

**DEFENDANTS SAMSUNG ELECTRONICS CO., LTD AND SAMSUNG
ELECTRONICS AMERICA, INC'S LOCAL PATENT RULE 3-3 DISCLOSURES**

I. INTRODUCTION

Defendants Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. (collectively, “Defendants”), by their attorneys, make these Invalidity Contentions concerning U.S. Patent Nos. 10,852,846 (“the ’846 Patent”) and 11,698,687 (“the ’687 Patent”) (collectively, “Asserted Patents”), purportedly to Plaintiff CM HK Limited (“Plaintiff” or “CM HK”) in connection with the above-referenced action, pursuant to the Docket Control Order entered by the Court (Dkt. No. 23) and Local Patent Rule (P.R.) 3-3. The citation of prior art herein and the accompanying Exhibits are not intended to reflect Defendants’ claim construction contentions, which will be disclosed in due course in accordance with the Docket Control Order, and may instead reflect Plaintiff’s apparent (and potentially erroneous) claim constructions based on its Infringement Contentions.

Defendants’ Invalidity Contentions herein reflect Defendants’ knowledge as of this early date in the present action. Defendants reserve the right, to the extent permitted by the Court and the applicable statutes and rules, to modify and/or supplement their Invalidity Contentions in response to becoming aware of additional prior art or information regarding prior art, any modification or supplementation of Plaintiff’s Infringement Contentions, any claim construction by the Court, or as otherwise may be appropriate.

The Docket Control Order and the Patent Rules contemplate that these Invalidity Contentions would be prepared and served in response to Plaintiff’s Infringement Contentions. However, Plaintiff’s Infringement Contentions are insufficient because they lack proper and complete disclosure as to how Plaintiff contends that Defendants infringe the Asserted Claims. Due to Plaintiff’s failure to provide proper and complete disclosure of its Infringement Contentions under P.R. 3-1, Defendants reserve the right to seek leave from the Court to amend these Invalidity Contentions should Plaintiff be allowed by the Court to amend its Infringement Contentions or its

apparent claim constructions. Defendants also reserve the right to amend these Invalidity Contentions in light of positions that Plaintiff or its expert witnesses may assert concerning claim construction, infringement, and/or invalidity issues. Defendants also reserve the right to serve supplemental invalidity contentions that amend claim elements identified as software limitations by Plaintiff pursuant to P.R. 3-1(g) of the Discovery Order (Dkt. No. 22). In its Infringement Contentions served on January 28, 2025, Plaintiff alleges a priority date of November 11, 2010. Defendants reserve the right to amend these Invalidity Contentions should the Plaintiff be allowed by the Court to amend its infringement contentions to allege an earlier priority date. Defendants reserve the right to serve and rely upon certified translations of foreign-language prior art references that are identified and charted herewith using machine translations.

II. BACKGROUND AND STATE OF THE ART

Defendants' Exhibits attached hereto cite to particular teachings and disclosures of the prior art and other state of the art as applied to features of the asserted claims. However, persons having ordinary skill in the art generally may view an item of prior art or other state of the art document in the context of other publications, literature, products, and understanding. As such, the cited portions of prior art and other state of the art identified herein are exemplary only. Defendants may rely on the entirety of the prior art or other state of the art references listed herein, including un-cited portions of those references, and on other publications and expert testimony shedding light on those references, including as aids in understanding and interpreting the cited portions, as providing context thereto and as additional evidence that the prior art discloses a claim limitation.

Defendants will also rely on documents, products, testimony, and other evidence to establish bases for and motivations to make combinations of certain cited references that render the asserted claims obvious. Defendants may rely upon corroborating documents, products, testimony, and other evidence including materials obtained through further investigation and third-

party discovery of the prior art identified herein, that describes the invalidating features identified in these contentions; evidence of the state of the art in the relevant time period (irrespective of whether such references themselves qualify as prior art to the Asserted Patents), including prior art listed on the face of the Asserted Patents and/or disclosed in the specification (“Admitted Prior Art”); and/or expert testimony to provide context to or aid in understanding the cited portions of the identified prior art. Defendants may rely upon representations made by Plaintiff or entities related to plaintiff in proceedings before the PTAB concerning patents that are related to the asserted patents. Defendants may further rely upon representations made by Plaintiff or entities related to plaintiff in other litigations and PTAB proceedings concerning patents that are related to the asserted patents.

The references discussed in the Exhibits herein disclose the elements of the asserted claims explicitly or inherently, and/or they may be relied upon to show the state of the art in the relevant time frame. To the extent the attached claim charts relating to prior art cite to a reference for each element or limitation of an asserted claim, Defendants contend that such reference anticipates that claim. In addition, to the extent that the attached claim charts relating to prior art cite to additional references, Defendants contend, in the alternative, that the asserted claim is rendered obvious for the reasons set forth in the attached charts. To the extent suggested obviousness combinations are presented herein, they are provided in the alternative to Defendants’ anticipation contentions and are not to be construed to suggest that any reference included in the combinations is not by itself anticipatory.

For purposes of these Invalidity Contentions, Defendants identify prior art and state of the art references and provide element-by-element claim charts based, in part, on the apparent claim constructions advanced by Plaintiff in its Infringement Contentions. Nothing stated herein shall be

treated as an admission or suggestion that Defendants agree with Plaintiff regarding either the scope of any of the asserted claims or the claim constructions advanced in the Infringement Contentions. Moreover, nothing in these Invalidity Contentions shall be treated as an admission that any of Defendants' accused technology meets any limitations of the claims.

Pursuant to P.R. 3-3 and 3-4, Defendants have provided disclosures and related documents pertaining only to the asserted claims as identified by Plaintiff in its Infringement Contentions. *See* SAM-CMHK-PA-00000001–SAM-CMHK-PA-00002424. Defendants will further supplement their P.R. 3-4 document production should they later find additional, responsive documents. Much of the art identified below reflects common knowledge and the state of the art prior to the filing date of the Asserted Patents.

Each of the asserted claims of the Asserted Patents is anticipated by and/or obvious in view of one or more items of prior art identified herein, alone or in combination. Specific examples of this anticipation and obviousness, along with the motivation to combine the selected prior art, are set forth in Section III. The identification of obviousness combinations is not intended to be exhaustive, as there are many possible combinations of the references that one of ordinary skill in the art would have been motivated to make, and it is not practical to provide details of all such possible combinations.

III. IDENTIFICATION OF PRIOR ART – LOCAL PATENT RULE 3-3(A)

The identity of each item of prior art that allegedly anticipates each asserted claim or renders it obvious.

P.R. 3-3(a).

In addition to the prior art identified in the prosecution histories of the Asserted Patents, Defendants intend to rely upon the prior art identified pursuant to P.R. 3-3(a) below in support of these Invalidity Contentions. In these Contentions, Defendants provide the full identity of each item of prior art, including: (1) each patent by its patent number, country of origin, and date of

issue; (2) each non-patent publication by its title, date of publication, and, where feasible, author and publisher; (3) 35 U.S.C. § 102(b) prior art by the item offered for sale or publicly used or known, the date the offer or use took place or the information became known, and the identity of the person or entity which made the use or which made and received the offer, or the person or entity which made the information known or to whom it was made known; (4) 35 U.S.C. § 102(f) prior art by the name of the person(s) from whom and the circumstances under which the invention or any part of it was derived; and (5) 35 U.S.C. § 102(g) prior art by the identities of the person(s) or entities involved in and the circumstances surrounding the making of the invention before the patent applicant(s), based on currently available information.

Defendants' identification of patents and publications as prior art herein and in the attached claim charts under 35 U.S.C. §§ 102(a), (b), (e), and/or (g) and § 103 includes the publications themselves as well as the use of the products, devices, and systems described therein. Although Defendants' investigation continues, information available to date indicates that such products, devices, and systems were known or used in the country before the alleged invention of the claimed subject matter of the asserted claims, and/or were invented by another who did not abandon, suppress, or conceal, before the alleged invention of the claimed subject matter of the asserted claim. Upon information and belief, these prior art products, devices, and systems and their associated references anticipate and/or render obvious each of the asserted claims. Defendants further intend to rely on inventor admissions concerning the scope of the prior art relevant to the Asserted Patents found in, inter alia, the prosecution histories of the Asserted Patents and any related patents, patent applications, and/or re-examinations; any deposition testimony of the named inventors on the Asserted Patents; and the papers filed and any evidence submitted by Plaintiff in conjunction with this litigation.

Discovery is in its earliest stages, and Defendants' prior art investigation, including via discovery and third party discovery, is therefore not yet complete. Defendants reserve the right to rely upon additional evidence of invalidity obtained in the future. In addition, Defendants reserve the right to assert invalidity under 35 U.S.C. § 102(c) or (d) to the extent that further investigation and discovery yield information forming the basis for such claims.

A. Prior Art Patents

Each prior art patent shall be identified by its number, country of origin, and date of issue.

P.R. 3-3(a).

Defendants contend the following prior art patents anticipate or render obvious one or more asserted claims of the Asserted Patents under 35 U.S.C. §§ 102(a), (b), and/or (e) or 35 U.S.C. § 103:

Country	Patent/Publication No.	Filing/Publication/ Issue Date	Inventor (et al.)
PCT/ France	WO 2009/156499	Filing Date: June 27, 2008 Pub. Date: December 29, 2009	Bassompierre
US	7,418,364	Filing Date: June 1, 2006 Pub. Date: Aug. 26, 2008	Horton et al.
US	US 2006/0287824	Filing Date: Jan. 28, 2006 Pub. Date: Dec. 21, 2006	Lin et al.
US	US 2006/0038718 (US 7,230,567)	Filing Date: Oct. 27, 2005 Pub. Date: Feb. 23, 2006	Arakane et al.
US	US 2010/0105479	Filing Date: Oct, 23, 2008 Pub. Date: Apr. 29, 2010	Wilson et al.
US	8,462,109	Filing Date: June 16, 2009 Pub. Date: June 11, 2013	Nasiri
US	2007/0299626	Filing Date: Jun. 13, 2007 Pub. Date: Dec. 27, 2007	Song et al.
US	8,267,785	Filing Date: Dec, 22, 2008 Pub. Date: Sept. 2012	Yamashita et al.

Country	Patent/Publication No.	Filing/Publication/ Issue Date	Inventor (et al.)
JP	JP 2006-38650	Filing Date: Jan. 2001 Pub. Date: Feb. 9, 2006	Masaru
JP	JPH0-5104	Filing Date: June 23, 1995 Pub. Date: January 10, 1997	Kotani et al.
US	2004/0095317	Filing Date: Nov. 20, 2002, Pub. Date: May 20, 2004	Zhang <i>et al.</i>
US	7,158,118	Filing Date: May 2, 2005, Pub. Date: Jan. 2, 2007	Liberty
US	8,515,707	Filing Date: May 6, 2009, Pub. Date: Aug. 20, 2013	Joseph <i>et al.</i>

B. Prior Art Publications

Each prior art publication must be identified by its title, date of publication, and where feasible, author and publisher.

P.R. 3-3(a).

Defendants contend the following publications anticipate or render obvious one or more asserted claims of the Asserted Patents under 35 U.S.C. §§ 102(a) and/or (b) or 35 U.S.C. § 103.

Publication Title	Date	Publisher	Author(s)
A Quaternion-Based Orientation Estimation Algorithm Using an Inertial Measurement Unit	May, 2004	IEEE	Kim
Mobile Robot Attitude Estimation by Fusion of Inertial Data	1993	IEEE	J. Vaganay et al.
A sensor fusion algorithm for an integrated angular position estimation with inertial measurement units	2011	EDAA	Simone Sabatelli et al.
Inertial Head-Tracker Sensor Fusion by a Complementary	1996	IEEE	Eric Foxlin

Publication Title	Date	Publisher	Author(s)
Separate-Bias Kalman Filter			
A Quaternion-based Unscented Kalman Orientation Tracking	2003	ISIF	Edgar Kraft
“Improved State Estimation for Miniature Air Vehicles”	2006	BYU, Theses and Dissertations	Eldredge, Andrew Mark,
An Extended Kalman Filter for Quaternion-Based Orientation Estimation Using MARG Sensors	2001	IEEE	Marins et al.
Design, Implementation, and Experimental Results of a Quaternion-Based Kalman Filter for Human Body Motion Tracking	2005	IEEE	Xiaoping Yun, et al.
Robust real-time tracking by fusing measurements from inertial and vision sensor	20th September 2007	Journal of Real-Time Image Processing	Jeroen Hol, et al
Inclination Measurement of Human Movement Using a 3-D Accelerometer With Autocalibration	2004	IEEE	Henk J. Luinge and Peter H. Veltink,
Development of a MEMS Based Wearable Motion Capture System	2009	IEEE	N. Abbate et. al.
“Inertial and Magnetic Sensing of Human Motion” by	2006		Daniel Roetenberg

C. Prior Art Public Uses/Sales/Offer for Sale

Prior art sales or public disclosures under pre-AIA 35 U.S.C. § 102(b) / post-AIA 35 U.S.C. § 102(a)(1) shall be identified by specifying the item offered for sale or publicly

used or the information known, the date the offer or use took place or the information became known, and the identity of the person or entity which made the use or which made and received the offer, or the person or entity which made the information known or to whom it was made known.

P.R. 3-3(a).

Defendants contend the following prior art uses, sales, and/or offers for sale anticipate or render obvious one or more asserted claims of the Asserted Patents under 35 U.S.C. §§ 102(a) and/or (b) or 35 U.S.C. §103.

Item	Date	Identity of Persons
VN-100	At least as early as June 2009	VectorNav
MTi/MTx	At least as early as May 2005	xSens
InertiaDot	At least as early as April 2009	InertiaDot
AHRS400	At least as early as 2007	Crossbow
CHR-6dm	At least as early as 2009	CH Robotics
Samsung Galaxy S	At least as early as June 2010	Samsung
SCH-S310	At least as early as June 2005	Samsung
iPhone 3G	At least as early as July 2008	Apple
Wii	At least as early as November 2006	Nintendo

D. Prior Art under 35 U.S.C. § 102(f)

Prior art under 35 U.S.C. § 102(f) shall be identified by providing the name of the person(s) from whom and the circumstances under which the invention or any part of it was derived.

P.R. 3-3(a).

Defendants will assert that the Asserted Patents are invalid under 35 U.S.C. § 102(f) in the event Defendants obtain evidence that the named inventors of the Asserted Patents did not alone invent the subject matter claimed in the Asserted Patents. Should Defendants obtain such evidence, they will provide the name of the person(s) from whom and the circumstances under which the invention or any part of it was derived.

E. Prior Art under 35 U.S.C. § 102(e) and 35 U.S.C. § 102(g)

Prior art under 35 U.S.C. § 102(g) shall be identified by providing the identities of the person(s) or entities involved in and the circumstances surrounding the making of the invention before the patent applicant(s).

P.R. 3-3(a).

At present, Plaintiff has neither adequately alleged nor provided sufficient evidence of a conception date for the Asserted Patents earlier than the claimed priority date on the face of the Asserted Patents. In its Infringement Contentions served on January 28, 2025, Plaintiff alleges a priority date of **November 11, 2010**. Should the Court permit Plaintiff to provide evidence of an earlier conception date, Defendants reserve the right to assert that any of the § 102(a) prior art is § 102(e) and/or § 102(g) prior art. Moreover, on information and belief, the following references may provide evidence that prior to the alleged priority dates the claimed invention was made in this country by another inventor who did not abandon, suppress, or conceal it.

Prior Art	Persons/Entities Involved and Circumstances Surrounding the Making of the Invention
VN-100	The VectorNav VN-100 device developed by researchers at VectorNav as described in, for example, the VectorNav VN-100 User Manual.
MTi/MTx	The xSens MTi/MTx device developed by researchers at xSens as described in, for example, the MTi and MTx User Manual and Technical Documentation, rev. G.
InertiaDot	The Intel InertiaDot device developed by researchers at Intel as described in, for example, Intel Research Seattle's InertiaDot IMU Video, available at:

Prior Art	Persons/Entities Involved and Circumstances Surrounding the Making of the Invention
	www.youtube.com/watch?v=g-65Q3BpwH4
AHRS400	The Crossbow AHRS400 device developed by researchers at Crossbow as described in, for example, the Crossbow Technology, Inc., 400 Series User's Manual, Rev C.
CHR-6dm	The CH Robotics CHR-6dm device developed by researchers at CH Robotics as described in, for example, the CHR-6dm Attitude and Heading Reference System, Rev. 1.0 (November 2009).

Defendants further contend that each of the disclosures in **Sections III.A.** (list of prior art patents), **III.B.** (list of prior art publications), and **III.C.** (list of prior art offered for sale or publicly used or known) constitute prior inventions to the asserted claims as detailed above.

IV. LOCAL PATENT RULES 3-3(B) AND (C)

Whether each item of prior art anticipates each asserted claim or renders it obvious. If a combination of items of prior art makes a claim obvious, each such combination, and the motivation to combine such items must be identified.

A chart identifying where specifically in each alleged item of prior art each element of each asserted claim is found, including for each element that such party contends is governed by 35 U.S.C. § 112 ¶ 6, the identity of the structure(s), act(s), or material(s) in each item of prior art that performs the claimed function.

P.R. 3-3(b) and 3-3(c).

In addition to and including the prior art disclosed in the Exhibits incorporated by reference herein, each of the asserted claims of the Asserted Patents is anticipated by and/or obvious in view of one or more of items of prior art identified above in Sections III.A. (list of prior art patents), III.B. (list of prior art publications), III.C. (list of prior art offered for sale or publicly used or known), and/or III.E. (list of prior invention prior art), alone or in combination. Generally, it would have been obvious to one of ordinary skill in the art to combine any of these references to arrive at the claimed invention. The combination of familiar elements according to known methods is obvious here because it yielded predictable results. Motivation to combine any two or more of the

identified references comes from the fact that all of the references teach systems and methods of tracking the real-time or near-real-time orientation of a device using a combination of sensor devices (e.g., accelerometers, gyroscopes, magnetometers) and one would be motivated by considerations of efficiency, effectiveness, convenience, cost-savings, and accessibility, to combine the various teachings.

