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Paper 17
Entered: December 18, 2025

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD.,
Petitioner,

v.

CM HK LIMITED,
Patent Owner.

IPR2025-01071
Patent 11,698,687 B2

Before BENJAMIN D. M. WOOD, MICHAEL J. STRAUSS, and ARTHUR M. PESLAK, *Administrative Patent Judges*.

WOOD, *Administrative Patent Judge*.

DECISION
Granting Institution of *Inter Partes* Review
35 U.S.C. § 314

I. INTRODUCTION

A. Background

Samsung Electronics Co., Ltd. ("Petitioner") filed a Petition (Paper 1, "Pet.") requesting *inter partes* review of claims 1–7, 12, 14, and 25 of U.S. Patent No. 11,698,687 B2 (Ex. 1001, "the '687 patent"). CM HK LIMITED ("Patent Owner") requested discretionary denial of the Petition (Paper 7), and filed a Preliminary Response (Paper 8, "Prelim. Resp."). Patent Owner's request for discretionary denial was denied and the Petition was referred to the Board. Paper 12. We requested additional briefing from the parties regarding Patent Owner's allegation that Petitioner has taken inconsistent claim-construction positions. Paper 13. Petitioner filed a responsive brief (Paper 14), to which Patent Owner responded (Paper 16).

We have authority under 35 U.S.C. § 314, which provides that an *inter partes* review may not be instituted "unless . . . there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition." 35 U.S.C. § 314(a). On the preliminary record before us, we determine that Petitioner has satisfied this threshold requirement, and therefore we institute *inter partes* review of claims 1–7, 12, 14, and 25 of the '687 patent.

B. Real Parties-in-Interest

Petitioner identifies Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. as real parties-in-interest. Pet. 1.

Patent Owner identifies CM HK LIMITED as real party-in-interest. Paper 4, 2.

C. Related Proceedings

The Parties identify *CM HK Ltd. v. Samsung Electronics Co., Ltd.*, No. 2:24-cv-00880-JRG (E.D. Tex.), and *Samsung Electronics Co. Ltd. v. CM HK, Ltd.*, No. 4:24-cv-06567-JST (N.D. Cal.) ("the California Litigation") as related matters. Pet. 1; Paper 4, 2.

The Parties further note that the '687 patent is related to two patents, U.S. Patent No. 8,441,438 ("the '438 patent") (Ex. 1009) and U.S. Patent No. 8,552,978 ("the '978 patent") (Ex. 1010), that were at issue in the following IPRs:

> *Google LLC v. CyWee Group Ltd.*, IPR2018-01258, Paper 86 (PTAB Jan. 9, 2020) (Ex. 1011) ("the '1258 IPR") (invalidating claims of the '438 patent);
>
> *ZTE (USA), Inc. and LG Electronics Inc. v. CyWee Group Ltd.*, IPR2019-00143, Paper 87 (PTAB Feb. 17, 2021) (Ex. 1012) ("the '0143 IPR") (invalidating claims of the '438 patent); and
>
> *Google LLC v. CyWee Group Ltd.*, IPR2018-01257, Paper 87 (PTAB Jan. 9, 2020) (Ex. 1013) ("the '1257 IPR") (invalidating claims of the '978 patent).[1]

Pet. 2; Prelim. Resp. 3–4.

Patent Owner also informs us that the '438 and '978 patents were asserted against Petitioner in *CyWee Group Ltd. v. Samsung Electronics Co. Ltd., et al.*, 2:17-cv-00140-WCB-RSP (E.D. Tex. ("the CyWee Litigation"). Prelim. Resp. 2–3.

[1] According to Patent Owner, CyWee Group Ltd. "is a prior assignee of the portfolio of patents related to the '687 Patent." Prelim. Resp. 3 n.1.

Patent Owner further identifies IPR2025-01023, concerning U.S. Patent No. 10,852,846 ("the '846 patent"), which is related to the '687 patent. Prelim. Resp. 4; Paper 4, 2.

