gyroscope}$:

> A similar update term is generated from the gyroscope data using quaternion integration:

> $q_{gyroscope}=0.5qw(dt)$
>
> The vector w contains the raw gyroscope data, q is the current quaternion, and dt is the sample time of the sensor data. The quaternion is updated as follows:
>
> q'=normalize($q+q_{accelerometer}+q_{gyroscope}$)"

Ex.1009, ¶¶ 0072-73.

The updated state is also based on a measured state associated with the second signal set (axial accelerations):

> The orientation of the device is stored in both quaternion form and rotation matrix form. To update the quaternion, first the raw accelerometer data is rotated into world coordinates using the previous rotation matrix:
>
> $a'=Ra$
>
> The vector a contains the raw accelerometer data, R is the rotation matrix representing the orientation of the device, and a' is the resulting acceleration term in world coordinates. A feedback term is generated from the cross product of a' with a vector representing gravity:
>
> $f=k(a*g)$
>
> Constant k is a time constant which determines the timescale in which the acceleration data is used. A quaternion update term is generated from this by multiplying with the current quaternion:
>
> $q_{accelerometer}=fq$

Id., ¶¶ 0069-71.

Sachs, incorporated into Nasiri, discloses "an update program to obtain an updated state based on a previous state associated with said first signal set and a measured state associated with said second signal set." The quaternion is updated as follows: q'=normalize($q+q_{accelerometer}+q_{gyroscope}$)" *Id.*, ¶0073.

15. **<u>1(n)</u>** <u>"*wherein the measured state includes a measurement of said second signal set and a predicted measurement obtained based on the first signal set without using any derivatives of the first signal set.*"</u>

Sachs, incorporated into Nasiri, discloses a system for producing augmented data for recognizing motion gestures, as shown FIG. 7. Ex.1009, ¶0062, FIG. 7

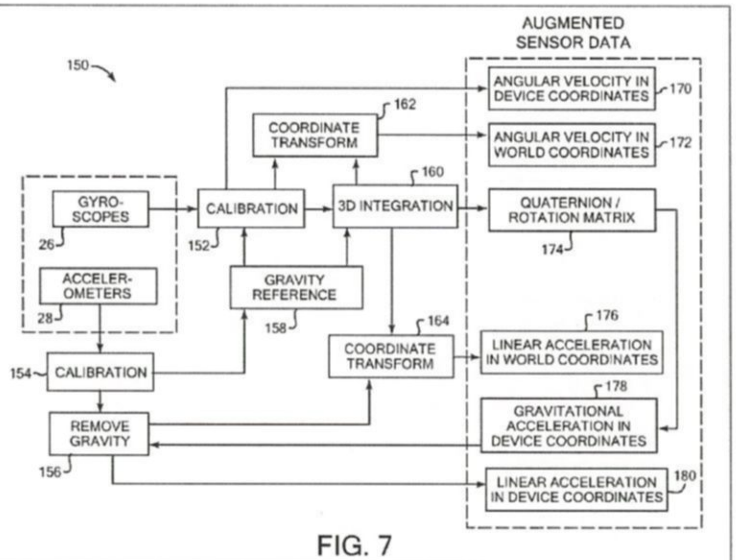


FIG. 7

Sachs, incorporated into Nasiri, discloses "the measured state includes a measurement of said second signal set." Sachs discloses accelerometers 28 generates acceleration data as part of the augmented data for device 10. *Id.*, ¶0062. The coordinate transform block 164 receives calibrated linear acceleration data from the remove gravity block 156 and the 3D integration block 160 to produce a linear acceleration 176 of the device in world coordinates. *Id.*, ¶0066.

Sachs, incorporated into Nasiri, also discloses "a predicted measurement obtained based on the first signal set without using any derivatives of the first signal set." When the processing is done in a discrete time system, the time increment is known and fixed. Ex.1003, ¶233. The device 10 computes the changes directly using only delta rotations, not rotation rates. *Id.* Sachs discloses:

> Constant k is a time constant which determines the timescale in which the acceleration data is used. A quaternion update term is generated from this by multiplying with the current quaternion:
>
> $q_{accelerometer}=fq$
>
> A similar update term is generated from the gyroscope data using quaternion integration:
>
> $q_{gyroscope}=0.5qw(dt)$
>
> The vector w contains the raw gyroscope data, q is the current quaternion, and dt is the sample time of the sensor data. The quaternion is updated as follows:
>
> $q'=\text{normalize}(q+q_{accelerometer}+q_{gyroscope})$

Ex.1009, ¶¶0071-73.