The asserted claims of the Asserted Patents are directed to obvious combinations of old and familiar steps or elements, each performing the same function it has long been known to perform, which yield nothing more than predictable results. Put another way, the claimed subject matter is obvious because it is nothing more than (i) combinations of prior art elements according to known methods to yield predictable results, (ii) simple substitutions of one known element for another to yield predictable results, (iii) applications of known techniques to known devices ready for improvement to yield predictable results, and/or (iv) obvious to try. One of skill in the art would have been motivated to either modify the prior art identified in the Invalidity Exhibits or to combine that prior art in the manner indicated, by, for example, their background knowledge, design incentives, effects of demands known to the design community, or other market forces, in particular the desire and need for more effective ways of determining the rotation and orientation of an object. Relevant background knowledge of a person of ordinary skill in the art includes known techniques in the industry of gyroscope and accelerometer use to determine the orientation of a device:

- The utilization of Kalman Filters and Extended Kalman Filters (*see, e.g.,* Bassompierre, Kotani, Abbate, Luinge, Foxlin, Eldridge, CH Robotics CM CHR-6d)

- The use of gyroscopes and accelerometers (*see, e.g.,* Bassompierre, Kotani, Abbate, CHR-6dm, Horton, Luinge, Foxlin, Eldridge, MTi-MTx, Crossbow, VectorNav)
- The application of Extended Kalman Filters with gyroscopes and accelerometers (*see, e.g.,* Bassompierre, Kotani, Kim, Foxlin, Eldridge)
- The use of gyroscopes and accelerometers in a MEMS sensor (e.g., VectorNav)
- The use of gyroscopes and accelerometers sensors incorporated with and/or used with a display (*see, e.g.,* Bassompierre, Song, Zhang, Liberty, Joseph, Kraft)
- The use of microprocessors to read data from gyroscopes and accelerometers and processing the same using an Extended Kalman Filter (*see, e.g.,* Bassompierre, Kotani, CH Robotics CM CHR-6d)
- Translating angles from three dimensions to two dimensions (*see, e.g.,* Bassompierre, Song, Joseph)
- Translating between and among references frames (*see, e.g.,* Bassompierre, Song, Joseph, Luinge, Eldridge, MTi-MTx, VectorNav, InertialDot)
- Rotation matrices (*see, e.g.,* Kotani, Kim, Roetenberg, Marins)
- Quaternions and quaternion algebra (*see, e.g.,* Bassompierre, Kotani, Kim, Kraft)
- Euler angles, including pitch, roll, and yaw (*see, e.g.,* Song, Kim, Roetenberg, Marins, Eldridge, MTi-MTx, Crossbow)

Further, the prior art discussed in this section all relates to the same general field of sensor devices and sensor fusion algorithms, and addresses many of the same as well as different design and features of these devices and algorithms. This would have further motivated one of skill in the art to combine those references. In view of the well-known use of the claimed subject matter and its use of well-known components with recognized benefits, the common sense of those skilled in

the art also would have served as a motivation to combine any of the identified references and demonstrates that the asserted claims of the Asserted Patents would be obvious.

Defendants have attached Exhibits containing claim charts identifying examples of prior art that anticipate and/or render obvious each asserted claim of the Asserted Patents. Specifically, to the extent the attached claim charts cite to a reference for each element or limitation of an asserted claim, Defendants contend that such reference anticipates that claim. See Local Patent Rule 3-3(b) and (c). In addition, to the extent that the following describes combinations of such references, Defendants contend, in the alternative, that the asserted claims are rendered obvious for the reasons as discussed above and as follows. To the extent suggested obviousness combinations are included herein, they are provided in the alternative to Defendants' anticipation contentions and are not to be construed to suggest that any reference included in the combinations is not by itself anticipatory.

A. '846 and '687 Patents

Invalidity Charts
Ex. 1 - Hol, "Robust Real-Time Tracking by Fusing Measurements from Inertial and Vision Sensors" (September 20, 2007).
Ex. 2 - Sabatelli, "A Sensor Fusion Algorithm for an Integrated Angular Position Estimation with Inertial Measurement Units" (2011).
Ex. 3 - Luinge, "Inclination Measurement of Human Movement Using a 3-D Accelerometer With Autocalibration" (March 2004).
Ex. 4 - Roetenberg, "Inertial and Magnetic Sensing of Human Motion" (2006).
Ex. 5 - Abbate <i>et al.</i> , "Development of a MEMS Based Wearable Motion Capture System," IEEE (2009)
Ex. 6 - Marins, "An Extended Kalman Filter for Quaternion-Based Orientation Estimation Using MARG Sensors" (2001).
Ex. 7 - Vaganay, "Mobile Robot Attitude Estimation by Fusion of Inertial Data" (1993).

Invalidity Charts
Ex. 8 - Kraft, “A Quaternion-based Unscented Kalman Filter for Orientation Tracking,” (1993).
Ex. 9 - Kim, “A Quaternion-Based Orientation Estimation Algorithm Using an Inertial Measurement Unit,” (2004).
Ex. 10 - Foxlin, “Inertial Head-Tracker Sensor Fusion by a Complementary Separate-Bais Kalman Filter,” (1996).
Ex. 11 - Eldridge, “Improved State Estimation for Miniature Air Vehicles,” (2006).
Ex. 12 - CH Robotics CHR-6dm
Ex. 13 - AHRS400 Series User’s Manual (“Crossbow”)
Ex. 14 - VectorNav VN-100
Ex. 15 - Intel InertiaDot
Ex. 16 - xSens MTi/MTx
Ex. 17 - Japanese Patent No. 2006038650 to Masaru (filed July 27.2004, published February 9, 2006)
Ex. 18 - U.S. Patent No. 7,418,364 to Horton <i>et al.</i> (filed June 1, 2006, issued August 26, 2008)
Ex. 19 - U.S. Patent 8,267,785 to Yamashita <i>et al.</i> (filed Dec. 22, 2008, issued Sept. 18, 2012)
Ex. 20 - U.S. Patent Pub. No. 2007/0299626 to Song <i>et al.</i> (filed June 13, 2007, published Sept. 18, 2012)
Ex. 21 - U.S. Patent No. 8,462,109 to Nasiri <i>et al.</i> (filed June 16, 2009, issued June 11, 2013)
Ex. 22 - U.S. Patent Publication No. 2006/0287824 to Lin (filed January 28, 2006, published December 21, 2006)
Ex. 23 - PCT Publication No 2009/156499 to Bassompierre <i>et al.</i> (filed June 26, 2009, published December 30, 2009)
Ex. 24 - U.S. Patent Publication No. 2010/0105479 to Wilson <i>et al.</i> (filed October 23, 2008, published April 29, 2010)

Invalidity Charts
Ex. 25 - U.S. Patent Publication No. 2006/0038718 to Arakane <i>et al.</i> (filed October 27, 2005, published February 23, 2006)
Ex. 26 - U.S. Patent Pub. No. 2004/0095317 to Zhang <i>et al.</i> (filed Nov. 20, 2002, published May 20, 2004)
Ex. 27 - U.S. Patent No. 7,158,118 to Liberty (filed May 2, 2005, issued Jan. 2, 2007)
Ex. 28 - U.S. Patent No 8,515,707 to Joseph <i>et al.</i> (filed May 6, 2009, issued Aug. 20, 2013)
Ex. 29 - Japanese Patent Publication No. H09-5104 to Kotani <i>et al.</i> (filed on June 23, 1995, published on January 10, 1997)
Ex. 30 - SME Chart '846
Ex. 31 - SME Chart '687
Ex. 32 - State of the Art including Admitted Prior Art

To the extent not identified above in Section III, Defendants identify all references listed in the Invalidity Charts table as prior art references anticipating and/or rendering obvious one or more claims of the Asserted Patents.

To the extent that Plaintiff contends that any one of the primary references does not disclose one or more elements of the asserted claims, it would have been obvious to combine the primary references in the Invalidity Charts with one or more references, as discussed more fully below.

All of the asserted claims of the Asserted Patents are anticipated, expressly or inherently, and therefore fail to meet one or more of the requirements for patentability, as detailed in the Invalidity Charts. Additionally, and in the alternative, the asserted claims of the Asserted Patents are obvious in view of the state of the prior art (including Admitted Prior Art) alone and/or in combination with the references described in the above-referenced Exhibits as well as the references and disclosures described below.

The alleged “inventions” claimed in the asserted claims of the Asserted Patents would have been obvious because the prior art, common knowledge, and the nature of the problems, viewed through the eyes of a person ordinarily skilled in the art, suggested the claimed elements. A person of ordinary skill in the relevant fields would have possessed knowledge and skills rendering him or her capable of combining the prior art references with knowledge in the field and common sense. Moreover, the asserted claims represent well-known combinations of familiar and pre-existing elements, yielding only predictable results.

In addition to the specific combinations of prior art and the specific combinations of groups of prior art disclosed, Defendants will rely on any other combination of any prior art references disclosed herein. Defendants further will rely upon combinations disclosed within the prosecution histories of the references cited herein. The obviousness combinations set forth in these contentions reflect Defendants’ present understanding of the potential scope of the claims that Plaintiff appears to be advocating and should not be seen as Defendants’ acquiescence to Plaintiff’s interpretation of the patent claims. Defendants will amend or supplement these contentions regarding anticipation or obviousness of the asserted claims as appropriate under the applicable Rules, including in response to further information from Plaintiff or information discovered during discovery. Plaintiff has not identified what elements or combinations it alleges were not known to one of ordinary skill in the art at the time. Therefore, for any claim limitation that Plaintiff alleges is not disclosed in a particular prior art reference, Defendants reserve the right to assert that any such limitation is either inherent in the disclosed reference or obvious to one of ordinary skill in the art at the time in light of the same, or that the limitation is disclosed in another of the references disclosed above and in combination would have rendered the asserted claim obvious.

In an effort to focus the issues, Defendants have cited representative portions of identified references, even where a reference may contain additional support for a particular claim element. In addition, persons of ordinary skill in the art generally read a prior art reference as a whole and in the context of other publications and literature. Thus, to understand and interpret any specific statement or disclosure within a prior art reference, such persons would rely on other information within the reference, along with other publications and their general scientific knowledge. As noted above, Defendants will rely upon the prior art references identified herein in their entirety, including un-cited portions.

Additionally, any reference or combination of references that anticipates or renders obvious an asserted independent claim also renders obvious any asserted claim dependent on that independent claim because every element of each dependent claim was known by a person of ordinary skill at the time of the alleged invention, and it would have been obvious to combine those known elements with the independent claims at least as a matter of common sense and routine innovation.

Defendants put forth the below exemplary combinations that further demonstrate the obviousness of the asserted claims. The inclusion of certain exemplary combinations does not exclude other combinations, upon which Defendants expressly reserve the right to rely. In particular, Defendants are currently unaware of the extent, if any, to which Plaintiff will contend that limitations of the claims at issue are not disclosed in the art identified by Defendants as anticipatory. To the extent that an issue arises with any such limitation, Defendants reserve the right to identify other references that would have made obvious the additional allegedly missing limitation to the disclosed device or method of operation.

The asserted claims of the Asserted Patents are rendered obvious under 35 U.S.C. § 103 in view of at least, and without limitation, the following combinations of references:

B. Obvious Combinations

One of the Following Primary References:	In Combination With One or More of the Following:
<ul style="list-style-type: none"> PCT Publication No. 2009/156499 to Bassompierre 	<ul style="list-style-type: none"> Japanese Patent Publication H09-5104 to Kotani <i>et al.</i> “Development of a MEMS based wearable motion capture system” to Abbate <i>et al.</i> CH Robotics CHR-6dm and 6d U.S. Patent 7,418,364 by Horton <i>et al.</i> “A sensor fusion algorithm for an integrated angular position estimation with inertial measurement units” by Sabatelli <i>et al.</i> U.S. Patent 8,462,109 to Nasiri Japanese Patent No. 2006/038650 to Masaru State of the Art including Admitted Prior Art U.S. Patent Publication 2006/0287824 to Lin U.S. Patent Publication 2004/0095317 to Zhang <i>et al.</i> U.S. Patent 7,158,118 to Liberty U.S. Patent 8,515,707 to Joseph <i>et al.</i> “Mobile Robot Attitude Estimation by Fusion of Inertial Data” by Vaganay <i>et al.</i> “A Quaternion-Based Orientation Estimation Algorithm Using an Inertial Measurement Unit” by Kim <i>et al.</i> “Robust real-time tracking by fusing measurements from inertial and vision sensors” by Hol <i>et al.</i> “Inertial and Magnetic Sensing of Human Motion” by Rotenberg

One of the Following Primary References:	In Combination With One or More of the Following:
<ul style="list-style-type: none"> Japanese Patent Publication H09-5104 to Kotani <i>et al.</i> 	<ul style="list-style-type: none"> PCT Publication No. 2009/156499 to Bassompierre “Development of a MEMS based wearable motion capture system” to Abbate <i>et al.</i> CH Robotics CHR-6dm and 6d U.S. Patent 7,418,364 by Horton <i>et al.</i> “A sensor fusion algorithm for an integrated angular position estimation with inertial measurement units” by Sabatelli <i>et al.</i> U.S. Patent 8,462,109 to Nasiri Japanese Patent No. 2006/038650 to Masaru State of the Art including Admitted Prior Art U.S. Patent Publication 2006/0287824 to Lin U.S. Patent Publication 2004/0095317 to Zhang <i>et al.</i> U.S. Patent 7,158,118 to Liberty U.S. Patent 8,515,707 to Joseph <i>et al.</i> “Mobile Robot Attitude Estimation by Fusion of Inertial Data” by Vaganay <i>et al.</i> “A Quaternion-Based Orientation Estimation Algorithm Using an Inertial Measurement Unit” by Kim <i>et al.</i> “Robust real-time tracking by fusing measurements from inertial and vision sensors” by Hol <i>et al.</i> “Inertial and Magnetic Sensing of Human Motion” by Rotenberg

One of the Following Primary References:	In Combination With One or More of the Following:
<ul style="list-style-type: none"> • “Development of a MEMS based wearable motion capture system” to Abbate <i>et al.</i> 	<ul style="list-style-type: none"> • PCT Publication No. 2009/156499 to Bassompierre • Japanese Patent Publication H09-5104 to Kotani <i>et al.</i> • CH Robotics CHR-6dm and 6d • U.S. Patent 7,418,364 by Horton <i>et al.</i> • “A sensor fusion algorithm for an integrated angular position estimation with inertial measurement units” by Sabatelli <i>et al.</i> • U.S. Patent 8,462,109 to Nasiri • Japanese Patent No. 2006/038650 to Masaru • State of the Art including Admitted Prior Art • U.S. Patent Publication 2006/0287824 to Lin • U.S. Patent Publication 2004/0095317 to Zhang <i>et al.</i> • U.S. Patent 7,158,118 to Liberty • U.S. Patent 8,515,707 to Joseph <i>et al.</i> • “Mobile Robot Attitude Estimation by Fusion of Inertial Data” by Vaganay <i>et al.</i> • “A Quaternion-Based Orientation Estimation Algorithm Using an Inertial Measurement Unit” by Kim <i>et al.</i> • “Robust real-time tracking by fusing measurements from inertial and vision sensors” by Hol <i>et al.</i> • “Inertial and Magnetic Sensing of Human Motion” by Rotenberg

One of the Following Primary References:	In Combination With One or More of the Following:
<ul style="list-style-type: none"> CH Robotics CHR-6dm and 6d 	<ul style="list-style-type: none"> PCT Publication No. 2009/156499 to Bassompierre Japanese Patent Publication H09-5104 to Kotani <i>et al.</i> “Development of a MEMS based wearable motion capture system” to Abbate <i>et al.</i> U.S. Patent 7,418,364 by Horton <i>et al.</i> “A sensor fusion algorithm for an integrated angular position estimation with inertial measurement units” by Sabatelli <i>et al.</i> U.S. Patent 8,462,109 to Nasiri Japanese Patent No. 2006/038650 to Masaru State of the Art including Admitted Prior Art U.S. Patent Publication 2006/0287824 to Lin U.S. Patent Publication 2004/0095317 to Zhang <i>et al.</i> U.S. Patent 7,158,118 to Liberty U.S. Patent 8,515,707 to Joseph <i>et al.</i> “Mobile Robot Attitude Estimation by Fusion of Inertial Data” by Vaganay <i>et al.</i> “A Quaternion-Based Orientation Estimation Algorithm Using an Inertial Measurement Unit” by Kim <i>et al.</i> “Robust real-time tracking by fusing measurements from inertial and vision sensors” by Hol <i>et al.</i> “Inertial and Magnetic Sensing of Human Motion” by Rotenberg

One of the Following Primary References:	In Combination With One or More of the Following:
<ul style="list-style-type: none"> • U.S. Patent 7,418,364 by Horton <i>et al.</i> 	<ul style="list-style-type: none"> • PCT Publication No. 2009/156499 to Bassompierre • Japanese Patent Publication H09-5104 to Kotani <i>et al.</i> • “Development of a MEMS based wearable motion capture system” to Abbate <i>et al.</i> • CH Robotics CHR-6dm and 6d • “A sensor fusion algorithm for an integrated angular position estimation with inertial measurement units” by Sabatelli <i>et al.</i> • U.S. Patent 8,462,109 to Nasiri • Japanese Patent No. 2006/038650 to Masaru • State of the Art including Admitted Prior Art • U.S. Patent Publication 2006/0287824 to Lin • U.S. Patent Publication 2004/0095317 to Zhang <i>et al.</i> • U.S. Patent 7,158,118 to Liberty • U.S. Patent 8,515,707 to Joseph <i>et al.</i> • “Mobile Robot Attitude Estimation by Fusion of Inertial Data” by Vaganay <i>et al.</i> • “A Quaternion-Based Orientation Estimation Algorithm Using an Inertial Measurement Unit” by Kim <i>et al.</i> • “Robust real-time tracking by fusing measurements from inertial and vision sensors” by Hol <i>et al.</i> • “Inertial and Magnetic Sensing of Human Motion” by Rotenberg

One of the Following Primary References:	In Combination With One or More of the Following:
<ul style="list-style-type: none"> • “A sensor fusion algorithm for an integrated angular position estimation with inertial measurement units” by Sabatelli <i>et al.</i> 	<ul style="list-style-type: none"> • PCT Publication No. 2009/156499 to Bassompierre • Japanese Patent Publication H09-5104 to Kotani <i>et al.</i> • “Development of a MEMS based wearable motion capture system” to Abbate <i>et al.</i> • CH Robotics CHR-6dm and 6d • U.S. Patent 7,418,364 by Horton <i>et al.</i> • U.S. Patent 8,462,109 to Nasiri • Japanese Patent No. 2006/038650 to Masaru • State of the Art including Admitted Prior Art • U.S. Patent Publication 2006/0287824 to Lin • U.S. Patent Publication 2004/0095317 to Zhang <i>et al.</i> • U.S. Patent 7,158,118 to Liberty • U.S. Patent 8,515,707 to Joseph <i>et al.</i> • “Mobile Robot Attitude Estimation by Fusion of Inertial Data” by Vaganay <i>et al.</i> • “A Quaternion-Based Orientation Estimation Algorithm Using an Inertial Measurement Unit” by Kim <i>et al.</i> • “Robust real-time tracking by fusing measurements from inertial and vision sensors” by Hol <i>et al.</i> • “Inertial and Magnetic Sensing of Human Motion” by Rotenberg

The motivation to combine these references is described in detail above and below.