D. The '687 patent

The '687 patent[2] relates to "an electronic device for use in computers, motion detection or navigation" having a "nine-axis motion sensor module" that detects the device's movements and "translat[es] the detected motions to a cursor display" on the screen of a 2D display device. Ex. 1001, 1:27–46. The nine-axis motion sensor module comprises an accelerometer to measure axial accelerations A_x, A_y, A_z; a rotation sensor to measure angular velocities ω_x, ω_y, ω_z, and a magnetometer to measure magnetism M_x, M_y, M_z. *Id.* at 4:36–44, Fig. 4. The electronic device may be a 3D pointing device, such as that depicted in Figure 1, reproduced below:

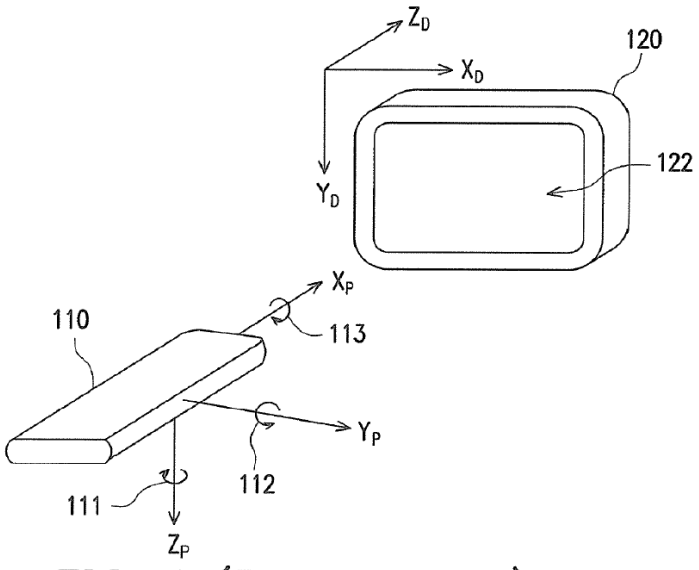

FIG. 1 (RELATED ART)

[2] The '687 patent issued on July 11, 2023, from an application filed November 20, 2020, and claims priority to an application filed March 28, 2011. Ex. 1001, codes (45), (22), (63).

Figure 1 depicts electronic device 110 and display device 120 with screen 122. Ex. 1001, 1:41–46. When a user moves the device, for example, in the course of playing a video game, a cursor or pointer on the screen "move[s] along with the orientation, direction and distance travelled by the pointing device." *Id.* at 1:65–2:6. The orientation in space of pointing device 110 may be represented by three "deviation angles" associated with the device's "reference frame X_p, Y_p, Z_p," shown in Figure 1: yaw angle 111 representing rotation about the Z_p axis; pitch angle 112 representing rotation about the Y_p axis; and roll angle 113 representing rotation about the X_p axis. *Id.* at
2:8–20.

To determine the device's deviation angles "in an absolute manner," i.e., "reflecting or associated with the actual movements and rotations of the electronic device . . . preferably excluding undesirable external interferences in the dynamic environments," the device uses an "enhanced comparison method" that may be a program performed by an onboard processing unit. Ex. 1001, 4:44–61, 14:6–18. Figure 7 depicts this method, and is reproduced below:

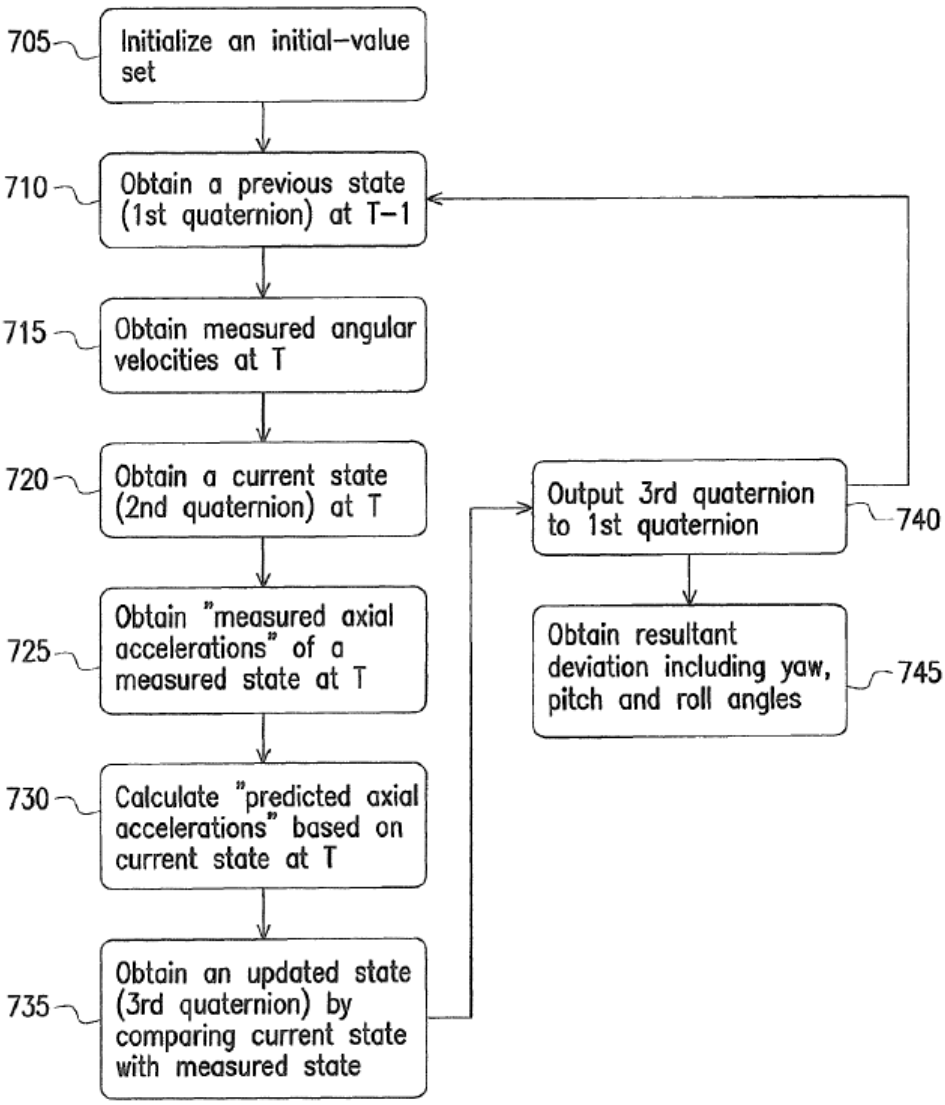

FIG. 7

Figure 7 depicts a process for determining the deviation angles (yaw, pitch, and roll) at time "T" of an electronic device using a nine-axis motion sensor module. Ex. 1001, 14:6–24. The process depicted in Figure 7 starts with "obtaining a previous state of the nine-axis motion sensor module," or "an initial value set predetermined to initialize said previous state . . . at a beginning of the method" where a previous state is not available (steps 705,

710). *Id.* at 14:36–45. This previous state may be represented by "a first quaternion[3] . . . associated with at least previous angular velocities ω_x, ω_y, ω_z gained from the motion sensor signals of the nine–axis motion sensor module at a previous time T–1." *Id.* at 14:46–50.

The method proceeds by "obtaining measured angular velocities ω_x, ω_y, ω_z gained from the motion sensor signals of the nine-axis motion sensor module at a current time T (. . . steps 715, 720)," which are used to calculate a "second quaternion" representing the "current state." Ex. 1001, 14:50–55, 16:42–50. The method then obtains a "measured state" using "measured axial accelerations Ax, Ay[,] Az" obtained from the accelerometer (step 725), and "predicted axial accelerations Ax', Ay', Az'," which are calculated based on the measured angular velocities (step 730). *Id.* at 14:55–62, 17:5–24.

From the "measured state," the process obtains an "updated state,"—which may be represented by a "third quaternion"—by "comparing the current state with the measured state" of the sensor module (step 735). *Id.* at 14:66–15:3, 18:39–42. Finally, the process converts the updated state to the device's deviation angles, i.e., the "yaw angle, pitch angle and roll angle of the electronic device associated with the spatial reference frame" at time T (step 745). *Id.* at 14:66–15:3, 19:21–27. The deviation angles may be

[3] Petitioner's declarant, Dr. Sarrafzadeh, states that "a quaternion is a four-valued vector generalization of complex numbers with special mathematical properties that allow them to describe rotations efficiently." Ex. 1002 ¶ 24; *see id.* ¶ 34 n.2 (stating that quaternions "have the unique property of maintaining rotational relationships with relatively limited computational complexity"). At this stage of the proceeding, Patent Owner does not dispute these assertions. *See* Prelim. Resp. 7–8 (citing to part of Dr. Sarrafzadeh's discussion of quaternions).

translated "to a movement pattern in a mapping area in a display reference frame" X_D, Y_D, Z_D. *Id.* at 20:29–33, Figs. 8, 9. "[T]o provide a continuous loop," the process repeats by using the updated state determined in step 735 as the previous state in step 710 (step 740). *Id.* at 15:7–15.