The process described by Nasiri and Sachs, incorporated into Nasiri, uses only integration so of measured rates (i.e., acceleration and angular velocity), and thus does not use any derivatives. Ex.1003, ¶234.

16. **4** "*The 3D pointing device of claim 1, wherein the spatial pointer reference frame is a reference frame in three dimensions; and wherein said resultant angles of the resulting deviation includes yaw, pitch and roll angles about each of three orthogonal coordinate axes of the spatial pointer reference frame.*"

Nasiri discloses a pointing device. As shown in FIGs. 1, Nasiri discloses a handheld electronic device 10 that "can be a mobile phone … video game player, video game controller ...." Ex.1008, 8:26-35. The device can be held in one or more hands of a user to be operated and can include a variety of different functions including using the device as a pointing device to facilitate user interaction with video games. *Id.*, 3:5-10, 7:56-8:6.

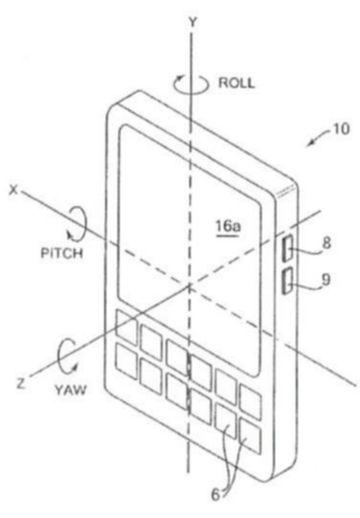


FIG. 1

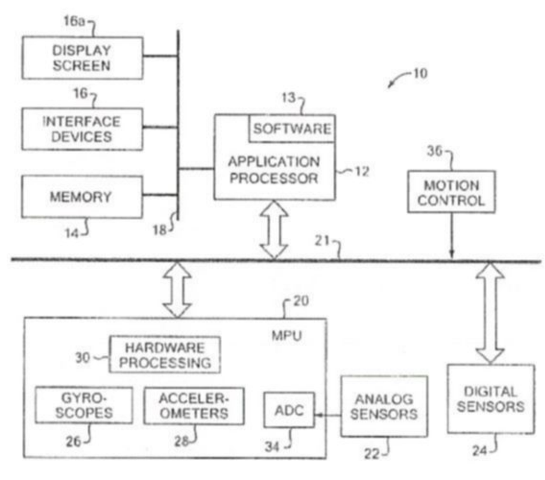


FIG. 2

Nasiri discloses that the pointing device, the handheld device, is a 3D device that is capable of facilitate interaction based on "sensing rotational rate around at least three axes and linear acceleration along at least three axes." *Id.*, Abstract, 11:17-33. FIG. 1 shows that the device 10 can rotate in the yaw, pitch and roll angles. *Id.*, FIG. 1.

The spatial pointer reference frame moves with the device 10, and is shown, for example, by the X, Y and Z axes in Fig. 1.

17. <u>**5** "*The 3D pointing device of claim 1, wherein the data transmitting unit of the processing and transmitting module is attached to the PCB enclosed by the housing and transmits said first and second signal of the six-axis motion sensor module to the computing processor via electronic connections on the PCB.*"</u>

Nasiri disclose this limitation. As discussed above, Nasiri discloses that the handheld electronic device 10 includes the housing, the cover, and a PCB resides in the housing. Ex.1008, FIG. 1. The data transmitting unit is functionally between the sensors and the processor, and must be electrically connected. *Id.*, 9:64-10:11, 35:19-31, Ex.1003, ¶¶239-40.

Nasiri describes that the bus connecting the processor and the sensors may be external, and may be implemented using the I2C bus standard. Ex.1008, 36:46 to 37:14. A POSITA would have understood that the I2C bus is a well-known serial chip-to-chip interconnect standard, and that many processors and peripheral chips include the I2C bus interface circuitry and software.

Nasiri also describes that in some embodiments the sensors pass their information directly to the processor over such an external (i.e. I2C) bus, as shown in Fig. 9C. *Id.*, 37:34-38, Fig. 9C.