Defendants will further specify the motivations to combine the prior art, including through reliance on expert testimony, at the appropriate later stage of this lawsuit.

- a. **Claims 1, 3, 7, and 9 of the '846 Patent and Claims 1, 2, 3, 4, 5, 6, 7, 12, 14, and 25 of the '687 Patent are obvious in view of the PCT Publication No. 2009/156499 to Bassompierre (“Bassompierre”) in combination with one or more of Japanese Patent Publication H09-5104 to Kotani *et al.* (“Kotani”), “Development of a MEMS based wearable motion capture**

system” to Abbate *et al.* (“Abbate”), CH Robotics CHR-6dm and 6d (“CHR-6dm”), U.S. Patent 7,418,364 by Horton *et al.* (“Horton”), “A sensor fusion algorithm for an integrated angular position estimation with inertial measurement units” by Sabatelli *et al.* (“Sabatelli”), U.S. Patent 7,158,118 to Nasiri (“Nasiri”), Japanese Patent No. 2006/038650 to Masaru (“Masaru”), State of the Art including Admitted Prior Art (“State”), U.S. Patent Publication 2006/0287824 to Lin (“Lin”), U.S. Patent Publication 2004/0095317 to Zhang *et al.* (“Zhang”), U.S. Patent 7,158,118 to Liberty (“Liberty”), U.S. Patent 8,515,707 to Joseph *et al.* (“Joseph”), “Mobile Robot Attitude Estimation by Fusion of Inertial Data” by Vaganay *et al.* (“Vaganay”), “A Quaternion-Based Orientation Estimation Algorithm Using an Inertial Measurement Unit” by Kim *et al.* (“Kim”), “Robust real-time tracking by fusing measurements from inertial and vision sensors” by Hol *et al.* (“Hol”), and “Inertial and Magnetic Sensing of Human Motion” by Rotenberg (“Rotenburg”)

A person of ordinary skill in the art, at the time of the inventions of Claims 1, 3, 7, and 9 of the '846 Patent and Claims 1, 2, 3, 4, 5, 6, 7, 12, 14, and 25 of the '687 Patent, would have been motivated to combine the teachings of the Bassompierre with one or more of Kotani, Abbate, CHR-6dBm, Horton, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and/or Rotenberg.

Each of Bassompierre, Kotani, Abbate, CHR-6dBm, Horton, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and Rotenberg describes systems and methods of tracking the real-time orientation of a device using a combination of sensor devices. *See e.g.*, Bassompierre at Abstract (“This result is achieved by global resolution of the angles of torsion by virtue of the combining of the measurements of the first and second sensors either within an extended Kalman filter or by applying an optimization criterion.”); Kotani ¶ [0026] (“With the present invention, even if an error occurs in the measurement value of the angular velocity sensor due to noise or drift, a gravitational acceleration vector indicating the direction of gravity is obtained from the acceleration sensor, and orientation information is corrected using the

gravitational acceleration vector as an absolute reference.”); Abbate at 255 (“Each of these modules is provided by miniature MEMS 3-axes accelerometer, three MEMS gyroscopes, a MEMS 3-axes magnetometer, and a MCU for collecting measurements from the sensors and compute the orientation through a customized Extended Kalman Filter (EKF) for sensor fusion.”); CHR-6dBm Datasheet at 1 (“An Extended Kalman Filter (EKF) combines data from onboard accelerometers, rate gyros, and magnetic sensors to produce yaw, pitch, and roll angle estimates.”); Horton at Abstract (“A method and system senses the attitude of an accelerating object by measuring acceleration with accelerometers in three orthogonal axes and measuring angular rate with angular rate sensors disposed about each such axis to compute attitude of the object accurately relative to a vertical axis.”); Sabatelli at Abstract (“This work presents an orientation tracking system for 6D inertial measurements units [including] a 3D gyro and a 3D accelerometer”); Nasiri at 30:27-30 (“In one embodiment, the gyroscopes and accelerometers can be combined in a sensor fusion algorithm in order to provide a rotation matrix, quaternion, or Euler angle representation of the devices orientation in space.”); *id.* at 9:62-64 (“MPU 20 includes motion sensors, including one or more rotational motion sensors (gyroscopes) 26 and one or more linear motion sensors (accelerometers) 28.”); Masaru ¶ [0001] (“The present invention relates to a method for measuring an orientation with respect to the ground surface by measuring acceleration and angular velocity, an orientation measuring device, an orientation meter for measuring an orientation including true north, and a computer program.”); *Samsung Introduced the World’s First ‘3-dimensional Movement Recognition’ Phone*, January 12, 2005, p. 1 (“Samsung Electronics unveiled the world’s first ‘3D movement recognition’ mobile phone SCH-S310. ‘Accelerometer’ is built in to accurately calculate and ascertain movement in three dimensional space and then carry out commands according to those calculations.”); *Apple Apps Could Be Killer App to Some CE; iPhone’s potential*

may extend far beyond expectations, say analysts. TWICE. July 21, 2008, p. 1 (“The *iPhone* 3G will be a game changer in consumer electronics, analysts explained, because it brings a large touchscreen display, accelerometer and fast Internet access to whatever applications are loaded on it.”); Lin ¶ [0017] (“A unique sophisticated Kalman filter [that] removes the inherent drift of the free inertial positioning solution derived from the output of the low cost coremicro IMU by means of fusing information from the coremicro IMU, magnetic heading sensor, and velocity producer.”); Zhang ¶ [0008] (“The remote handheld device includes a set of orientation sensors that detect the device's current orientation.”); Liberty at 7:57-60 (“According to one exemplary embodiment of the present invention, two rotational sensors 502 and 504 and one accelerometer 506 can be employed as sensors in 3D pointing device 400 as shown in FIG. 4. “); Joseph at Abstract (“An attitude of the device is determined using the Kalman filter based at least in part on the Kalman gain, the first accelerometer measurement, the second accelerometer measurement, and a magnetic field measurement received from a multi-dimensional magnetometer of the device.”); Vaganay at Abstract (“This paper describes an attitude estimation system based on inertial measurements for a mobile robot. Five low- cost inertial sensors are used: two accelerometers and three gyros”); Kim at abstract (“This paper presents a real-time orientation estimation algorithm based on signals from a low-cost inertial measurement unit (IMU). The IMU consists of three MEMS accelerometers and three MEMS rate gyros.”); Hol at Abstract (“The problem of estimating and predicting position and orientation (pose) of a camera is approached by fusing measurements from inertial sensors (accelerometers and rate gyroscopes) and vision.”); Rotenberg at 16 (“In Chapter 2, a method is introduced for estimating body segment orientation combining the sensor signals of miniature 3D gyroscopes, accelerometers and magnetometers in a complementary Kalman filter.”).

More specifically, each of Bassompierre, Kotani, Abbate, CHR-6dBm, Horton, Sabatelli, Masaru, Lin, Joseph, Vaganay, Kim, Hol, and Rotenberg describes systems and methods of combining the sensor readings to calculate the orientation—including through a predictive step. Bassompierre at 24:4-7 (“The measurement models are generally taken into account in the error criterion which globally measures the distance between the real measurement at the instant t and the measurement predicted by the model knowing the estimation of the state at the instant $t-1$.”); Kotani ¶ [0056] (“At the next time point $t+1$, the integral of the angular velocity from time t to $t+1$ is added to $\dot{q}(t)^+$ to obtain $\dot{q}(t+1)$ ”); Abbate at 258 (“The estimation step of the EKF, performed at 50Hz, uses the angular rate velocities to make a prediction of the state, as shown in Fig. 6.”); CHR-6dBm Datasheet at 8 (“The CHR-6dm uses a continuous-discrete implementation of the EKF, where rate gyro measurements are used to drive the prediction step.”); Horton at 13:61-63 (“The state model predicts where the attitude errors and rate sensor bias states will propagate based on input data from the rate sensors”); Sabatelli at 2 (“From the estimated angular position it is possible to estimate the gravity vector $[g\text{-hat}]$ ”); Masaru ¶ [0066] (“The CPU11 repeats the processes of steps S4 to S7 in which the estimation value of the state variable and the error covarianc[e] of the state variable is calculated based on the measured values of the angular velocity and the acceleration until the error of the state variable x becomes sufficiently small”); Lin ¶¶ [0248]-[0252] (“the Kalman filter module 35 further comprises: ... a state estimation module 353, for filtering the measurements and obtaining the optimal estimates of the IMU positioning errors”); Joseph at col. 12:58-59 (“The Kalman filter generally includes two phases: a “predict” phase and an “update” phase.”); Vaganay at 277 (“We thus propose a multisensor fusion method which consists of correlating these angle estimations with those resulting from the integration of the angular velocities measured by three orthogonal gyrometers.”); Kim at 270 (shows that the acceleration

due to gravity can be predicted using the quaternion); Hol at 13 (“Valid models and parameters are imperative to obtain good estimates. The innovations, defined as the difference between a measurement and its expected value ... can be used to assess whether the models are correctly tuned.”); Rotenberg at 22 (“The four parts of the complementary filter are: the a priori model prediction of the state, the error model, the Kalman filter, and the state correction yielding the a posteriori state estimate (see Figure 2.2).”).

Nasiri, State, Lin, Zhang, Liberty, and Joseph also disclose transforming the results of an orientation calculation to a display. *See e.g.*, Nasiri at 30:30-32 (“This orientation can be mapped directly or with constraints to a virtual world shown in the display of the device.”); *Motion-sensing comes to mobile phones; The technology made popular by Nintendo's Wii game controller is adding new utility--and excitement--to the cell phone. Photos: Motion-sensing phones*, p. 1 (“Responding to a flick of the wrist or sweep of the arm, tiny sensors called accelerometers, which measure linear acceleration in the Wiimote game controller, translate motion into action on the screen.”); *Apple Apps Could Be Killer App to Some CE; iPhone's potential may extend far beyond expectations, say analysts*. TWICE. July 21, 2008, p. 1 (“If you tilt the iPhone forward, for example, a racing car can go faster, or if you tilt it backward, the car will go slower, he explained”); 12/3/2018 LaViola Expert Report, *CyWee v. Samsung*, para. 14. (“Further, a POSITA would have been able to utilize the information provided by the API or SDK to determine how to apply changes in orientation (such as rotation) to a movement pattern, graphical element, cursor, pointer, textual representation or any other representation of orientation that could be presented on the display screen.”); Lin ¶¶ [0244]-[0246] (the system includes “a transformation module 331, for transforming the input relative velocity data expressed in the body frame to the relative velocity expressed in the navigation frame”); Zhang at [0030] (“The difference angles calculated are

translated into screen coordinates and the target device is instructed to move the pointer to the new location.”); Liberty at 7:15-18 (“[R]emote devices which operate as 3D pointers are of particular interest for the present specification. Such devices enable the translation of movement, e.g., gestures, into commands to a user interface.”).

Similarly, each of the Kotani, Abbate, CHR-6dBm, Horton, Sabatelli, Nasiri, Masaru, Lin, Joseph, Vaganay, Kim, Hol, and Rotenberg describes systems and methods of using quaternions to estimate orientation. See e.g., Kotani ¶ [0034] (“The three dimensional orientation angle measurement and estimation method of the present method example uses a quaternion expression (also called a quaternion)”); Abbate at 255 (“The EKF is based on quaternion to determinate limbs orientation starting from the information taken from the sensors.”); CHR-6dBm Datasheet at 9 (“To fix this problem, a quaternion representation must be used instead of Euler Angles..”); Horton at 9:37-38 (“FIG. 7 illustrates a method of updating and normalizing a quaternion that is obtained from the sensor outputs.”); Sabatelli at Abstract (“Quaternions were used to represent the angular position and an Extended Kalman filter was used for the sensor fusion algorithm.”); Nasiri at 30:27-30 (“provide a ... quaternion ... representation of the devices orientation in space”); Masaru ¶ [0010] (“The posture of the object relative to the ground can be expressed using parameters such as Euler angle or Quaternion as described above.”); Lin ¶ [0364] (“The quaternion representation is often used in the attitude computation because of its conciseness and efficiency.”); Joseph at 2:34-35 (“In some embodiments, the attitude of the device is represented using a quaternion.”); Vaganay at 279 (“We chose to use quaternions mainly because they never lead to singularities.”); Kim at 270 (“The state vector consists of the quaternion associated with the orientation, qt ...”); Hol at 9 (“The reason for using unit quaternions is that they offer a nonsingular parameterization

with a rather simple dynamics.”); Rotenberg at 109 (“A different way to describe orientations is by means of quaternions.”).

As such, each of Bassompierre, Kotani, Abbate, CHR-6dBm, Horton, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and Rotenberg occupies the same technological space and is directed to the same concepts and problems. This would have led one of skill in the art at the time of the purported invention of the ’846 Patent and the ’687 Patent to consult each reference and combine their teachings to provide the most efficient and capable system for tracking the real-time orientation of a device using sensor devices.

Because Bassompierre, Kotani, Abbate, CHR-6dBm, Horton, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and Rotenberg disclose similar steps and components that are highly compatible with each other, it would be natural for one of skill to contemplate adding to, or substituting the Bassompierre’ method and system of calculating orientation via combining sensor readings with the methods and components of calculating orientation via sensor readings in Kotani, Abbate, CHR-6dBm, Horton, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and/or Rotenberg—in order to provide additional functionality, to improve upon the same basic techniques taught in each reference, and/or to solve similar issues recited in each.

In addition, there is no essential feature in any of the references that conflicts with an essential feature of any other. Thus, one of ordinary skill in the art would have naturally been motivated to combine the teachings found within these references.

Accordingly, combining the teachings of Bassompierre with one or more of Kotani, Abbate, CHR-6dBm, Horton, Sabatelli, Nasiri, Masaru, State Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and/or Rotenberg is merely: (a) a combination of prior art elements according to known

methods to yield predictable results; (b) a simple substitution of one known element for another to obtain predictable results; (c) a use of known technique to improve similar devices in the same way; (d) application of a known technique to a known device ready for improvement to yield predictable results; (e) obvious to try; and/or (f) known work in one field of endeavor prompting variations of it for use in either the same field or a different one based on design incentives or other market forces since the variations are predictable to one of ordinary skill in the art.

- b. Claims 1, 3, 7, and 9 of the '846 Patent and Claims 1, 2, 3, 4, 5, 6, 7, 12, 14, and 25 of the '687 Patent are obvious in view of the Japanese Patent Publication H09-5104 to Kotani *et al.* ("Kotani") in combination with one or more of PCT Publication No. 2009/156499 to Bassompierre ("Bassompierre"), "Development of a MEMS based wearable motion capture system" to Abbate *et al.* ("Abbate"), CH Robotics CHR-6dm and 6d ("CHR-6dm"), U.S. Patent 7,418,364 by Horton *et al.* ("Horton"), "A sensor fusion algorithm for an integrated angular position estimation with inertial measurement units" by Sabatelli *et al.* ("Sabatelli"), U.S. Patent 7,158,118 to Nasiri ("Nasiri"), Japanese Patent No. 2006/038650 to Masaru ("Masaru"), State of the Art including Admitted Prior Art ("State"), U.S. Patent Publication 2006/0287824 to Lin ("Lin"), U.S. Patent Publication 2004/0095317 to Zhang *et al.* ("Zhang"), U.S. Patent 7,158,118 to Liberty ("Liberty"), U.S. Patent 8,515,707 to Joseph *et al.* ("Joseph"), "Mobile Robot Attitude Estimation by Fusion of Inertial Data" by Vaganay *et al.* ("Vaganay"), "A Quaternion-Based Orientation Estimation Algorithm Using an Inertial Measurement Unit" by Kim *et al.* ("Kim"), "Robust real-time tracking by fusing measurements from inertial and vision sensors" by Hol *et al.* ("Hol"), and "Inertial and Magnetic Sensing of Human Motion" by Rotenberg ("Rotenburg")**

A person of ordinary skill in the art, at the time of the inventions of Claims 1, 3, 7, and 9 of the '846 Patent and Claims 1, 2, 3, 4, 5, 6, 7, 12, 14, and 25 of the '687 Patent, would have been motivated to combine the teachings of the Kotani with one or more of Bassompierre, Abbate, CHR-6dBm, Horton, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and/or Rotenberg.