E. The Challenged Claims

Petitioner challenges claims 1–7, 12, 14, and 25 of the '687 patent. Pet. 1. Claims 1 and 14 are independent. Claims 2–7 and 12 depend directly or indirectly from independent claim 1 and claim 25 depends directly from independent claim 14. Claim 1 is illustrative and is reproduced below:[4]

> 1. [1.pre] An electronic device subject to movements and rotations in a spatial reference frame, comprising:
>
> [1.a] a motion sensor module having sensor circuitry configured to generate measured angular velocities and measured axial accelerations; and
>
> [1.b] a computing processor having processor circuitry configured 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:
>
> > [1.c] providing a previous quaternion corresponding to time T−1 based on the measured axial accelerations corresponding to time T−1 and the measured angular velocities corresponding to time T−1, without using the measured angular velocities corresponding to time T;
> >
> > [1.d] converting measured angular velocities corresponding to time T, based on the previous quaternion, into a current quaternion corresponding to

[4] We use Petitioner's bracketed identifiers for each limitation. *See* Pet. 25–52.

time T, without using measured axial accelerations corresponding to time T;

[1.e] 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;

[1.f] comparing the predicted axial accelerations with the measured axial accelerations corresponding to time T to obtain a first comparison result;

[1.g] obtaining an updated quaternion associated with time T based on the current quaternion and the first comparison result;

[1.h] using the updated quaternion as a next occurrence of the previous quaternion; and

[1.i] providing the resulting deviation based on the updated quaternion;

[1.j] wherein the processor circuitry is further configured to provide content based on the resulting deviation in the spatial reference frame.

Ex. 1001, 31:16–52.

F. Asserted Ground of Unpatentability

Petitioner contends that claims 1–7, 12, 14, 25 would have been obvious under 35 U.S.C. § 103(a)[5] over Bassompiere.[6] Pet. 3. Petitioner

[5] Because the challenged claims of the '687 patent have an apparent effective filing date that precedes the effective date of the amendments to 35 U.S.C. §§ 102 and 103 enacted by the Leahy-Smith America Invents Act (AIA), we apply the pre-AIA version of these sections (although our decision would be the same under either version). *See* AIA, Pub. L. No. 112–29, § 3(n)(1), 125 Stat. 284, 293 (2011).

[6] WO 2009/156499 A1 (published Dec. 30, 2009) (Ex. 1005). All citations to Bassompiere are to its certified English-language translation, Ex. 1006.

relies on the Declaration of Dr. Majid Sarrafzadeh (Ex. 1002) to support its asserted grounds.

II. ANALYSIS

A. Legal Standards Used in the Merits Analysis

"In an IPR, the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable." *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify "with particularity . . . the evidence that supports the grounds for the challenge to each claim")); *Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015) (discussing the burden of proof in *inter partes* review).

"A patent may not be obtained through the invention is not identically disclosed or described as set forth in [35 U.S.C. § 102], if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains." 35 U.S.C. § 103(a) (pre-AIA version). Obviousness is a question of law based on underlying factual considerations, including the scope and content of the prior art, the differences between the prior art and the claimed invention, the level of ordinary skill in the art, and any relevant secondary considerations of non-obviousness, including commercial success of the patented product or method, a long-felt but unmet need for the functionality of the patented invention, and the failure of others who have unsuccessfully attempted to accomplish what the patentee has

achieved. *Graham v. John Deere Co.*, 383 U.S. 1, 17 (1966). The obviousness analysis should not be conducted "in a narrow, rigid manner," but should instead focus on whether a claimed invention is merely "the result[] of ordinary innovation," which is not entitled to patent protection. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406, 427–28 (2007).