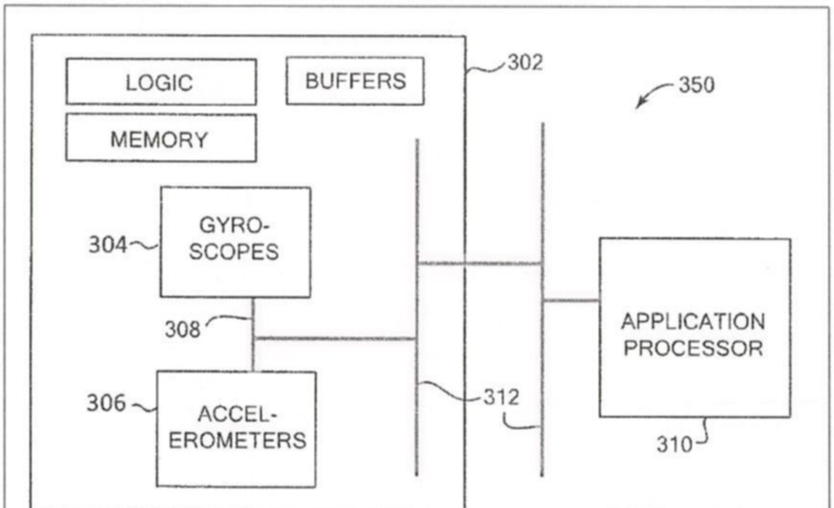


FIG. 9C

A PSOITA would have fund it obvious to attach the transmitting unit to the PCB and use the PCB traces to transfer the data between the sensors and the processor. Ex.1003, ¶241-42. *See supra* Sections X.B.1-4, 8.

18. <u>**14(pre)/19(pre)** "*A method for obtaining a resulting deviation including resultant angles in a spatial pointer reference frame of a three-dimensional (3D) pointing device utilizing a six-axis motion sensor module therein and subject to movements and rotations in dynamic environments in said spatial pointer reference frame, comprising the steps of*"</u>

Nasiri discloses "obtaining a resulting deviation including resultant angles" in limitation 1(i). *See supra* Section XI.B.10.

Nasiri discloses combining with a three-dimensional (3D) pointing device and the sensor module being subject to movements and rotations in dynamic environments in the spatial pointer reference frame in limitation 1(pre). *See supra* Section XI.B.1.

Nasiri discloses "a six- axis motion sensor module" in limitation 1(c). *See supra* Section XI.B.4.

19. 14(a)/19(a) "*obtaining a previous state of the six-axis motion sensor module; wherein the previous state includes an initial-value set associated with previous angular velocities gained from the motion sensor signals of the six-axis motion sensor module at a previous time T-1*"

Nasiri and Sachs, incorporated into Nasiri, disclose "obtaining a previous state of the six-axis motion sensor module, including an initial-value set associated with previous angular velocities gained from the motion sensor signals of the six-axis motion sensor module at previous time T-1" in limitations (1j) and (1m). *See supra* Sections XI.B.11, 14.

20. 14(b)/19(b) "*obtaining a current state of the six-axis motion sensor module by obtaining measured angular velocities ωx, ωy, ωz gained from the motion sensor signals of the six-axis motion sensor module at a current time T*"

Nasiri and Sachs, incorporated into Nasiri, disclose "obtaining a current state of the six-axis motion sensor module by obtaining measured angular velocities ωx, ωy, ωz gained from the motion sensor signals of the six-axis motion sensor module at a current time T" in limitations (1d), (1j), and (1m). *See supra* Sections XI.B.5, 11, and 14.

21. <u>**14(c)/19(c)** "*obtaining a measured state of the six-axis motion sensor module by obtaining measured axial accelerations Ax, Ay, Az gained from the motion sensor signals of the six-axis motion sensor module at the current time T and calculating predicted axial accelerations Ax', Ay', Az' based on the measured angular velocities velocities ωx, ωy, ωz of the current state of the six-axis motion sensor module without using any derivatives of the measured angular velocities velocities ωx, ωy, ωz*"</u>

Nasiri and Sachs, incorporated into Nasiri, disclose "obtaining a measured state of the six-axis motion sensor module by obtaining measured axial accelerations Ax, Ay, Az gained from the motion sensor signals of the six-axis motion sensor module at the current time T and calculating predicted axial accelerations Ax′, Ay′, Az′ based on the measured angular velocities velocities ω_x, ω_y, ω_z of the current state of the six-axis motion sensor module without using any derivatives of the measured angular velocities velocities ω_x, ω_y, ω_z" in limitations (1d), (1j), and (1m). *See supra* Sections XI.B.5, 11, and 14.

22. <u>**14(d)/19(d)** "*said current state of the six-axis motion sensor module is a second quaternion with respect to said current time T*"</u>

Nasiri and Sachs, incorporated into Nasiri, disclose "the current state of the six-axis motion sensor module being a second quaternion with respect to said current time T" in limitation (1i) and (14b). *See supra* Sections XI.B.5, 10, 11, and 14.