Each of Kotani, Bassompierre, Abbate, CHR-6dBm, Horton, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and Rotenberg describes systems and methods of tracking the real-time orientation of a device using a combination of sensor devices. *See e.g.*, Kotani ¶ [0026] (“With the present invention, even if an error occurs in the measurement value of the angular velocity sensor due to noise or drift, a gravitational acceleration vector indicating the direction of gravity is obtained from the acceleration sensor, and orientation information is corrected using the gravitational acceleration vector as an absolute reference.”); Bassompierre at Abstract (“This result is achieved by global resolution of the angles of torsion by virtue of the combining of the measurements of the first and second sensors either within an extended Kalman filter or by applying an optimization criterion.”); Abbate at 255 (“Each of these modules is provided by miniature MEMS 3-axes accelerometer, three MEMS gyroscopes, a MEMS 3-axes magnetometer, and a MCU for collecting measurements from the sensors and compute the orientation through a customized Extended Kalman Filter (EKF) for sensor fusion.”); CHR-6dBm Datasheet at 1 (“An Extended Kalman Filter (EKF) combines data from onboard accelerometers, rate gyros, and magnetic sensors to produce yaw, pitch, and roll angle estimates.”); Horton at Abstract (“A method and system senses the attitude of an accelerating object by measuring acceleration with accelerometers in three orthogonal axes and measuring angular rate with angular rate sensors disposed about each such axis to compute attitude of the object accurately relative to a vertical axis.”); Sabatelli at Abstract (“This work presents an orientation tracking system for 6D inertial measurements units [including] a 3D gyro and a 3D accelerometer”); Nasiri at 30:27-30 (“In one embodiment, the gyroscopes and accelerometers can be combined in a sensor fusion algorithm in order to provide a rotation matrix, quaternion, or Euler angle representation of the devices orientation in space.”); *id.* at 9:62-64 (“MPU 20 includes motion sensors, including

one or more rotational motion sensors (gyroscopes) 26 and one or more linear motion sensors (accelerometers) 28.”); Masaru ¶ [0001] (“The present invention relates to a method for measuring an orientation with respect to the ground surface by measuring acceleration and angular velocity, an orientation measuring device, an orientation meter for measuring an orientation including true north, and a computer program.”); *Samsung Introduced the World’s First ‘3-dimensional Movement Recognition’ Phone*, January 12, 2005, p. 1 (“Samsung Electronics unveiled the world’s first ‘3D movement recognition’ mobile phone SCH-S310. ‘Accelerometer’ is built in to accurately calculate and ascertain movement in three dimensional space and then carry out commands according to those calculations.”); *Apple Apps Could Be Killer App to Some CE; iPhone’s potential may extend far beyond expectations, say analysts*. TWICE. July 21, 2008, p. 1 (“The iPhone 3G will be a game changer in consumer electronics, analysts explained, because it brings a large touchscreen display, accelerometer and fast Internet access to whatever applications are loaded on it.”); Lin ¶ [0017] (“A unique sophisticated Kalman filter [that] removes the inherent drift of the free inertial positioning solution derived from the output of the low cost coremicro IMU by means of fusing information from the coremicro IMU, magnetic heading sensor, and velocity producer.”); Zhang ¶ [0008] (“The remote handheld device includes a set of orientation sensors that detect the device's current orientation.”); Liberty at 7:57-60 (“According to one exemplary embodiment of the present invention, two rotational sensors 502 and 504 and one accelerometer 506 can be employed as sensors in 3D pointing device 400 as shown in FIG. 4. “); Joseph at Abstract (“An attitude of the device is determined using the Kalman filter based at least in part on the Kalman gain, the first accelerometer measurement, the second accelerometer measurement, and a magnetic field measurement received from a multi-dimensional magnetometer of the device.”); Vaganay at Abstract (“This paper describes an attitude estimation system based on inertial measurements for

a mobile robot. Five low- cost inertial sensors are used: two accelerometers and three gyros”); Kim at abstract (“This paper presents a real-time orientation estimation algorithm based on signals from a low-cost inertial measurement unit (IMU). The IMU consists of three MEMS accelerometers and three MEMS rate gyros.”); Hol at Abstract (“The problem of estimating and predicting position and orientation (pose) of a camera is approached by fusing measurements from inertial sensors (accelerometers and rate gyroscopes) and vision.”); Rotenberg at 16 (“In Chapter 2, a method is introduced for estimating body segment orientation combining the sensor signals of miniature 3D gyroscopes, accelerometers and magnetometers in a complementary Kalman filter.”).

More specifically, each of Kotani, Bassompierre, Abbate, CHR-6dBm, Horton, Sabatelli, Masaru, Lin, Joseph, Vaganay, Kim, Hol, and Rotenberg describes systems and methods of combining the sensor readings to calculate the orientation—including through a predictive step. Kotani ¶ [0056] (“At the next time point $t+1$, the integral of the angular velocity from time t to $t+1$ is added to $\dot{q}(t)^+$ to obtain $\dot{q}(t+1)^-$ ”); Bassompierre at 24:4-7 (“The measurement models are generally taken into account in the error criterion which globally measures the distance between the real measurement at the instant t and the measurement predicted by the model knowing the estimation of the state at the instant $t-1$.”); Abbate at 258 (“The estimation step of the EKF, performed at 50Hz, uses the angular rate velocities to make a prediction of the state, as shown in Fig. 6.”); CHR-6dBm Datasheet at 8 (“The CHR-6dm uses a continuous-discrete implementation of the EKF, where rate gyro measurements are used to drive the prediction step.”); Horton at 13:61-63 (“The state model predicts where the attitude errors and rate sensor bias states will propagate based on input data from the rate sensors”); Sabatelli at 2 (“From the estimated angular position it is possible to estimate the gravity vector $[g\text{-hat}]$ ”); Masaru ¶ [0066] (“The CPU11 repeats the

processes of steps S4 to S7 in which the estimation value of the state variable and the error covarianc[e] of the state variable is calculated based on the measured values of the angular velocity and the acceleration until the error of the state variable x becomes sufficiently small”; Lin ¶¶ [0248]-[0252] (“the Kalman filter module 35 further comprises: ... a state estimation module 353, for filtering the measurements and obtaining the optimal estimates of the IMU positioning errors”); Joseph at col. 12:58-59 (“The Kalman filter generally includes two phases: a “predict” phase and an “update” phase.”); Vaganay at 277 (“We thus propose a multisensor fusion method which consists of correlating these angle estimations with those resulting from the integration of the angular velocities measured by three orthogonal gyrometers.”); Kim at 270 (shows that the acceleration due to gravity can be predicted using the quaternion); Hol at 13 (“Valid models and parameters are imperative to obtain good estimates. The innovations, defined as the difference between a measurement and its expected value ... can be used to assess whether the models are correctly tuned.”); Rotenberg at 22 (“The four parts of the complementary filter are: the a priori model prediction of the state, the error model, the Kalman filter, and the state correction yielding the a posteriori state estimate (see Figure 2.2).”).

Nasiri, State, Lin, Zhang, Liberty, and Joseph also disclose transforming the results of an orientation calculation to a display. *See e.g.*, Nasiri at 30:30-32 (“This orientation can be mapped directly or with constraints to a virtual world shown in the display of the device.”); *Motion-sensing comes to mobile phones; The technology made popular by Nintendo's Wii game controller is adding new utility--and excitement--to the cell phone. Photos: Motion-sensing phones*, p. 1 (“Responding to a flick of the wrist or sweep of the arm, tiny sensors called accelerometers, which measure linear acceleration in the Wiimote game controller, translate motion into action on the screen.”); *Apple Apps Could Be Killer App to Some CE; iPhone's potential may extend far beyond*

expectations, say analysts. TWICE. July 21, 2008, p. 1 (“If you tilt the iPhone forward, for example, a racing car can go faster, or if you tilt it backward, the car will go slower, he explained”); 12/3/2018 LaViola Expert Report, *CyWee v. Samsung*, para. 14. (“Further, a POSITA would have been able to utilize the information provided by the API or SDK to determine how to apply changes in orientation (such as rotation) to a movement pattern, graphical element, cursor, pointer, textual representation or any other representation of orientation that could be presented on the display screen.”); Lin ¶¶ [0244]-[0246] (the system includes “a transformation module 331, for transforming the input relative velocity data expressed in the body frame to the relative velocity expressed in the navigation frame”); Zhang at [0030] (“The difference angles calculated are translated into screen coordinates and the target device is instructed to move the pointer to the new location.”); Liberty at 7:15-18 (“[R]emote devices which operate as 3D pointers are of particular interest for the present specification. Such devices enable the translation of movement, e.g., gestures, into commands to a user interface.”).

Similarly, each of the Bassompierre, Abbate, CHR-6dBm, Horton, Sabatelli, Nasiri, Masaru, Lin, Joseph, Vaganay, Kim, Hol, and Rotenberg describes systems and methods of using quaternions to estimate orientation. *See e.g.*, Bassompierre at 20:10-11 (“A first variant embodiment consists in replacing the angles of torsion θ and ψ by a quaternion formulation of the same torsion.”); Abbate at 255 (“The EKF is based on quaternion to determinate limbs orientation starting from the information taken from the sensors.”); CHR-6dBm Datasheet at 9 (“To fix this problem, a quaternion representation must be used instead of Euler Angles..”); Horton at 9:37-38 (“FIG. 7 illustrates a method of updating and normalizing a quaternion that is obtained from the sensor outputs.”); Sabatelli at Abstract (“Quaternions were used to represent the angular position and an Extended Kalman filter was used for the sensor fusion algorithm.”); Nasiri at 30:27-30

(“provide a ... quaternion ... representation of the devices orientation in space”); Masaru ¶ [0010] (“The posture of the object relative to the ground can be expressed using parameters such as Euler angle or Quaternion as described above.”); Lin ¶ [0364] (“The quaternion representation is often used in the attitude computation because of its conciseness and efficiency.”); Joseph at 2:34-35 (“In some embodiments, the attitude of the device is represented using a quaternion.”); Vaganay at 279 (“We chose to use quaternions mainly because they never lead to singularities.”); Kim at 270 (“The state vector consists of the quaternion associated with the orientation, qt ...”); Hol at 9 (“The reason for using unit quaternions is that they offer a nonsingular parameterization with a rather simple dynamics.”); Rotenberg at 109 (“A different way to describe orientations is by means of quaternions.”).

As such, each of Kotani, Bassompierre, Abbate, CHR-6dBm, Horton, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and Rotenberg occupies the same technological space and is directed to the same concepts and problems. This would have led one of skill in the art at the time of the purported invention of the '846 Patent and the '687 Patent to consult each reference and combine their teachings to provide the most efficient and capable system for tracking the real-time orientation of a device using sensor devices.

Because Kotani, Bassompierre, Abbate, CHR-6dBm, Horton, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and Rotenberg disclose similar steps and components that are highly compatible with each other, it would be natural for one of skill to contemplate adding to, or substituting the Kotani's method and system of calculating orientation via combining sensor readings with the methods and components of calculating orientation via sensor readings in Bassompierre, Abbate, CHR-6dBm, Horton, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and/or Rotenberg—in order to provide

additional functionality, to improve upon the same basic techniques taught in each reference, and/or to solve similar issues recited in each.

In addition, there is no essential feature in any of the references that conflicts with an essential feature of any other. Thus, one of ordinary skill in the art would have naturally been motivated to combine the teachings found within these references.

Accordingly, combining the teachings of Kotani with one or more of Bassompierre, Abbate, CHR-6dBm, Horton, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and/or Rotenberg is merely: (a) a combination of prior art elements according to known methods to yield predictable results; (b) a simple substitution of one known element for another to obtain predictable results; (c) a use of known technique to improve similar devices in the same way; (d) application of a known technique to a known device ready for improvement to yield predictable results; (e) obvious to try; and/or (f) known work in one field of endeavor prompting variations of it for use in either the same field or a different one based on design incentives or other market forces since the variations are predictable to one of ordinary skill in the art.

- c. **Claims 1, 3, 7, and 9 of the '846 Patent and Claims 1, 2, 3, 4, 5, 6, 7, 12, 14, and 25 of the '687 Patent are obvious in view of "Development of a MEMS based wearable motion capture system" to Abbate *et al.* ("Abbate") in combination with one or more of PCT Publication No. 2009/156499 to Bassompierre ("Bassompierre"), Japanese Patent Publication H09-5104 to Kotani *et al.* ("Kotani"), CH Robotics CHR-6dm and 6d ("CHR-6dm"), U.S. Patent 7,418,364 by Horton *et al.* ("Horton"), "A sensor fusion algorithm for an integrated angular position estimation with inertial measurement units" by Sabatelli *et al.* ("Sabatelli"), U.S. Patent 7,158,118 to Nasiri ("Nasiri"), Japanese Patent No. 2006/038650 to Masaru ("Masaru"), State of the Art including Admitted Prior Art ("State"), U.S. Patent Publication 2006/0287824 to Lin ("Lin"), U.S. Patent Publication 2004/0095317 to Zhang *et al.* ("Zhang"), U.S. Patent 7,158,118 to Liberty ("Liberty"), U.S. Patent 8,515,707 to Joseph *et al.* ("Joseph"), "Mobile Robot Attitude Estimation by Fusion of Inertial Data" by Vaganay *et***

***al.* (“Vaganay”), “A Quaternion-Based Orientation Estimation Algorithm Using an Inertial Measurement Unit” by Kim *et al.* (“Kim”), “Robust real-time tracking by fusing measurements from inertial and vision sensors” by Hol *et al.* (“Hol”), and “Inertial and Magnetic Sensing of Human Motion” by Rotenberg (“Rotenburg”)**

A person of ordinary skill in the art, at the time of the inventions of Claims 1, 3, 7, and 9 of the ’846 Patent and Claims 1, 2, 3, 4, 5, 6, 7, 12, 14, and 25 of the ’687 Patent, would have been motivated to combine the teachings of the Abbate with one or more of Bassompierre, Kotani, CHR-6dBm, Horton, Sabatelli, Nasiri, Masaru, State Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and/or Rotenberg.

Each of Abbate, Bassompierre, Kotani, CHR-6dBm, Horton, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and Rotenberg describes systems and methods of tracking the real-time orientation of a device using a combination of sensor devices. *See e.g.*, Abbate at 255 (“Each of these modules is provided by miniature MEMS 3-axes accelerometer, three MEMS gyroscopes, a MEMS 3-axes magnetometer, and a MCU for collecting measurements from the sensors and compute the orientation through a customized Extended Kalman Filter (EKF) for sensor fusion.”); Bassompierre at Abstract (“This result is achieved by global resolution of the angles of torsion by virtue of the combining of the measurements of the first and second sensors either within an extended Kalman filter or by applying an optimization criterion.”); Kotani ¶ [0026] (“With the present invention, even if an error occurs in the measurement value of the angular velocity sensor due to noise or drift, a gravitational acceleration vector indicating the direction of gravity is obtained from the acceleration sensor, and orientation information is corrected using the gravitational acceleration vector as an absolute reference.”); CHR-6dBm Datasheet at 1 (“An Extended Kalman Filter (EKF) combines data from onboard accelerometers, rate gyros, and magnetic sensors to produce yaw,

pitch, and roll angle estimates.”); Horton at Abstract (“A method and system senses the attitude of an accelerating object by measuring acceleration with accelerometers in three orthogonal axes and measuring angular rate with angular rate sensors disposed about each such axis to compute attitude of the object accurately relative to a vertical axis.”); Sabatelli at Abstract (“This work presents an orientation tracking system for 6D inertial measurements units [including] a 3D gyro and a 3D accelerometer”); Nasiri at 30:27-30 (“In one embodiment, the gyroscopes and accelerometers can be combined in a sensor fusion algorithm in order to provide a rotation matrix, quaternion, or Euler angle representation of the devices orientation in space.”); *id.* at 9:62-64 (“MPU 20 includes motion sensors, including one or more rotational motion sensors (gyroscopes) 26 and one or more linear motion sensors (accelerometers) 28.”); Masaru ¶ [0001] (“The present invention relates to a method for measuring an orientation with respect to the ground surface by measuring acceleration and angular velocity, an orientation measuring device, an orientation meter for measuring an orientation including true north, and a computer program.”); *Samsung Introduced the World’s First ‘3-dimensional Movement Recognition’ Phone*, January 12, 2005, p. 1 (“Samsung Electronics unveiled the world’s first ‘3D movement recognition’ mobile phone SCH-S310. ‘Accelerometer’ is built in to accurately calculate and ascertain movement in three dimensional space and then carry out commands according to those calculations.”); *Apple Apps Could Be Killer App to Some CE; iPhone’s potential may extend far beyond expectations, say analysts*. TWICE. July 21, 2008, p. 1 (“The *iPhone* 3G will be a game changer in consumer electronics, analysts explained, because it brings a large touchscreen display, accelerometer and fast Internet access to whatever applications are loaded on it.”); Lin ¶ [0017] (“A unique sophisticated Kalman filter [that] removes the inherent drift of the free inertial positioning solution derived from the output of the low cost coremicro IMU by means of fusing information from the coremicro IMU, magnetic heading sensor, and

velocity producer.”); Zhang ¶ [0008] (“The remote handheld device includes a set of orientation sensors that detect the device's current orientation.”); Liberty at 7:57-60 (“According to one exemplary embodiment of the present invention, two rotational sensors 502 and 504 and one accelerometer 506 can be employed as sensors in 3D pointing device 400 as shown in FIG. 4. “); Joseph at Abstract (“An attitude of the device is determined using the Kalman filter based at least in part on the Kalman gain, the first accelerometer measurement, the second accelerometer measurement, and a magnetic field measurement received from a multi-dimensional magnetometer of the device.”); Vaganay at Abstract (“This paper describes an attitude estimation system based on inertial measurements for a mobile robot. Five low- cost inertial sensors are used: two accelerometers and three gyros”); Kim at abstract (“This paper presents a real-time orientation estimation algorithm based on signals from a low-cost inertial measurement unit (IMU). The IMU consists of three MEMS accelerometers and three MEMS rate gyros.”); Hol at Abstract (“The problem of estimating and predicting position and orientation (pose) of a camera is approached by fusing measurements from inertial sensors (accelerometers and rate gyroscopes) and vision.”); Rotenberg at 16 (“In Chapter 2, a method is introduced for estimating body segment orientation combining the sensor signals of miniature 3D gyroscopes, accelerometers and magnetometers in a complementary Kalman filter.”).