B. Level of Ordinary Skill in the Art

Petitioner contends that, for the '687 patent, one of ordinary skill in the art "would have had an undergraduate degree in electrical engineering, computer engineering, computer science, physics or a related field along with two years of work experience in the field of sensors (such as accelerometers, gyroscopes and magnetometers), sensor fusion algorithms, including Kalman filters, quaternion mathematics, and mobile computing technologies," and that "[m]ore education can supplement practical experience and vice versa." Pet. 4 (citing Ex. 1002 ¶¶ 17–18).

Patent Owner disputes that one of ordinary skill in the art would have had experience with quaternion mathematics and sensor-fusion algorithms such as Kalman filters. Prelim. Resp. 24–26. Patent Owner contends that Petitioner's only evidence supporting its definition of the level of ordinary skill is the testimony of its declarant, Dr. Sarrafzadeh, which Patent Owner asserts is "conclusory" and "contradicts his prior sworn opinions." *Id.* at 25–26. Patent Owner does not offer its own proposed level of skill.

As noted above, the '687 patent is related to the '438 patent and '978 patents. The portions of the '687 patent Specification relevant to the challenged claims appears in substantially the same form in the '438 and '978 patents. *Compare, e.g.*, Ex. 1001, 14:6–18:42, Fig. 7 *with* Ex. 1009, 10:42–14:27, Fig. 7 *and* Ex. 1010, 13:60–18–34, Fig. 7. In the prior IPRs

reviewing the ’438 and ’978 patents, the Board determined that a person of ordinary skill would have had knowledge of Kalman filters and quaternion mathematics. Ex. 1011, 13–16; Ex. 1012, 22–26; Ex. 1013, 43–45. The Board based this determination in large part on the testimony of then-Patent Owner’s declarant, Dr. Joseph J. LaViola. Ex. 1011, 14–16; Ex. 1012, 23–25; Ex. 1013, 43–44. For example, Dr. LaViola testified in the ’1258 IPR that one of ordinary skill “would be familiar with Kalman filters and [extended Kalman filters], and with equations typically used with such filters,” and that “quaternions were well-known mathematical tools for computer graphics in the relevant timeframe.” Ex. 1011, 14–15.

Patent Owner does not offer any reason why we should deviate from the Board’s determinations in the prior IPRs that one of ordinary skill in the art would have had knowledge of Kalman filters and quaternion mathematics. Nor are we aware of any such reason. On the contrary, the Board’s prior determinations are consistent with the level of ordinary skill reflected by prior art of record. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001); *In re GPAC Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995); *In re Oelrich*, 579 F.2d 86, 91 (CCPA 1978). Bassompiere, for example, teaches using a data merging algorithm that is, “[a]dvantageously,” extended Kalman filtering. Ex. 1006, 4:17. Bassompiere also teaches using quaternions to determine a device’s pitch and roll about a horizontal reference frame. *Id.* at 6:3–8, 20:10–21:1.

Patent Owner argues that Dr. Sarrafzadeh’s testimony regarding the level of skill in the art in this proceeding contradicts his testimony in the prior IPRs, which did not include knowledge of Kalman filters and quaternion mathematics in his definition of the level of ordinary skill in the

art. Prelim. Resp. 24–26. Patent Owner asserts that this contradiction "undermin[es] his credibility." *Id.* at 26. We disagree. The testimony Dr. Sarrafzadeh provided in the earlier IPRs obviously preceded the Board's determinations in those proceedings that, on the whole record, including the testimony of then-Patent Owner's declarant, the level of ordinary skill included knowledge of Kalman Filters and quaternions. Dr. Sarrafzadeh's testimony in this proceeding reasonably aligns with those determinations.

Accordingly, we adopt Petitioner's definition of the level of ordinary skill in the art for purposes of this Decision.

C. Claim Construction

We construe claim terms "using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. [§] 282(b)." 37 C.F.R. § 42.100(b). Under this standard, claim terms are generally given their plain and ordinary meaning as would have been understood by a person of ordinary skill in the art at the time of the invention and in the context of the entire patent disclosure. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312–13 (Fed. Cir. 2005) (en banc). Any special definitions for claim terms must be set forth in the specification "with reasonable clarity, deliberateness, and precision." *See In re Paulsen*, 30 F.3d 1475, 1480 (Fed. Cir. 1994). Extrinsic evidence is "less significant than the intrinsic record in determining 'the legally operative meaning of claim language.'" *Phillips*, 415 F.3d at 1317.