23. **14(e)/19(e)** "*comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T*"

Nasiri and Sachs, incorporated into Nasiri, discloses "comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax′, Ay′, Az′ also at current time T" in limitations (1i), (1j), (1m), and (1n). *See supra* Sections XI.B.10, 11, 14, and 15.

24. **14(f)/19(f)** "*obtaining an updated state of the six-axis motion sensor module by comparing the current state with the measured state of the six-axis motion sensor module; and*"

Nasiri and Sachs, incorporated into Nasiri, disclose "show obtaining an updated state of the six-axis motion sensor module by comparing the current state with the measured state of the six-axis motion sensor module" in limitations (1j), (1m), and (14e). *See supra* Sections XI.B.10, 11, 14, and 15.

25. **14(g)/19(g)** "*calculating and converting the updated state of the six axis motion sensor module to said resulting deviation comprising said resultant angles in said spatial pointer reference frame of the 3D pointing device.*"

Nasiri and Sachs, incorporated into Nasiri, disclose "calculating and converting the updated state of the six axis motion sensor module to said resulting deviation comprising said resultant angles in said spatial pointer reference frame of the 3D pointing device" in limitations (1i), (14d), and (14e). *See supra* Sections XI.B.10, 11, 14, and 15.

> **26.** **15** "*The method for obtaining a resulting deviation of a 3D pointing device of claim 14, further comprises the step of outputting the updated state of the six-axis motion sensor module to the previous state of the six-axis motion sensor module; and wherein said resultant angles of the resulting deviation includes yaw, pitch and roll angles about each of three orthogonal coordinate axes of the spatial pointer reference frame.*"

Nasiri and Sachs, incorporated into Nasiri, disclose the use of a recursive sensor fusion algorithm using the updated state as the previous state for the next time period in limitations (1j) and (1m). *See supra* Sections XI.B.11, and 14.

Nasiri and Sachs, incorporated into Nasiri, disclose the use of yaw, pitch, and roll angles in (1pre) and (1i). *See supra* Section XI.B.1 and10.

> **27.** **16** "*The method for obtaining a resulting deviation of a 3D pointing device of claim 14, wherein said previous state of the six-axis motion sensor module is a first quaternion with respect to said previous time T-1; and said updated state of the six-axis motion sensor module is a third quaternion with respect to said current time T.*"

Nasiri and Sachs, incorporated into Nasiri, disclose "previous state of the six-axis motion sensor module is a first quaternion with respect to said previous time T-1; and said updated state of the six-axis motion sensor module is a third quaternion with respect to said current time T" in limitations (1i), (1j), and (1m). *See supra* Sections XI.B.10, 11, and 14.

28. 17 "*The method for obtaining a resulting deviation of 3D pointing device of claim 14, wherein the obtaining of said previous state of the six-axis motion sensor module further comprises initializing said initial-value set.*"

Nasiri and Sachs, incorporated into Nasiri, disclose "the obtaining of said previous state of the six-axis motion sensor module" in limitations (1m) and (1n). *See supra* Sections XI.A.14 and 15.

Song discloses "initial-value set." Song discloses "the input device using the conventional accelerometer has to maintain a level state as an initial state. Therefore, if the input device is initialized when not in the level state, its movement is limited. Consequently, the input device cannot calculate an angle when a sensor sensing gravity stands longitudinally." Ex.1010, ¶13.

XI. CONCLUSION

Petitioner requests that claims 1, 4-5, 14-17, and 19 of the '438 patent be canceled.

Dated: June 15, 2019

Respectfully submitted,

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CERTIFICATE OF WORD COUNT

The undersigned hereby certifies that the foregoing Petition complies with the requirements of 37 C.F.R. § 42.24 and contains 13,991 words, excluding those contained in the following: Table of Contents, Table of Authorities, List of Exhibits, Mandatory Notices, Certificate of Word Count, and Certificate of Service.

June 15, 2019

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CERTIFICATE OF SERVICE

The undersigned hereby certifies that a true copy of the "**PETITION FOR INTER PARTES REVIEW OF U.S. PATENT NO. 8,441,438**" and supporting materials (Exhibits 1001 – 1019 and Power of Attorney) have been served in their entirety by FEDERAL EXPRESS™ this 15th day of June, 2019, on the patent owner at the correspondence address of record for the subject patent, as indicated below:

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