More specifically, each of Abbate, Bassompierre, Kotani, CHR-6dBm, Horton, Sabatelli, Masaru, Lin, Joseph, Vaganay, Kim, Hol, and Rotenberg describes systems and methods of combining the sensor readings to calculate the orientation—including through a predictive step. Abbate at 258 (“The estimation step of the EKF, performed at 50Hz, uses the angular rate velocities to make a prediction of the state, as shown in Fig. 6.”); Bassompierre at 24:4-7 (“The measurement models are generally taken into account in the error criterion which globally measures the distance

between the real measurement at the instant t and the measurement predicted by the model knowing the estimation of the state at the instant $t-1$."); Kotani ¶ [0056] ("At the next time point $t+1$, the integral of the angular velocity from time t to $t+1$ is added to $\dot{q}(t)^+$ to obtain $\dot{q}(t+1)$ "); CHR-6dBm Datasheet at 8 ("The CHR-6dm uses a continuous-discrete implementation of the EKF, where rate gyro measurements are used to drive the prediction step."); Horton at 13:61-63 ("The state model predicts where the attitude errors and rate sensor bias states will propagate based on input data from the rate sensors"); Sabatelli at 2 ("From the estimated angular position it is possible to estimate the gravity vector $[g\text{-hat}]$ "); Masaru ¶ [0066] ("The CPU11 repeats the processes of steps S4 to S7 in which the estimation value of the state variable and the error covarianc[e] of the state variable is calculated based on the measured values of the angular velocity and the acceleration until the error of the state variable x becomes sufficiently small"; Lin ¶¶ [0248]-[0252] ("the Kalman filter module 35 further comprises: ... a state estimation module 353, for filtering the measurements and obtaining the optimal estimates of the IMU positioning errors"); Joseph at col. 12:58-59 ("The Kalman filter generally includes two phases: a "predict" phase and an "update" phase."); Vaganay at 277 ("We thus propose a multisensor fusion method which consists of correlating these angle estimations with those resulting from the integration of the angular velocities measured by three orthogonal gyrometers."); Kim at 270 (shows that the acceleration due to gravity can be predicted using the quaternion); Hol at 13 ("Valid models and parameters are imperative to obtain good estimates. The innovations, defined as the difference between a measurement and its expected value ... can be used to assess whether the models are correctly tuned."); Rotenberg at 22 ("The four parts of the complementary filter are: the a priori model prediction of the state, the error model, the Kalman filter, and the state correction yielding the a posteriori state estimate (see Figure 2.2).").

Nasiri, State, Lin, Zhang, Liberty, and Joseph also disclose transforming the results of an orientation calculation to a display. *See e.g.*, Nasiri at 30:30-32 (“This orientation can be mapped directly or with constraints to a virtual world shown in the display of the device.”); *Motion-sensing comes to mobile phones; The technology made popular by Nintendo's Wii game controller is adding new utility--and excitement--to the cell phone. Photos: Motion-sensing phones*, p. 1 (“Responding to a flick of the wrist or sweep of the arm, tiny sensors called accelerometers, which measure linear acceleration in the Wiimote game controller, translate motion into action on the screen.”); *Apple Apps Could Be Killer App to Some CE; iPhone's potential may extend far beyond expectations, say analysts*. TWICE. July 21, 2008, p. 1 (“If you tilt the iPhone forward, for example, a racing car can go faster, or if you tilt it backward, the car will go slower, he explained”); 12/3/2018 LaViola Expert Report, *CyWee v. Samsung*, para. 14. (“Further, a POSITA would have been able to utilize the information provided by the API or SDK to determine how to apply changes in orientation (such as rotation) to a movement pattern, graphical element, cursor, pointer, textual representation or any other representation of orientation that could be presented on the display screen.”); Lin ¶¶ [0244]-[0246] (the system includes “a transformation module 331, for transforming the input relative velocity data expressed in the body frame to the relative velocity expressed in the navigation frame”); Zhang at [0030] (“The difference angles calculated are translated into screen coordinates and the target device is instructed to move the pointer to the new location.”); Liberty at 7:15-18 (“[R]emote devices which operate as 3D pointers are of particular interest for the present specification. Such devices enable the translation of movement, e.g., gestures, into commands to a user interface.”).

Similarly, each of the Bassompierre, Kotani, CHR-6dBm, Horton, Sabatelli, Nasiri, Masaru, Lin, Joseph, Vaganay, Kim, Hol, and Rotenberg describes systems and methods of using

quaternions to estimate orientation. *See e.g.*, Bassompierre at 20:10-11 (“A first variant embodiment consists in replacing the angles of torsion θ and ψ by a quaternion formulation of the same torsion.”); Kotani ¶ [0034] (“The three dimensional orientation angle measurement and estimation method of the present method example uses a quaternion expression (also called a quaternion) “); CHR-6dBm Datasheet at 9 (“To fix this problem, a quaternion representation must be used instead of Euler Angles..”); Horton at 9:37-38 (“FIG. 7 illustrates a method of updating and normalizing a quaternion that is obtained from the sensor outputs.”); Sabatelli at Abstract (“Quaternions were used to represent the angular position and an Extended Kalman filter was used for the sensor fusion algorithm.”); Nasiri at 30:27-30 (“provide a ... quaternion ... representation of the devices orientation in space”); Masaru ¶ [0010] (“The posture of the object relative to the ground can be expressed using parameters such as Euler angle or Quaternion as described above.”); Lin ¶ [0364] (“The quaternion representation is often used in the attitude computation because of its conciseness and efficiency.”); Joseph at 2:34-35 (“In some embodiments, the attitude of the device is represented using a quaternion.”); Vaganay at 279 (“We chose to use quaternions mainly because they never lead to singularities.”); Kim at 270 (“The state vector consists of the quaternion associated with the orientation, q_t ...”); Hol at 9 (“The reason for using unit quaternions is that they offer a nonsingular parameterization with a rather simple dynamics.”); Rotenberg at 109 (“A different way to describe orientations is by means of quaternions.”).

As such, each of Abbate, Bassompierre, Kotani, CHR-6dBm, Horton, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and Rotenberg occupies the same technological space and is directed to the same concepts and problems. This would have led one of skill in the art at the time of the purported invention of the '846 Patent and the '687 Patent to

consult each reference and combine their teachings to provide the most efficient and capable system for tracking the real-time orientation of a device using sensor devices.

Because Abbate, Bassompierre, Kotani, CHR-6dBm, Horton, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and Rotenberg disclose similar steps and components that are highly compatible with each other, it would be natural for one of skill to contemplate adding to, or substituting the Abbate's method and system of calculating orientation via combining sensor readings with the methods and components of calculating orientation via sensor readings in Bassompierre, Kotani, CHR-6dBm, Horton, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and/or Rotenberg—in order to provide additional functionality, to improve upon the same basic techniques taught in each reference, and/or to solve similar issues recited in each.

In addition, there is no essential feature in any of the references that conflicts with an essential feature of any other. Thus, one of ordinary skill in the art would have naturally been motivated to combine the teachings found within these references.

Accordingly, combining the teachings of Abbate with one or more of Bassompierre, Kotani, CHR-6dBm, Horton, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and/or Rotenberg is merely: (a) a combination of prior art elements according to known methods to yield predictable results; (b) a simple substitution of one known element for another to obtain predictable results; (c) a use of known technique to improve similar devices in the same way; (d) application of a known technique to a known device ready for improvement to yield predictable results; (e) obvious to try; and/or (f) known work in one field of endeavor prompting variations of it for use in either the same field or a different one based on design incentives or other market forces since the variations are predictable to one of ordinary skill in the art.

- d. **Claims 1, 3, 7, and 9 of the '846 Patent and Claims 1, 2, 3, 4, 5, 6, 7, 12, 14, and 25 of the '687 Patent are obvious in view of CHR-6dm by CH Robotics ("CHR-6dm") in combination with one or more of PCT Publication No. 2009/156499 to Bassompierre ("Bassompierre"), Japanese Patent Publication H09-5104 to Kotani *et al.* ("Kotani"), "Development of a MEMS based wearable motion capture system" to Abbate *et al.* ("Abbate"), U.S. Patent 7,418,364 by Horton *et al.* ("Horton"), "A sensor fusion algorithm for an integrated angular position estimation with inertial measurement units" by Sabatelli *et al.* ("Sabatelli"), U.S. Patent 7,158,118 to Nasiri ("Nasiri"), Japanese Patent No. 2006/038650 to Masaru ("Masaru"), State of the Art including Admitted Prior Art ("State"), U.S. Patent Publication 2006/0287824 to Lin ("Lin"), U.S. Patent Publication 2004/0095317 to Zhang *et al.* ("Zhang"), U.S. Patent 7,158,118 to Liberty ("Liberty"), U.S. Patent 8,515,707 to Joseph *et al.* ("Joseph"), "Mobile Robot Attitude Estimation by Fusion of Inertial Data" by Vaganay *et al.* ("Vaganay"), "A Quaternion-Based Orientation Estimation Algorithm Using an Inertial Measurement Unit" by Kim *et al.* ("Kim"), "Robust real-time tracking by fusing measurements from inertial and vision sensors" by Hol *et al.* ("Hol"), and "Inertial and Magnetic Sensing of Human Motion" by Rotenberg ("Rotenburg")**

A person of ordinary skill in the art, at the time of the inventions of Claims 1, 3, 7, and 9 of the '846 Patent and Claims 1, 2, 3, 4, 5, 6, 7, 12, 14, and 25 of the '687 Patent, would have been motivated to combine the teachings of the CHR-6dm with one or more of Bassompierre, Kotani, Abbate, Horton, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and/or Rotenberg.

Each of CHR-6dm, Bassompierre, Kotani, Abbate, Horton, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and Rotenberg describes systems and methods of tracking the real-time orientation of a device using a combination of sensor devices. *See e.g.*, CHR-6dBm Datasheet at 1 ("An Extended Kalman Filter (EKF) combines data from onboard accelerometers, rate gyros, and magnetic sensors to produce yaw, pitch, and roll angle estimates."); Bassompierre at Abstract ("This result is achieved by global resolution of the angles of torsion by

virtue of the combining of the measurements of the first and second sensors either within an extended Kalman filter or by applying an optimization criterion.”); Kotani ¶ [0026] (“With the present invention, even if an error occurs in the measurement value of the angular velocity sensor due to noise or drift, a gravitational acceleration vector indicating the direction of gravity is obtained from the acceleration sensor, and orientation information is corrected using the gravitational acceleration vector as an absolute reference.”); Abbate at 255 (“Each of these modules is provided by miniature MEMS 3-axes accelerometer, three MEMS gyroscopes, a MEMS 3-axes magnetometer, and a MCU for collecting measurements from the sensors and compute the orientation through a customized Extended Kalman Filter (EKF) for sensor fusion.”); Horton at Abstract (“A method and system senses the attitude of an accelerating object by measuring acceleration with accelerometers in three orthogonal axes and measuring angular rate with angular rate sensors disposed about each such axis to compute attitude of the object accurately relative to a vertical axis.”); Sabatelli at Abstract (“This work presents an orientation tracking system for 6D inertial measurements units [including] a 3D gyro and a 3D accelerometer”); Nasiri at 30:27-30 (“In one embodiment, the gyroscopes and accelerometers can be combined in a sensor fusion algorithm in order to provide a rotation matrix, quaternion, or Euler angle representation of the devices orientation in space.”); *id.* at 9:62-64 (“MPU 20 includes motion sensors, including one or more rotational motion sensors (gyroscopes) 26 and one or more linear motion sensors (accelerometers) 28.”); Masaru ¶ [0001] (“The present invention relates to a method for measuring an orientation with respect to the ground surface by measuring acceleration and angular velocity, an orientation measuring device, an orientation meter for measuring an orientation including true north, and a computer program.”); *Samsung Introduced the World’s First ‘3-dimensional Movement Recognition’ Phone*, January 12, 2005, p. 1 (“Samsung Electronics unveiled the world’s first ‘3D

movement recognition' mobile phone SCH-S310. 'Accelerometer' is built in to accurately calculate and ascertain movement in three dimensional space and then carry out commands according to those calculations.”); *Apple Apps Could Be Killer App to Some CE; iPhone's potential may extend far beyond expectations, say analysts*. TWICE. July 21, 2008, p. 1 (“The iPhone 3G will be a game changer in consumer electronics, analysts explained, because it brings a large touchscreen display, accelerometer and fast Internet access to whatever applications are loaded on it.”); Lin ¶ [0017] (“A unique sophisticated Kalman filter [that] removes the inherent drift of the free inertial positioning solution derived from the output of the low cost coremicro IMU by means of fusing information from the coremicro IMU, magnetic heading sensor, and velocity producer.”); Zhang ¶ [0008] (“The remote handheld device includes a set of orientation sensors that detect the device's current orientation.”); Liberty at 7:57-60 (“According to one exemplary embodiment of the present invention, two rotational sensors 502 and 504 and one accelerometer 506 can be employed as sensors in 3D pointing device 400 as shown in FIG. 4. “); Joseph at Abstract (“An attitude of the device is determined using the Kalman filter based at least in part on the Kalman gain, the first accelerometer measurement, the second accelerometer measurement, and a magnetic field measurement received from a multi-dimensional magnetometer of the device.”); Vaganay at Abstract (“This paper describes an attitude estimation system based on inertial measurements for a mobile robot. Five low- cost inertial sensors are used: two accelerometers and three gyros”); Kim at abstract (“This paper presents a real-time orientation estimation algorithm based on signals from a low-cost inertial measurement unit (IMU). The IMU consists of three MEMS accelerometers and three MEMS rate gyros.”); Hol at Abstract (“The problem of estimating and predicting position and orientation (pose) of a camera is approached by fusing measurements from inertial sensors (accelerometers and rate gyroscopes) and vision.”); Rotenberg at 16 (“In Chapter 2, a

method is introduced for estimating body segment orientation combining the sensor signals of miniature 3D gyroscopes, accelerometers and magnetometers in a complementary Kalman filter.”).

More specifically, each of CHR-6dm, Bassompierre, Kotani, Abbate, Horton, Sabatelli, Masaru, Lin, Joseph, Vaganay, Kim, Hol, and Rotenberg describes systems and methods of combining the sensor readings to calculate the orientation—including through a predictive step. CHR-6dBm Datasheet at 8 (“The CHR-6dm uses a continuous-discrete implementation of the EKF, where rate gyro measurements are used to drive the prediction step.”); Bassompierre at 24:4-7 (“The measurement models are generally taken into account in the error criterion which globally measures the distance between the real measurement at the instant t and the measurement predicted by the model knowing the estimation of the state at the instant $t-1$.”); Kotani ¶ [0056] (“At the next time point $t+1$, the integral of the angular velocity from time t to $t+1$ is added to $\dot{q}(t)^+$ to obtain $\dot{q}(t+1)$ ”); Abbate at 258 (“The estimation step of the EKF, performed at 50Hz, uses the angular rate velocities to make a prediction of the state, as shown in Fig. 6.”); Horton at 13:61-63 (“The state model predicts where the attitude errors and rate sensor bias states will propagate based on input data from the rate sensors”); Sabatelli at 2 (“From the estimated angular position it is possible to estimate the gravity vector $[g\text{-hat}]$ ”); Masaru ¶ [0066] (“The CPU11 repeats the processes of steps S4 to S7 in which the estimation value of the state variable and the error covarianc[e] of the state variable is calculated based on the measured values of the angular velocity and the acceleration until the error of the state variable x becomes sufficiently small”; Lin ¶¶ [0248]-[0252] (“the Kalman filter module 35 further comprises: ... a state estimation module 353, for filtering the measurements and obtaining the optimal estimates of the IMU positioning errors”); Joseph at col. 12:58-59 (“The Kalman filter generally includes two phases: a “predict” phase and an “update”

phase.”); Vaganay at 277 (“We thus propose a multisensor fusion method which consists of correlating these angle estimations with those resulting from the integration of the angular velocities measured by three orthogonal gyrometers.”); Kim at 270 (shows that the acceleration due to gravity can be predicted using the quaternion); Hol at 13 (“Valid models and parameters are imperative to obtain good estimates. The innovations, defined as the difference between a measurement and its expected value ... can be used to assess whether the models are correctly tuned.”); Rotenberg at 22 (“The four parts of the complementary filter are: the a priori model prediction of the state, the error model, the Kalman filter, and the state correction yielding the a posteriori state estimate (see Figure 2.2).”).