Petitioner proffers a construction of the term "spatial reference frame" recited in independent claims 1 and 7. Pet. 23–25. Petitioner does not propose constructions for any other claim term. Patent Owner disputes Petitioner's construction of "spatial reference frame" and proffers its own

construction of that term. Prelim. Resp. 15–17. Patent Owner also provides a construction of the term "predicted axial accelerations," criticizes Petitioner for failing to construe "predicted axial accelerations," and asserts that Petitioner has "taken inconsistent and shifting positions on the meaning" of that term. *Id.* at 18–24.

1. "spatial reference frame" (claims 1 and 3)

Claim 1 is drawn to "[a]n electronic device subject to movements and rotations . . . in a spatial reference frame," and recites tracking the "movements and the rotations of the electronic device in the spatial reference frame." Ex. 1001, Claim 1. Petitioner contends that "spatial reference frame" means a "reference frame associated with a 3D pointing device, which always has its origin at the same point in the device and in which the axes are always fixed with respect to the device." Pet. 23 (citing Ex. 1002 ¶ 40).

Patent Owner "largely agree[s]" with Petitioner's construction, but notes that claims 1, 7, and 14 do not recite a "3D pointing device." Prelim. Resp. 15. Instead, notes Patent Owner, the claims recite "tracking the 'movements and rotations of **the electronic device** in the spatial reference frame.'" *Id.* at 17. Patent Owner thus contends that the term should be construed as a "frame of reference associated with **the electronic device**, which always has its origin at the same point in the device and in which the axes are always fixed with respect to the device." *Id.*

The parties agree that the claimed "spatial reference frame" is associated with a device, has its origin at the same point in the device, and has axes that are always fixed with respect to the device. The only disagreement is whether that device is a "3D pointing device" or an

"electronic device." The Specification indicates that "electronic device" encompasses 3D pointing devices as well as, e.g., smartphones and navigation equipment, and therefore is the broader term. Ex. 1001, 13:20–23. At this stage of the proceeding, we determine that the threshold question of institution can be decided under either construction, because Patent Owner does not dispute that the primary asserted reference, Bassompiere, teaches a "spatial reference frame" associated with a 3D pointing device. Pet. 25–27. Therefore, at this stage of the proceeding, we decline to resolve the parties' dispute. *See Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.,* 200 F.3d 795, 803 (Fed. Cir. 1999) ("[O]nly those [claim] terms need be construed that are in controversy, and only to the extent necessary to resolve the controversy."); *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (approving Board decision not to construe claim language where the construction is not material to the dispute).

2. "predicted axial accelerations"

Petitioner does not propose a construction for "predicted axial accelerations," but, in the concurrent California Litigation, contends that it should be accorded its "plain and ordinary meaning." Ex. 2007, 3. In subsequent briefing that will be discussed more fully below, Petitioner asserts that its declarant, Dr. Sarrafzadeh, "applied the 'plain and ordinary' meaning for all claim terms, including the 'predicted axial accelerations' term," in this proceeding. Paper 14, 1. Petitioner also submits in that briefing that "the term 'axial acceleration' (whether predicted or measured) . . . ordinarily encompasses three types of acceleration," i.e., "linear, centrifugal, and gravitational." *Id.* at 3, 4.

Patent Owner contends that "predicted axial accelerations" should be construed as "[g]ravitational acceleration along the electronic device's axes derived from the current quaternion." Prelim. Resp. 18. Patent Owner asserts that "[t]he claims and specification consistently define 'predicted axial accelerations' as gravitational accelerations along the device's axes at time T, derived from the current quaternion." *Id.* (citing Ex. 1001, claim 1, 17:18–30, 17:45–52). Patent Owner further submits that "because 'predicted axial accelerations' are computed from the current quaternion they *only contain* gravitational accelerations along the device's axes." *Id.* at 19 (citing Ex. 2023 ¶ 23).

Here too, the threshold question of institution can be decided without expressly construing "predicted axial accelerations." First, whether or not "predicted axial accelerations" includes only gravitational accelerations is not, at this stage at least, material to our decision whether to institute, because Patent Owner does not distinguish Bassompiere on this basis.