Nasiri, State, Lin, Zhang, Liberty, and Joseph also disclose transforming the results of an orientation calculation to a display. *See e.g.*, Nasiri at 30:30-32 (“This orientation can be mapped directly or with constraints to a virtual world shown in the display of the device.”); *Motion-sensing comes to mobile phones; The technology made popular by Nintendo's Wii game controller is adding new utility--and excitement--to the cell phone. Photos: Motion-sensing phones*, p. 1 (“Responding to a flick of the wrist or sweep of the arm, tiny sensors called accelerometers, which measure linear acceleration in the Wiimote game controller, translate motion into action on the screen.”); *Apple Apps Could Be Killer App to Some CE; iPhone's potential may extend far beyond expectations, say analysts*. TWICE. July 21, 2008, p. 1 (“If you tilt the iPhone forward, for example, a racing car can go faster, or if you tilt it backward, the car will go slower, he explained”); 12/3/2018 LaViola Expert Report, *CyWee v. Samsung*, para. 14. (“Further, a POSITA would have been able to utilize the information provided by the API or SDK to determine how to apply changes in orientation (such as rotation) to a movement pattern, graphical element, cursor, pointer, textual representation or any other representation of orientation that could be presented on the display

screen.”); Lin ¶¶ [0244]-[0246] (the system includes “a transformation module 331, for transforming the input relative velocity data expressed in the body frame to the relative velocity expressed in the navigation frame”); Zhang at [0030] (“The difference angles calculated are translated into screen coordinates and the target device is instructed to move the pointer to the new location.”); Liberty at 7:15-18 (“[R]emote devices which operate as 3D pointers are of particular interest for the present specification. Such devices enable the translation of movement, e.g., gestures, into commands to a user interface.”).

Similarly, each of the Bassompierre, Kotani, Abbate, Horton, Sabatelli, Nasiri, Masaru, Lin, Joseph, Vaganay, Kim, Hol, and Rotenberg describes systems and methods of using quaternions to estimate orientation. See e.g., Bassompierre at 20:10-11 (“A first variant embodiment consists in replacing the angles of torsion θ and ψ by a quaternion formulation of the same torsion.”); Kotani ¶ [0034] (“The three dimensional orientation angle measurement and estimation method of the present method example uses a quaternion expression (also called a quaternion) ”); Abbate at 255 (“The EKF is based on quaternion to determinate limbs orientation starting from the information taken from the sensors.”); Horton at 9:37-38 (“FIG. 7 illustrates a method of updating and normalizing a quaternion that is obtained from the sensor outputs.”); Sabatelli at Abstract (“Quaternions were used to represent the angular position and an Extended Kalman filter was used for the sensor fusion algorithm.”); Nasiri at 30:27-30 (“provide a ... quaternion ... representation of the devices orientation in space”); Masaru ¶ [0010] (“The posture of the object relative to the ground can be expressed using parameters such as Euler angle or Quaternion as described above.”); Lin ¶ [0364] (“The quaternion representation is often used in the attitude computation because of its conciseness and efficiency.”); Joseph at 2:34-35 (“In some embodiments, the attitude of the device is represented using a quaternion.”); Vaganay at 279 (“We chose to use quaternions mainly

because they never lead to singularities.”); Kim at 270 (“The state vector consists of the quaternion associated with the orientation, $qt \dots$ ”); Hol at 9 (“The reason for using unit quaternions is that they offer a nonsingular parameterization with a rather simple dynamics.”); Rotenberg at 109 (“A different way to describe orientations is by means of quaternions.”).

As such, each of CHR-6dm, Bassompierre, Kotani, Abbate, Horton, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and Rotenberg occupies the same technological space and is directed to the same concepts and problems. This would have led one of skill in the art at the time of the purported invention of the ’846 Patent and the ’687 Patent to consult each reference and combine their teachings to provide the most efficient and capable system for tracking the real-time orientation of a device using sensor devices.

Because CHR-6dm, Bassompierre, Kotani, Abbate, Horton, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and Rotenberg disclose similar steps and components that are highly compatible with each other, it would be natural for one of skill to contemplate adding to, or substituting the CHR-6dm’s method and system of calculating orientation via combining sensor readings with the methods and components of calculating orientation via sensor readings in Bassompierre, Kotani, Abbate, Horton, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and/or Rotenberg—in order to provide additional functionality, to improve upon the same basic techniques taught in each reference, and/or to solve similar issues recited in each.

In addition, there is no essential feature in any of the references that conflicts with an essential feature of any other. Thus, one of ordinary skill in the art would have naturally been motivated to combine the teachings found within these references.

Accordingly, combining the teachings of CHR-6dm with one or more of Bassompierre, Kotani, Abbate, Horton, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and/or Rotenberg is merely: (a) a combination of prior art elements according to known methods to yield predictable results; (b) a simple substitution of one known element for another to obtain predictable results; (c) a use of known technique to improve similar devices in the same way; (d) application of a known technique to a known device ready for improvement to yield predictable results; (e) obvious to try; and/or (f) known work in one field of endeavor prompting variations of it for use in either the same field or a different one based on design incentives or other market forces since the variations are predictable to one of ordinary skill in the art.

- e. **Claims 1, 3, 7, and 9 of the '846 Patent and Claims 1, 2, 3, 4, 5, 6, 7, 12, 14, and 25 of the '687 Patent are obvious in view of U.S. Patent 7,418,364 by Horton *et al.* ("Horton") in combination with one or more of PCT Publication No. 2009/156499 to Bassompierre ("Bassompierre"), Japanese Patent Publication H09-5104 to Kotani *et al.* ("Kotani"), "Development of a MEMS based wearable motion capture system" to Abbate *et al.* ("Abbate"), CH Robotics CHR-6dm and 6d ("CHR-6dm"), "A sensor fusion algorithm for an integrated angular position estimation with inertial measurement units" by Sabatelli *et al.* ("Sabatelli"), U.S. Patent 7,158,118 to Nasiri ("Nasiri"), Japanese Patent No. 2006/038650 to Masaru ("Masaru"), State of the Art including Admitted Prior Art ("State"), U.S. Patent Publication 2006/0287824 to Lin ("Lin"), U.S. Patent Publication 2004/0095317 to Zhang *et al.* ("Zhang"), U.S. Patent 7,158,118 to Liberty ("Liberty"), U.S. Patent 8,515,707 to Joseph *et al.* ("Joseph"), "Mobile Robot Attitude Estimation by Fusion of Inertial Data" by Vaganay *et al.* ("Vaganay"), "A Quaternion-Based Orientation Estimation Algorithm Using an Inertial Measurement Unit" by Kim *et al.* ("Kim"), "Robust real-time tracking by fusing measurements from inertial and vision sensors" by Hol *et al.* ("Hol"), and "Inertial and Magnetic Sensing of Human Motion" by Rotenberg ("Rotenburg")**

A person of ordinary skill in the art, at the time of the inventions of Claims 1, 3, 7, and 9 of the '846 Patent and Claims 1, 2, 3, 4, 5, 6, 7, 12, 14, and 25 of the '687 Patent, would have been

motivated to combine the teachings of the Horton with one or more of Bassompierre, Kotani, Abbate, CHR-6dBm, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and/or Rotenberg.

Each of Horton, Bassompierre, Kotani, Abbate, CHR-6dBm, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and Rotenberg describes systems and methods of tracking the real-time orientation of a device using a combination of sensor devices. *See e.g.*, Horton at Abstract (“A method and system senses the attitude of an accelerating object by measuring acceleration with accelerometers in three orthogonal axes and measuring angular rate with angular rate sensors disposed about each such axis to compute attitude of the object accurately relative to a vertical axis.”); Bassompierre at Abstract (“This result is achieved by global resolution of the angles of torsion by virtue of the combining of the measurements of the first and second sensors either within an extended Kalman filter or by applying an optimization criterion.”); Kotani ¶ [0026] (“With the present invention, even if an error occurs in the measurement value of the angular velocity sensor due to noise or drift, a gravitational acceleration vector indicating the direction of gravity is obtained from the acceleration sensor, and orientation information is corrected using the gravitational acceleration vector as an absolute reference.”); Abbate at 255 (“Each of these modules is provided by miniature MEMS 3-axes accelerometer, three MEMS gyroscopes, a MEMS 3-axes magnetometer, and a MCU for collecting measurements from the sensors and compute the orientation through a customized Extended Kalman Filter (EKF) for sensor fusion.”); CHR-6dBm Datasheet at 1 (“An Extended Kalman Filter (EKF) combines data from onboard accelerometers, rate gyros, and magnetic sensors to produce yaw, pitch, and roll angle estimates.”); Sabatelli at Abstract (“This work presents an orientation tracking system for 6D inertial measurements units [including] a 3D gyro and a 3D accelerometer”); Nasiri at 30:27-

30 (“In one embodiment, the gyroscopes and accelerometers can be combined in a sensor fusion algorithm in order to provide a rotation matrix, quaternion, or Euler angle representation of the devices orientation in space.”); *id.* at 9:62-64 (“MPU 20 includes motion sensors, including one or more rotational motion sensors (gyroscopes) 26 and one or more linear motion sensors (accelerometers) 28.”); Masaru ¶ [0001] (“The present invention relates to a method for measuring an orientation with respect to the ground surface by measuring acceleration and angular velocity, an orientation measuring device, an orientation meter for measuring an orientation including true north, and a computer program.”); *Samsung Introduced the World’s First ‘3-dimensional Movement Recognition’ Phone*, January 12, 2005, p. 1 (“Samsung Electronics unveiled the world’s first ‘3D movement recognition’ mobile phone SCH-S310. ‘Accelerometer’ is built in to accurately calculate and ascertain movement in three dimensional space and then carry out commands according to those calculations.”); *Apple Apps Could Be Killer App to Some CE; iPhone’s potential may extend far beyond expectations, say analysts*. TWICE. July 21, 2008, p. 1 (“The iPhone 3G will be a game changer in consumer electronics, analysts explained, because it brings a large touchscreen display, accelerometer and fast Internet access to whatever applications are loaded on it.”); Lin ¶ [0017] (“A unique sophisticated Kalman filter [that] removes the inherent drift of the free inertial positioning solution derived from the output of the low cost coremicro IMU by means of fusing information from the coremicro IMU, magnetic heading sensor, and velocity producer.”); Zhang ¶ [0008] (“The remote handheld device includes a set of orientation sensors that detect the device’s current orientation.”); Liberty at 7:57-60 (“According to one exemplary embodiment of the present invention, two rotational sensors 502 and 504 and one accelerometer 506 can be employed as sensors in 3D pointing device 400 as shown in FIG. 4. “); Joseph at Abstract (“An attitude of the device is determined using the Kalman filter based at least in part on the Kalman

gain, the first accelerometer measurement, the second accelerometer measurement, and a magnetic field measurement received from a multi-dimensional magnetometer of the device.”); Vaganay at Abstract (“This paper describes an attitude estimation system based on inertial measurements for a mobile robot. Five low- cost inertial sensors are used: two accelerometers and three gyros”); Kim at abstract (“This paper presents a real-time orientation estimation algorithm based on signals from a low-cost inertial measurement unit (IMU). The IMU consists of three MEMS accelerometers and three MEMS rate gyros.”); Hol at Abstract (“The problem of estimating and predicting position and orientation (pose) of a camera is approached by fusing measurements from inertial sensors (accelerometers and rate gyroscopes) and vision.”); Rotenberg at 16 (“In Chapter 2, a method is introduced for estimating body segment orientation combining the sensor signals of miniature 3D gyroscopes, accelerometers and magnetometers in a complementary Kalman filter.”).

More specifically, each of Horton, Bassompierre, Kotani, Abbate, CHR-6dBm, Sabatelli, Masaru, Lin, Joseph, Vaganay, Kim, Hol, and Rotenberg describes systems and methods of combining the sensor readings to calculate the orientation—including through a predictive step. Horton at 13:61-63 (“The state model predicts where the attitude errors and rate sensor bias states will propagate based on input data from the rate sensors”); Bassompierre at 24:4-7 (“The measurement models are generally taken into account in the error criterion which globally measures the distance between the real measurement at the instant t and the measurement predicted by the model knowing the estimation of the state at the instant $t-1$.”); Kotani ¶ [0056] (“At the next time point $t+1$, the integral of the angular velocity from time t to $t+1$ is added to $\dot{q}(t)^+$ to obtain $\dot{q}(t+1)$ ”); Abbate at 258 (“The estimation step of the EKF, performed at 50Hz, uses the angular rate velocities to make a prediction of the state, as shown in Fig. 6.”); CHR-6dBm Datasheet at 8

(“The CHR-6dm uses a continuous-discrete implementation of the EKF, where rate gyro measurements are used to drive the prediction step.”); Sabatelli at 2 (“From the estimated angular position it is possible to estimate the gravity vector $[\hat{g}]$ ”); Masaru ¶ [0066] (“The CPU11 repeats the processes of steps S4 to S7 in which the estimation value of the state variable and the error covarianc[e] of the state variable is calculated based on the measured values of the angular velocity and the acceleration until the error of the state variable x becomes sufficiently small”; Lin ¶¶ [0248]-[0252] (“the Kalman filter module 35 further comprises: ... a state estimation module 353, for filtering the measurements and obtaining the optimal estimates of the IMU positioning errors”); Joseph at col. 12:58-59 (“The Kalman filter generally includes two phases: a “predict” phase and an “update” phase.”); Vaganay at 277 (“We thus propose a multisensor fusion method which consists of correlating these angle estimations with those resulting from the integration of the angular velocities measured by three orthogonal gyrometers.”); Kim at 270 (shows that the acceleration due to gravity can be predicted using the quaternion); Hol at 13 (“Valid models and parameters are imperative to obtain good estimates. The innovations, defined as the difference between a measurement and its expected value ... can be used to assess whether the models are correctly tuned.”); Rotenberg at 22 (“The four parts of the complementary filter are: the a priori model prediction of the state, the error model, the Kalman filter, and the state correction yielding the a posteriori state estimate (see Figure 2.2).”).

Nasiri, State, Lin, Zhang, Liberty, and Joseph also disclose transforming the results of an orientation calculation to a display. *See e.g.*, Nasiri at 30:30-32 (“This orientation can be mapped directly or with constraints to a virtual world shown in the display of the device.”); *Motion-sensing comes to mobile phones; The technology made popular by Nintendo's Wii game controller is adding new utility--and excitement--to the cell phone. Photos: Motion-sensing phones*, p. 1

(“Responding to a flick of the wrist or sweep of the arm, tiny sensors called accelerometers, which measure linear acceleration in the Wiimote game controller, translate motion into action on the screen.”); *Apple Apps Could Be Killer App to Some CE; iPhone's potential may extend far beyond expectations, say analysts*. TWICE. July 21, 2008, p. 1 (“If you tilt the iPhone forward, for example, a racing car can go faster, or if you tilt it backward, the car will go slower, he explained”); 12/3/2018 LaViola Expert Report, *CyWee v. Samsung*, para. 14. (“Further, a POSITA would have been able to utilize the information provided by the API or SDK to determine how to apply changes in orientation (such as rotation) to a movement pattern, graphical element, cursor, pointer, textual representation or any other representation of orientation that could be presented on the display screen.”); Lin ¶¶ [0244]-[0246] (the system includes “a transformation module 331, for transforming the input relative velocity data expressed in the body frame to the relative velocity expressed in the navigation frame”); Zhang at [0030] (“The difference angles calculated are translated into screen coordinates and the target device is instructed to move the pointer to the new location.”); Liberty at 7:15-18 (“[R]emote devices which operate as 3D pointers are of particular interest for the present specification. Such devices enable the translation of movement, e.g., gestures, into commands to a user interface.”).

Similarly, each of the Bassompierre, Kotani, Abbate, CHR-6dBm, Sabatelli, Nasiri, Masaru, Lin, Joseph, Vaganay, Kim, Hol, and Rotenberg describes systems and methods of using quaternions to estimate orientation. *See e.g.*, Bassompierre at 20:10-11 (“A first variant embodiment consists in replacing the angles of torsion θ and ψ by a quaternion formulation of the same torsion.”); Kotani ¶ [0034] (“The three dimensional orientation angle measurement and estimation method of the present method example uses a quaternion expression (also called a quaternion) “); Abbate at 255 (“The EKF is based on quaternion to determinate limbs orientation

starting from the information taken from the sensors.”); CHR-6dBm Datasheet at 9 (“To fix this problem, a quaternion representation must be used instead of Euler Angles.”); Sabatelli at Abstract (“Quaternions were used to represent the angular position and an Extended Kalman filter was used for the sensor fusion algorithm.”); Nasiri at 30:27-30 (“provide a ... quaternion ... representation of the devices orientation in space”); Masaru ¶ [0010] (“The posture of the object relative to the ground can be expressed using parameters such as Euler angle or Quaternion as described above.”); Lin ¶ [0364] (“The quaternion representation is often used in the attitude computation because of its conciseness and efficiency.”); Joseph at 2:34-35 (“In some embodiments, the attitude of the device is represented using a quaternion.”); Vaganay at 279 (“We chose to use quaternions mainly because they never lead to singularities.”); Kim at 270 (“The state vector consists of the quaternion associated with the orientation, qt ...”); Hol at 9 (“The reason for using unit quaternions is that they offer a nonsingular parameterization with a rather simple dynamics.”); Rotenberg at 109 (“A different way to describe orientations is by means of quaternions.”).

As such, each of Horton, Bassompierre, Kotani, Abbate, CHR-6dBm, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and Rotenberg occupies the same technological space and is directed to the same concepts and problems. This would have led one of skill in the art at the time of the purported invention of the '846 Patent and the '687 Patent to consult each reference and combine their teachings to provide the most efficient and capable system for tracking the real-time orientation of a device using sensor devices.

Because Horton, Bassompierre, Kotani, Abbate, CHR-6dBm, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and Rotenberg disclose similar steps and components that are highly compatible with each other, it would be natural for one of skill to contemplate adding to, or substituting the Horton's method and system of calculating orientation

via combining sensor readings with the methods and components of calculating orientation via sensor readings in Bassompierre, Kotani, Abbate, CHR-6dBm, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and/or Rotenberg—in order to provide additional functionality, to improve upon the same basic techniques taught in each reference, and/or to solve similar issues recited in each.

In addition, there is no essential feature in any of the references that conflicts with an essential feature of any other. Thus, one of ordinary skill in the art would have naturally been motivated to combine the teachings found within these references.

Accordingly, combining the teachings of Horton with one or more of Bassompierre, Kotani, Abbate, CHR-6dBm, Sabatelli, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and/or Rotenberg is merely: (a) a combination of prior art elements according to known methods to yield predictable results; (b) a simple substitution of one known element for another to obtain predictable results; (c) a use of known technique to improve similar devices in the same way; (d) application of a known technique to a known device ready for improvement to yield predictable results; (e) obvious to try; and/or (f) known work in one field of endeavor prompting variations of it for use in either the same field or a different one based on design incentives or other market forces since the variations are predictable to one of ordinary skill in the art.

- f. **Claims 1, 3, 7, and 9 of the '846 Patent and Claims 1, 2, 3, 4, 5, 6, 7, 12, 14, and 25 of the '687 Patent are obvious in view of “A sensor fusion algorithm for an integrated angular position estimation with inertial measurement units” by Sabatelli *et al.* (“Sabatelli”) in combination with one or more of PCT Publication No. 2009/156499 to Bassompierre (“Bassompierre”), Japanese Patent Publication H09-5104 to Kotani *et al.* (“Kotani”), “Development of a MEMS based wearable motion capture system” to Abbate *et al.* (“Abbate”), CH Robotics CHR-6dm and 6d (“CHR-6dm”), U.S. Patent 7,418,364 by Horton *et al.* (“Horton”), “A sensor fusion algorithm for an integrated angular position estimation with inertial**

measurement units” by Sabatelli *et al.* (“Sabatelli”), U.S. Patent 7,158,118 to Nasiri (“Nasiri”), Japanese Patent No. 2006/038650 to Masaru (“Masaru”), State of the Art including Admitted Prior Art (“State”), U.S. Patent Publication 2006/0287824 to Lin (“Lin”), U.S. Patent Publication 2004/0095317 to Zhang *et al.* (“Zhang”), U.S. Patent 7,158,118 to Liberty (“Liberty”), U.S. Patent 8,515,707 to Joseph *et al.* (“Joseph”), “Mobile Robot Attitude Estimation by Fusion of Inertial Data” by Vaganay *et al.* (“Vaganay”), “A Quaternion-Based Orientation Estimation Algorithm Using an Inertial Measurement Unit” by Kim *et al.* (“Kim”), “Robust real-time tracking by fusing measurements from inertial and vision sensors” by Hol *et al.* (“Hol”), and “Inertial and Magnetic Sensing of Human Motion” by Rotenberg (“Rotenburg”)

A person of ordinary skill in the art, at the time of the inventions of Claims 1, 3, 7, and 9 of the '846 Patent and Claims 1, 2, 3, 4, 5, 6, 7, 12, 14, and 25 of the '687 Patent, would have been motivated to combine the teachings of the Sabatelli with one or more of Bassompierre, Kotani, Abbate, CHR-6dBm, Horton, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and/or Rotenberg.

Each of Sabatelli, Bassompierre, Kotani, Abbate, CHR-6dBm, Horton, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and Rotenberg describes systems and methods of tracking the real-time orientation of a device using a combination of sensor devices. *See e.g.*, Sabatelli at Abstract (“This work presents an orientation tracking system for 6D inertial measurements units [including] a 3D gyro and a 3D accelerometer”); Bassompierre at Abstract (“This result is achieved by global resolution of the angles of torsion by virtue of the combining of the measurements of the first and second sensors either within an extended Kalman filter or by applying an optimization criterion.”); Kotani ¶ [0026] (“With the present invention, even if an error occurs in the measurement value of the angular velocity sensor due to noise or drift, a gravitational acceleration vector indicating the direction of gravity is obtained from the acceleration sensor, and orientation information is corrected using the gravitational acceleration

vector as an absolute reference.”); Abbate at 255 (“Each of these modules is provided by miniature MEMS 3-axes accelerometer, three MEMS gyroscopes, a MEMS 3-axes magnetometer, and a MCU for collecting measurements from the sensors and compute the orientation through a customized Extended Kalman Filter (EKF) for sensor fusion.”); CHR-6dBm Datasheet at 1 (“An Extended Kalman Filter (EKF) combines data from onboard accelerometers, rate gyros, and magnetic sensors to produce yaw, pitch, and roll angle estimates.”); Horton at Abstract (“A method and system senses the attitude of an accelerating object by measuring acceleration with accelerometers in three orthogonal axes and measuring angular rate with angular rate sensors disposed about each such axis to compute attitude of the object accurately relative to a vertical axis.”); Nasiri at 30:27-30 (“In one embodiment, the gyroscopes and accelerometers can be combined in a sensor fusion algorithm in order to provide a rotation matrix, quaternion, or Euler angle representation of the devices orientation in space.”); *id.* at 9:62-64 (“MPU 20 includes motion sensors, including one or more rotational motion sensors (gyroscopes) 26 and one or more linear motion sensors (accelerometers) 28.”); Masaru ¶ [0001] (“The present invention relates to a method for measuring an orientation with respect to the ground surface by measuring acceleration and angular velocity, an orientation measuring device, an orientation meter for measuring an orientation including true north, and a computer program.”); *Samsung Introduced the World’s First ‘3-dimensional Movement Recognition’ Phone*, January 12, 2005, p. 1 (“Samsung Electronics unveiled the world’s first ‘3D movement recognition’ mobile phone SCH-S310. ‘Accelerometer’ is built in to accurately calculate and ascertain movement in three dimensional space and then carry out commands according to those calculations.”); *Apple Apps Could Be Killer App to Some CE; iPhone’s potential may extend far beyond expectations, say analysts*. TWICE. July 21, 2008, p. 1 (“The *iPhone* 3G will be a game changer in consumer electronics, analysts explained, because it

brings a large touchscreen display, accelerometer and fast Internet access to whatever applications are loaded on it.”); Lin ¶ [0017] (“A unique sophisticated Kalman filter [that] removes the inherent drift of the free inertial positioning solution derived from the output of the low cost coremicro IMU by means of fusing information from the coremicro IMU, magnetic heading sensor, and velocity producer.”); Zhang ¶ [0008] (“The remote handheld device includes a set of orientation sensors that detect the device's current orientation.”); Liberty at 7:57-60 (“According to one exemplary embodiment of the present invention, two rotational sensors 502 and 504 and one accelerometer 506 can be employed as sensors in 3D pointing device 400 as shown in FIG. 4. “); Joseph at Abstract (“An attitude of the device is determined using the Kalman filter based at least in part on the Kalman gain, the first accelerometer measurement, the second accelerometer measurement, and a magnetic field measurement received from a multi-dimensional magnetometer of the device.”); Vaganay at Abstract (“This paper describes an attitude estimation system based on inertial measurements for a mobile robot. Five low- cost inertial sensors are used: two accelerometers and three gyros”); Kim at abstract (“This paper presents a real-time orientation estimation algorithm based on signals from a low-cost inertial measurement unit (IMU). The IMU consists of three MEMS accelerometers and three MEMS rate gyros.”); Hol at Abstract (“The problem of estimating and predicting position and orientation (pose) of a camera is approached by fusing measurements from inertial sensors (accelerometers and rate gyroscopes) and vision.”); Rotenberg at 16 (“In Chapter 2, a method is introduced for estimating body segment orientation combining the sensor signals of miniature 3D gyroscopes, accelerometers and magnetometers in a complementary Kalman filter.”).

More specifically, each of Sabatelli, Bassompierre, Kotani, Abbate, CHR-6dBm, Horton, Masaru, Lin, Joseph, Vaganay, Kim, Hol, and Rotenberg describes systems and methods of

combining the sensor readings to calculate the orientation—including through a predictive step. Sabatelli at 2 (“From the estimated angular position it is possible to estimate the gravity vector [$\hat{g}$ hat]”); Bassompierre at 24:4-7 (“The measurement models are generally taken into account in the error criterion which globally measures the distance between the real measurement at the instant t and the measurement predicted by the model knowing the estimation of the state at the instant $t-1$.”); Kotani ¶ [0056] (“At the next time point $t+1$, the integral of the angular velocity from time t to $t+1$ is added to $\dot{q}(t)^+$ to obtain $\dot{q}(t+1)^-$ ”); Abbate at 258 (“The estimation step of the EKF, performed at 50Hz, uses the angular rate velocities to make a prediction of the state, as shown in Fig. 6.”); CHR-6dBm Datasheet at 8 (“The CHR-6dm uses a continuous-discrete implementation of the EKF, where rate gyro measurements are used to drive the prediction step.”); Horton at 13:61-63 (“The state model predicts where the attitude errors and rate sensor bias states will propagate based on input data from the rate sensors”); Masaru ¶ [0066] (“The CPU11 repeats the processes of steps S4 to S7 in which the estimation value of the state variable and the error covarianc[e] of the state variable is calculated based on the measured values of the angular velocity and the acceleration until the error of the state variable x becomes sufficiently small”; Lin ¶¶ [0248]-[0252] (“the Kalman filter module 35 further comprises: ... a state estimation module 353, for filtering the measurements and obtaining the optimal estimates of the IMU positioning errors”); Joseph at col. 12:58-59 (“The Kalman filter generally includes two phases: a “predict” phase and an “update” phase.”); Vaganay at 277 (“We thus propose a multisensor fusion method which consists of correlating these angle estimations with those resulting from the integration of the angular velocities measured by three orthogonal gyrometers.”); Kim at 270 (shows that the acceleration due to gravity can be predicted using the quaternion); Hol at 13 (“Valid models and parameters are imperative to obtain good estimates. The innovations, defined as the difference between a

measurement and its expected value ... can be used to assess whether the models are correctly tuned.”); Rotenberg at 22 (“The four parts of the complementary filter are: the a priori model prediction of the state, the error model, the Kalman filter, and the state correction yielding the a posteriori state estimate (see Figure 2.2).”).

Nasiri, State, Lin, Zhang, Liberty, and Joseph also disclose transforming the results of an orientation calculation to a display. *See e.g.*, Nasiri at 30:30-32 (“This orientation can be mapped directly or with constraints to a virtual world shown in the display of the device.”); *Motion-sensing comes to mobile phones; The technology made popular by Nintendo's Wii game controller is adding new utility--and excitement--to the cell phone. Photos: Motion-sensing phones*, p. 1 (“Responding to a flick of the wrist or sweep of the arm, tiny sensors called accelerometers, which measure linear acceleration in the Wiimote game controller, translate motion into action on the screen.”); *Apple Apps Could Be Killer App to Some CE; iPhone's potential may extend far beyond expectations, say analysts*. TWICE. July 21, 2008, p. 1 (“If you tilt the iPhone forward, for example, a racing car can go faster, or if you tilt it backward, the car will go slower, he explained”); 12/3/2018 LaViola Expert Report, *CyWee v. Samsung*, para. 14. (“Further, a POSITA would have been able to utilize the information provided by the API or SDK to determine how to apply changes in orientation (such as rotation) to a movement pattern, graphical element, cursor, pointer, textual representation or any other representation of orientation that could be presented on the display screen.”); Lin ¶¶ [0244]-[0246] (the system includes “a transformation module 331, for transforming the input relative velocity data expressed in the body frame to the relative velocity expressed in the navigation frame”); Zhang at [0030] (“The difference angles calculated are translated into screen coordinates and the target device is instructed to move the pointer to the new location.”); Liberty at 7:15-18 (“[R]emote devices which operate as 3D pointers are of particular

interest for the present specification. Such devices enable the translation of movement, e.g., gestures, into commands to a user interface.”).

Similarly, each of the Bassompierre, Kotani, Abbate, CHR-6dBm, Horton, Nasiri, Masaru, Lin, Joseph, Vaganay, Kim, Hol, and Rotenberg describes systems and methods of using quaternions to estimate orientation. *See e.g.*, Bassompierre at 20:10-11 (“A first variant embodiment consists in replacing the angles of torsion θ and ψ by a quaternion formulation of the same torsion.”); Kotani ¶ [0034] (“The three dimensional orientation angle measurement and estimation method of the present method example uses a quaternion expression (also called a quaternion) “); Abbate at 255 (“The EKF is based on quaternion to determinate limbs orientation starting from the information taken from the sensors.”); CHR-6dBm Datasheet at 9 (“To fix this problem, a quaternion representation must be used instead of Euler Angles..”); Horton at 9:37-38 (“FIG. 7 illustrates a method of updating and normalizing a quaternion that is obtained from the sensor outputs.”); Nasiri at 30:27-30 (“provide a ... quaternion ... representation of the devices orientation in space”); Masaru ¶ [0010] (“The posture of the object relative to the ground can be expressed using parameters such as Euler angle or Quaternion as described above.”); Lin ¶ [0364] (“The quaternion representation is often used in the attitude computation because of its conciseness and efficiency.”); Joseph at 2:34-35 (“In some embodiments, the attitude of the device is represented using a quaternion.”); Vaganay at 279 (“We chose to use quaternions mainly because they never lead to singularities.”); Kim at 270 (“The state vector consists of the quaternion associated with the orientation, qt ...”); Hol at 9 (“The reason for using unit quaternions is that they offer a nonsingular parameterization with a rather simple dynamics.”); Rotenberg at 109 (“A different way to describe orientations is by means of quaternions.”).

As such, each of Sabatelli, Bassompierre, Kotani, Abbate, CHR-6dBm, Horton, Nasiri, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and Rotenberg occupies the same technological space and is directed to the same concepts and problems. This would have led one of skill in the art at the time of the purported invention of the '846 Patent and the '687 Patent to consult each reference and combine their teachings to provide the most efficient and capable system for tracking the real-time orientation of a device using sensor devices.

Because Sabatelli, Bassompierre, Kotani, Abbate, CHR-6dBm, Horton, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and Rotenberg disclose similar steps and components that are highly compatible with each other, it would be natural for one of skill to contemplate adding to, or substituting the Sabatelli's method and system of calculating orientation via combining sensor readings with the methods and components of calculating orientation via sensor readings in Bassompierre, Kotani, Abbate, CHR-6dBm, Horton, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and/or Rotenberg—in order to provide additional functionality, to improve upon the same basic techniques taught in each reference, and/or to solve similar issues recited in each.

In addition, there is no essential feature in any of the references that conflicts with an essential feature of any other. Thus, one of ordinary skill in the art would have naturally been motivated to combine the teachings found within these references.

Accordingly, combining the teachings of Sabatelli with one or more of Bassompierre, Kotani, Abbate, CHR-6dBm, Horton, Nasiri, Masaru, State, Lin, Zhang, Liberty, Joseph, Vaganay, Kim, Hol, and/or Rotenberg is merely: (a) a combination of prior art elements according to known methods to yield predictable results; (b) a simple substitution of one known element for another to obtain predictable results; (c) a use of known technique to improve similar devices in the same

way; (d) application of a known technique to a known device ready for improvement to yield predictable results; (e) obvious to try; and/or (f) known work in one field of endeavor prompting variations of it for use in either the same field or a different one based on design incentives or other market forces since the variations are predictable to one of ordinary skill in the art.

V. LOCAL PATENT RULE 3-3(D)

Any grounds of invalidity based on indefiniteness under 35 U.S.C. § 112(2) or enablement or written description under 35 U.S.C. § 112(1) of any of the asserted claims.

P.R. 3-3(d).

In addition to and including the grounds of invalidity set forth in the Invalidity Contentions incorporated by reference herein, Defendants contend that the asserted claims of the Asserted Patents are invalid under 35 U.S.C. § 112, paragraphs one and/or two for at least the following reasons.

A. Indefiniteness under 35 U.S.C. § 112(2)

The asserted claims of the Asserted Patents are invalid because they fail to meet the “definiteness” requirement of 35 U.S.C. § 112, ¶ 2, which states that the claims must “particularly point[] out and distinctly claim[] the subject matter which the inventor [] regards as [the] invention.” In particular, the asserted claims of the Asserted Patents are indefinite because of at least the following terms or phrases:

1. '846 Patent

Claim	Term
Asserted claims 1 and 7	“predicted”
Asserted claims 1 and 7	“axial acceleration”
Asserted claims 1 and 7	“spatial reference frame”
Asserted claim 1 and 7	“resulting deviations comprising resultant angles”

Claim	Term
Asserted claims 1 and 7	“based on”
Asserted claims 1 and 7	“real-time movement pattern”
Asserted claims 1 and 7	“comparing the predicted axial accelerations , which are based on the measured axial accelerations corresponding to time T - 1 and the measured angular velocities corresponding to time T , with the measured axial accelerations corresponding to time T to”
Asserted claim 1	“translate the resultant angles of the resulting deviation the spatial reference frame into a real - time movement pattern in the display reference frame.”
Asserted claim 3	“utilize a first data association model to determine whether compensation is needed to obtain the updated quaternion based on the measured axial accelerations corresponding to time T”
Asserted claim 7	“translating the resultant angles of the resulting deviation in the spatial reference frame into a real-time movement pattern in a display reference frame associated with a display device.”
Asserted claim 9	“utilizing a first data association model to determine whether compensation is needed to obtain the updated quaternion based on the measured axial accelerations corresponding to time T”

2. '687 Patent

Claim	Term
Asserted claims 1 and 14	“predicted”
Asserted claims 1 and 14	“axial accelerations”
Asserted claims 1 and 14	“spatial reference frame”
Asserted claims 1 and 14	“resulting deviations”

Claim	Term
Asserted claims 1, 4, 5, 14, and 25	“based on”
Asserted claims 1 and 14	“which is associated with the pitch and roll angles of the electronic device and without being associated with the yaw angle of the electronic device;”
Asserted claim 5	“the first comparison result is based on the measured axial accelerations corresponding to time T-1, measured axial accelerations corresponding to time T, and angular velocities corresponding to time T.”
Asserted claim 7	“real-time movement pattern”
Asserted claim 7	“translate the resulting deviation in the spatial reference frame into a real-time movement pattern”

To the extent other asserted claims contain one of these terms or phrases, either directly or through being a dependent claim of a claim that does, those asserted claims of the Asserted Patents are invalid under 35 U.S.C. § 112, ¶ 2.