Second, Patent Owner does not argue that Bassompiere fails to teach "predicted axial accelerations" *per se*. According to Patent Owner, "both Bassompiere and the '687 Patent employ the idea of predicting what the accelerometer should read." Prelim. Resp. 30. An accelerometer "measure[s] or detect[s] axial accelerations Ax, Ay, Az." Ex. 1001, 4:40–41. Patent Owner thus acknowledges that Bassompiere predicts axial accelerations. Patent Owner's argument is that Bassompiere "derives its predicted values from Euler angles (pitch and roll)," whereas the '687 patent "derives predicted accelerations from a quaternion-based state updated with gyroscope data." *Id.* at 30–31. This argument goes to whether or not Bassompiere teaches or suggests calculating predicted axial accelerations

using quaternions as opposed to Euler angles, which we address below in discussing Ground 1.

3. Whether Petitioner's Failure to Propose a Construction of "Predicted Axial Accelerations" Violates 37 C.F.R. § 42.104(b)(3)

Patent Owner argues that the Petition violates Rule 42.104(b)(3) because it does not provide an express construction of "predicted axial accelerations," despite the fact that:

> Petitioner put the scope of "predicted axial accelerations" at the heart of the case when it alleged its devices do not infringe claims 1, 14, and 27 of the '687 patent because they are not "obtaining a quaternion by *predicting axial accelerations*; comparing *predicted axial accelerations* with measured axial accelerations; and using *predicted axial accelerations* converted [from] measured angular velocities."

Prelim. Resp. 20–21 (quoting Ex. 2002 ¶ 88). Patent Owner asserts that "[t]he Board has denied institution when the petitioner fails to provide claim constructions." *Id.* (citing *Carefusion Corp. v. Baxter Int'l, Inc.*, 2017 WL 506561, at *2 (PTAB Feb. 6., 2017)). Patent Owner also contends that "the Federal Circuit has been clear that 'plain and ordinary meaning' is not an adequate construction 'when a term has more than one 'ordinary' meaning or when reliance on a term's 'ordinary' meaning does not resolve the parties' dispute.'" *Id.* at 21 (citing *NobelBiz, Inc. v. Glob. Connect, L.L.C.*, 701 F. App'x 994, 997 (Fed. Cir. 2017)); *O2 Micro Int'l Ltd. v. Beyond Innovation Tech. Co.*, 521 F.3d 1351, 1361 (Fed. Cir. 2008)). Finally, Patent Owner asserts that "[b]y failing to construe any term other than 'spatial reference frame,' [Petitioner] has deprived the Board of the framework it needs to evaluate the prior art." *Id.* at 23.

Rule 42.104(b)(3) requires a petition for Inter Partes Review to provide, inter alia, "a statement of the precise relief requested for each challenged claim," the statement identifying "[h]ow the challenged claim is to be construed." This rule does not, however, require a Petitioner to expressly construe every claim term. See Patent Trial and Appeal Board Consolidated Trial Practice Guide (Nov. 2019) ("CTPG"), 44;[7] *Nidec Motor Corp.*, 868 F.3d at 1017 (approving Board decision not to construe claim language where construction is not material to the dispute). We are not aware of any support for the notion that Rule 42.104(b)(3) imposes a higher burden on a Petitioner to construe a claim term when that term is at issue in infringement litigation. Although the scope of a claim is the same for purposes of determining infringement as for determining validity, the analysis itself is different. Infringement *vel non* is determined by comparing the claimed invention to an accused product or process. 35 U.S.C. § 271. Validity under 35 U.S.C. § 103, in the context of *inter partes* review, is determined by comparing the claimed invention to "prior art consisting of patents or printed publications." 35 U.S.C. § 311(b). Thus, an express construction of a term may be necessary for determining infringement but may not be for determining validity.

We have reviewed the cases cited by Patent Owner and find them inapposite. In *Carefusion*, the petitioner did provide claim constructions, those propounded by the patent owner in the district court lawsuit, but stated that it did not believe those constructions were correct. *Carefusion*, *2. Moreover, the Board agreed that they were "erroneous." *Id.* at *4–*7. The

[7] Available at https://www.uspto.gov/sites/default/files/documents/tpgnov.pdf.