The claims are indefinite because they fail to inform, with reasonable certainty, those skilled in the art about the scope of the invention.

B. Lack of Enablement under 35 U.S.C. §112(1)

The asserted claims of the Asserted Patents are invalid because they fail to meet the “enablement” requirement of 35 U.S.C. § 112, ¶ 1, because the Asserted Patents does not disclose sufficient information to enable or teach one skilled in the field of the invention to make and use the full scope of the claimed invention without undue experimentation for at least the following terms or phrases:

1. '846 Patent

Claim	Term
Asserted claim 1	“calculate a resulting deviation comprising resultant angles associated with the movements and the rotations of the electronic device in the spatial reference frame”
Asserted claims 1, 7	“converting the measured angular velocities ... without using the measured axial accelerations corresponding to time T”
Asserted claims 1, 7	“Comparing the predicted axial accelerations , which are based on the measured axial accelerations corresponding to time T - 1 and the measured angular velocities corresponding to time T , with the measured axial accelerations corresponding to time T to obtain a first comparison result”
Asserted claim 1	“translate the resultant angles of the resulting deviation in the spatial reference frame into a real-time movement pattern in the display reference frame”
Asserted claim 3	“utilize a first data association model to determine whether compensation is needed to obtain the updated quaternion based on the measured axial accelerations corresponding to time T”
Asserted claim 7	“calculating, with a computing processor having processor circuitry, a resulting deviation comprising resultant angles associated with the movements and the rotations in a spatial reference”

Claim	Term
Asserted claim 7	“translating the resultant angles of the resulting deviation in the spatial reference frame into a real-time movement pattern in a display reference frame associated with a display device”
Asserted claim 9	“utilizing a first data association model to determine whether compensation is needed to obtain the updated quaternion based on the measured axial accelerations corresponding to time T”

2. '687 Patent

Claim	Term
Asserted Claim 1	“a computing processor having processor circuitry configure to calculate a resulting deviation associated with the movements and the rotations of the electronic device in the spatial reference frame by performing the following in sequence:”
Asserted Claim 1	“wherein the processor circuitry is further configured to provide content based on the resulting deviation in the spatial reference frame”
Asserted Claims 1, 14	“providing a previous quaternion corresponding to time T-1 ... without using the measured angular velocities corresponding to time T”
Asserted Claims 1, 14	“converting measured angular velocities corresponding to time T ... without using measured axial accelerations corresponding to time T;”

Claim	Term
Asserted Claims 1, 14	“converting variables of the current quaternion into predicted axial accelerations corresponding to time T, which is associated with the pitch and roll angles of the electronic device and without being associated with the yaw angle of the electronic device”
Asserted Claims 1, 14	“comparing the predicted axial accelerations with the measured axial accelerations corresponding to time T to obtain a first comparison result”
Asserted Claim 1	“provide content based on the resulting deviation in the spatial reference frame”
Asserted Claim 4	“wherein the predicted axial accelerations are based on the measured axial accelerations corresponding to time T-1 and the measured angular velocities corresponding to time T.”
Asserted Claim 5	“wherein the first comparison result is based on the measured axial accelerations corresponding to time T-1, measured axial accelerations corresponding to time T, and angular velocities corresponding to time T.”
Asserted Claim 7	“the processor circuitry is further configured to translate the resulting deviation in the spatial reference frame into a real-time movement pattern in a display reference frame.”
Asserted Claim 12	“utilize a first data association model to determine whether compensation is needed to obtain the updated quaternion based on the measured axial accelerations corresponding to time T”

Claim	Term
Asserted Claim 14	“calculating, with a computing processor having processor circuitry, a resulting deviation associated with the movements and the rotations in the spatial reference frame by performing the following in sequence”
Asserted Claim 14	“providing content based on the resulting deviation in the spatial reference frame”
Asserted Claim 25	“utilizing a first data association model to determine whether compensation is needed to obtain the updated quaternion based on the measured axial accelerations corresponding to time T”

To the extent other asserted claims contain one of these terms or phrases, either directly or through being a dependent claim of a claim that does, those asserted claims of the Asserted Patents are invalid for lack of enablement under 35 U.S.C. § 112, ¶ 1.

C. Lack of Written Description under 35 U.S.C. §112(1)

The Asserted Claims of the Asserted Patents are invalid because they fail to meet the written description requirement of 35 U.S.C. § 112. *See* pre-AIA 35 U.S.C. § 112 ¶1 (“The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms”); AIA § 112(a) (same). “Specifically, the description must ‘clearly allow persons of ordinary skill in the art to recognize that [the inventor] invented what is claimed. . . . In other words, the test for sufficiency is whether the disclosure of the application relied upon reasonably conveys to those skilled in the art that the inventor had possession of the claimed subject matter as of the filing date.” *Ariad Pharm., Inc. v.*

Eli Lilly & Co., 598 F.3d 1336, 1351 (Fed. Cir. 2010) (citing *Vas-Cath Inc. v. Mahurkar*, 935 F.2d 1555, 1563 (Fed. Cir. 1991)) (internal citations omitted).

In particular, at least the following terms or phrases listed below are not sufficiently described. To the extent other Asserted Claims contain one of these terms or phrases, either directly or through being dependent on a claim that does, those Asserted Claims are also invalid under 35 U.S.C. § 112.

1. '846 Patent

Claim	Term
Asserted claim 1	“calculate a resulting deviation comprising resultant angles associated with the movements and the rotations of the electronic device in the spatial reference frame”
Asserted claims 1, 7	“converting the measured angular velocities ... without using the measured axial accelerations corresponding to time T”
Asserted claims 1, 7	“Comparing the predicted axial accelerations , which are based on the measured axial accelerations corresponding to time T - 1 and the measured angular velocities corresponding to time T , with the measured axial accelerations corresponding to time T to obtain a first comparison result”
Asserted claim 1	“translate the resultant angles of the resulting deviation in the spatial reference frame into a real-time movement pattern in the display reference frame”

Claim	Term
Asserted claim 3	“utilize a first data association model to determine whether compensation is needed to obtain the updated quaternion based on the measured axial accelerations corresponding to time T”
Asserted claim 7	“calculating, with a computing processor having processor circuitry, a resulting deviation comprising resultant angles associated with the movements and the rotations in a spatial reference”
Asserted claim 7	“translating the resultant angles of the resulting deviation in the spatial reference frame into a real-time movement pattern in a display reference frame associated with a display device”
Asserted claim 9	“utilizing a first data association model to determine whether compensation is needed to obtain the updated quaternion based on the measured axial accelerations corresponding to time T”

2. '687 Patent

Claim	Term
Asserted Claim 1	“a computing processor having processor circuitry configure to calculate a resulting deviation associated with the movements and the rotations of the electronic device in the spatial reference frame by performing the following in sequence:”
Asserted Claim 1	“wherein the processor circuitry is further configured to provide content based on the resulting deviation in the spatial reference frame”

Claim	Term
Asserted Claims 1, 14	“providing a previous quaternion corresponding to time T-1 ... without using the measured angular velocities corresponding to time T”
Asserted Claims 1, 14	“converting measured angular velocities corresponding to time T ... without using measured axial accelerations corresponding to time T;”
Asserted Claims 1, 14	“converting variables of the current quaternion into predicted axial accelerations corresponding to time T, which is associated with the pitch and roll angles of the electronic device and without being associated with the yaw angle of the electronic device”
Asserted Claims 1, 14	“comparing the predicted axial accelerations with the measured axial accelerations corresponding to time T to obtain a first comparison result”
Asserted Claim 1	“provide content based on the resulting deviation in the spatial reference frame”
Asserted Claim 4	“wherein the predicted axial accelerations are based on the measured axial accelerations corresponding to time T-1 and the measured angular velocities corresponding to time T.”
Asserted Claim 5	“wherein the first comparison result is based on the measured axial accelerations corresponding to time T-1, measured axial accelerations corresponding to time T, and angular velocities corresponding to time T.”

Claim	Term
Asserted Claim 7	“the processor circuitry is further configured to translate the resulting deviation in the spatial reference frame into a real-time movement pattern in a display reference frame.”
Asserted Claim 12	“utilize a first data association model to determine whether compensation is needed to obtain the updated quaternion based on the measured axial accelerations corresponding to time T”
Asserted Claim 14	“calculating, with a computing processor having processor circuitry, a resulting deviation associated with the movements and the rotations in the spatial reference frame by performing the following in sequence”
Asserted Claim 14	“providing content based on the resulting deviation in the spatial reference frame”
Asserted Claim 25	“utilizing a first data association model to determine whether compensation is needed to obtain the updated quaternion based on the measured axial accelerations corresponding to time T”

To the extent other asserted claims contain one of these terms or phrases, either directly or through being a dependent claim of a claim that does, those asserted claims of the Asserted Patents are invalid for lack of written description under 35 U.S.C. § 112, ¶ 1.

VI. ELIGIBILITY CONTENTIONS - LACK OF PATENT ELIGIBILITY UNDER 35 U.S.C. § 101

Defendants’ eligibility contentions are set forth below and in the attached Exhibits 30-31. Defendants incorporate by reference the discussion of the state of the art, set forth in Section II,

supra, the identification of prior art, set forth in Section III-IV, *supra*, as well as the exhibits attached hereto. Defendants intend to rely on those materials in challenging the subject-matter eligibility of the Asserted Claims, and may rely on additional information identified or learned during this case, including through discovery. These contentions are subject to revision and amendment pursuant to Federal Rule of Civil Procedure 26(e) to the extent appropriate in light of further investigation and discovery, the Court’s construction of the Asserted Claims, the positions taken during expert discovery, and/or any future prosecution history for the Asserted Claims or claims in related patents (including, but not limited to, during *inter partes* review, *ex parte* reexamination, or post-grant review of any claims).

A. Lack of Patentable Subject Matter

Defendants contend that the Asserted Claims are invalid under 35 U.S.C. § 101 (pre-AIA and AIA) because they are directed to abstract ideas and do not contain an inventive concept sufficient to transform the abstract idea into a patent-eligible invention. *See Alice Corp. Pty. Ltd. v. CLS Bank Int’l*, 134 S. Ct. 2347, 2357-58 (2014). Judicial precedent has “long held that [§ 101] contains an important implicit exception” in that “[l]aws of nature, natural phenomena, and abstract ideas are not patentable.” *Id.* at 2354 (2014).

35 U.S.C. § 101 lists four broad categories of patent-eligible subject matter but is subject to “an important implicit exception” that “[l]aws of nature, natural phenomena, and abstract ideas,” which form the “basic tools of scientific and technological work,” are not eligible for patent protection. *Alice Corp. Pty. Ltd. v. CLS Bank Int’l*, 573 U.S. 208, 216 (2014) (internal quotation marks omitted). “The ‘abstract ideas’ category embodies ‘the longstanding rule that an idea of itself is not patentable.’” *Id.* at 209 (quoting *Gottschalk v. Benson*, 409 U.S. 63, 67 (1972) (quoting *Rubber-Tip Pencil Co. v. Howard*, 87 U.S. 498 (1874))).

Alice set forth a two-step inquiry. “First, we determine whether the claims at issue are directed to one of those patent-ineligible concepts.” *Id.* at 217. In making this inquiry, the claims “must be considered as a whole.” *Alice*, 573 U.S. at 218 n.3 (quoting *Diamond v. Diehr*, 450 U.S. 175, 188 (1981)). If the claims recite an abstract idea, the second step requires a “search for an ‘inventive concept’— an element or combination of elements that is ‘sufficient to ensure that the patent in practice amounts to significantly more than a patent upon the [ineligible concept] itself.’” *Id.* at 218 (quoting *Mayo Collaborative Servs. v. Prometheus Labs., Inc.*, 566 U.S. 66, 73 (2016)). “A claim that recites an abstract idea must include ‘additional features’ to ensure ‘that the claim is more than a drafting effort designed to monopolize the abstract idea.’” *Id.* at 221 (quoting *Mayo*, 566 U.S. at 78) (alterations omitted). The recited “additional features must be more than well-understood, routine, conventional activity.” *Ultramercial, Inc. v. Hulu, LLC*, 772 F.3d 1335, 1339 (Fed. Cir. 2013) (internal quotations omitted). The Asserted Claims fail both steps of the *Alice* analytical framework and thus are patent-ineligible.

The below chart identifies each exception to eligibility to which each Asserted Claim is directed, and whether one or more of the Asserted Claims is representative of any other claim(s). Further detail regarding the factual and legal basis is presented in Exhibits 30-31.

1. '846 Patent

'846 Patent		
Asserted Claim	Exception to Eligibility	Representative of Other Claims
1	Abstract Idea	Representative of every Asserted Claim in all Asserted Patents because all Asserted Claims concern performance of the same basic process.

'846 Patent		
Asserted Claim	Exception to Eligibility	Representative of Other Claims
		In the alternative, Samsung contends that this claim is representative of the other asserted claims in this patent only.
3	Abstract Idea	
7	Abstract Idea	<p>Representative of every Asserted Claim in all Asserted Patents because all Asserted Claims concern performance of the same basic process.</p> <p>In the alternative, Samsung contends that this claim is representative of the other asserted claims in this patent only.</p>
9	Abstract Idea	

2. '687 Patent

'687 Patent		
Asserted Claim	Exception to Eligibility	Representative of Other Claims
1	Abstract Idea	<p>Representative of every Asserted Claim in all Asserted Patents because all Asserted Claims concern performance of the same basic process.</p> <p>In the alternative, Samsung contends that this claim is representative of the other asserted claims in this patent only.</p>
2	Abstract Idea	
3	Abstract Idea	
4	Abstract Idea	
5	Abstract Idea	
6	Abstract Idea	

'687 Patent		
Asserted Claim	Exception to Eligibility	Representative of Other Claims
7	Abstract Idea	
12	Abstract Idea	
14	Abstract Idea	<p>Representative of every Asserted Claim in all Asserted Patents because all Asserted Claims concern performance of the same basic process.</p> <p>In the alternative, Samsung contends that this claim is representative of the other asserted claims in this patent only.</p>
25	Abstract Idea	

Representative claims may be used for the *Alice* analysis when the claims are “substantially similar and linked to the same abstract idea.” *Content Extraction & Transmission LLC v. Wells Fargo Bank, Nat’l Ass’n*, 776 F.3d 1343, 1348 (Fed. Cir. 2014); *Smart Sys. Innovations, LLC v. Chicago Transit Auth.*, 873 F.3d 1364, 1368 n.7 (Fed. Cir. 2017) (concluding that claims “should rise or fall together” when they “contain only minor differences in terminology but require performance of the same basic process”) (internal quotation omitted). This Court applies a burden-shifting framework, in which “[t]he party asserting invalidity may overcome the presumption of independent validity by offering a substantial rationale for treating a claim as representative.” *PPS Data, LLC v. Jack Henry & Assocs.*, 2019 U.S. Dist. LEXIS 169218, at *9, 11 (E.D. Tex. Sept. 6, 2019) (Gilstrap, J.). “Once the defendant has made a prima facie case the burden shifts to the plaintiff to identify limitations that are present in the asserted claims but that are not represented by the allegedly representative claim.” *Id.* at *13. Further, “the representativeness inquiry must be ‘directly tethered to the claim language.’” *Id.* at *11 (quoting *Solutran, Inc. v. Elavon, Inc.*, 931 F.3d 1161, 1168 (Fed. Cir. 2019)). Should Plaintiff contend that any Asserted Claims are not

represented by the representative claim, as Defendants identified above, Defendants' reserve the right to supplement or amend these Subject Matter Ineligibility Contentions (including the attached exhibits) in response.

As set forth in Exhibits 30-31, each of the Asserted Claims relates to an abstract idea. Aside from these abstract ideas, the Asserted Claims include only well-understood, routine, and conventional components and steps. The Asserted Claims do not improve any aspect of technology, as they recite nothing more than using generic known components to perform well-known functions. The well-understood, routine, and conventional nature of the components and steps of the Asserted Claims are demonstrated by the discussion of the state of the art, set forth in Section II, *supra*, and the identification of prior art and prior art itself, set forth in Section III-IV, *supra*, including the charts attached to this document. The claims fail to provide any sort of inventive concept that would transform the abstract ideas to which they are directed into patent-eligible inventions. Exhibits 30-31 attached hereto further detail Defendants' factual and legal bases for their Subject Matter Ineligibility Contentions.

DATED: March 4, 2025

By: /s/ Elizabeth L. Brann

Elizabeth L. Brann
elizabethbrann@paulhastings.com
Ariell N. Bratton
ariellbratton@paulhastings.com
Sasha Vujcic (*Pro Hac Vice*)
sashavujcic@paulhastings.com
PAUL HASTINGS LLP
4655 Executive Dr., Suite 350
San Diego, CA 92121
Telephone: 1(858) 458-3000
Facsimile: 1(858) 458-3005

Robert Laurenzi
robertlaurenzi@paulhastings.com
PAUL HASTINGS LLP
200 Park Avenue, 26th Floor
New York, NY 10166
Telephone: (212) 318-6000
Facsimile: (212) 318-6100

Melissa R. Smith (TX Bar No. 24001351)
melissa@gillamsmithlaw.com
GILLAM & SMITH, LLP
303 S. Washington Ave.
Marshall, TX 75670
Telephone: (903) 934-8450
Facsimile: (903) 934-9257

*Attorneys for Defendants
Samsung Electronics Co., Ltd. and
Samsung Electronics America, Inc.*

CERTIFICATE OF SERVICE

I hereby certify that a true and correct copy of the foregoing document has been served via email on all counsel of record on this 4th day of March, 2025.

/s/ Elizabeth L. Brann
Elizabeth L. Brann