Board thus denied the petition because the proffered constructions were erroneous, not because the petitioner failed to provide constructions. Id. at *7–*8. In *O2 Micro* (cited in *NobelBiz*), the Federal Circuit held that the district court failed to resolve the scope of a disputed claim term, a question of law, but instead improperly let the jury decide the "plain and ordinary meaning" of the term. 521 F.3d at 1361–62; *see NobelBiz*, 701 Fed.Appx. 997 (same). This holding is not relevant to a petitioner's assertion of the "plain and ordinary meaning" of a term in a petition for inter partes review.

Finally, we are not persuaded that Petitioner's failure to expressly construe "predicted axial accelerations" prevents us from evaluating the prior art, for reasons discussed above in connection with the construction of the term.

4. Whether Petitioner has Presented Inconsistent Claim Constructions

Patent Owner asserts that "Petitioner has taken inconsistent and shifting positions on the meaning of the term 'predicted axial accelerations.'" Prelim. Resp. 21. According to Patent Owner, although Petitioner argued in the CyWee Litigation that the term was "indefinite," Petitioner contends in the California Litigation that it should be accorded its "plain and ordinary meaning." *Id.* at 21–22.

Petitioner responds that it did not argue in the prior litigation that the term "predicted axial accelerations" by itself was indefinite, but instead argued that terms into which "predicted axial accelerations" was imbedded were indefinite because the terms did not specify a particular type of axial acceleration. Paper 14, 2–3. Patent Owner replies that in the prior litigation Petitioner "told the court that 'predicted axial accelerations' does not have a

single, well-understood definition," because it asserted that "a POSA would not have known whether the predicted axial accelerations are: (i) linear accelerations; (ii) centrifugal accelerations; (iii) gravitational accelerations; or (iv) a combination from among the three." Paper 16, 1–2 (quoting Ex. 2025, 13).[8]

We are not persuaded that Petitioner previously asserted that "predicted axial accelerations," by itself, is indefinite. In the CyWee Litigation, Petitioner agreed that a term directed to "calculating predicted axial accelerations" has, and should be accorded, its "plain and ordinary" meaning. Ex. 1021, 5. This indicates that Petitioner did not consider the term "predicted axial accelerations" to be indefinite because, if it was,

[8] Patent Owner raises additional arguments in its supplemental briefing: first, that Petitioner in its supplemental briefing asserts that "predicted axial accelerations" "ordinarily encompasses three types" of acceleration, including " linear or centrifugal accelerations," but had not previously made that assertion in the Petition; and second, that Petitioner offered express constructions for other claim terms (e.g., "display reference frame") in the California Litigation while relying on the "[p]lain and ordinary meaning" of those terms in this proceeding, without explaining these "inconsistencies" to the Board. Paper 16, 3–4. Although these arguments went beyond the scope of our authorization of additional briefing (Paper 13), we have considered them and determine that Patent Owner's requested relief, denial of the Petition, is unwarranted. As to the first argument, Petitioner's position that there are three types of axial accelerations is consistent with its position in the earlier CyWee litigation (Ex. 2025, 12) and, as discussed above, whether or not the term encompasses axial accelerations other than gravitational accelerations is not material to Patent Owner's analysis. As to the second argument, Patent Owner assumes without explanation that the express constructions offered in the California Litigation are inconsistent with the "plain and ordinary meaning" of those terms. Further, it does not seem at this stage that express constructions for these terms are necessary because Patent Owner does not discuss any of them in its analysis of Ground 1.

calculating predicted axial accelerations would presumably also be indefinite.

Petitioner did, however, assert that a term directed to "comparing" "predicted axial accelerations" with "angular velocities" was indefinite because the term did not specify "the type of 'axial acceleration'" being compared. Paper 14, 2–3 (citing Ex. 2025, 4–14). Asserting that there may be different types of predicted axial accelerations does not necessarily constitute an assertion that the term is indefinite, only that the term describes a genus that encompasses multiple species. In any event, even if we were persuaded that Petitioner previously argued that "predicted axial accelerations" was indefinite because it could be any of three different types of accelerations, the district court determined otherwise:

> The patent is clear that "axial accelerations" refers to the acceleration vectors along three axes of the associated reference frame. Thus, regardless of whether the pointing device is undergoing linear, centrifugal, and/or gravitational acceleration, at any instant the acceleration of the device can be represented by vectors along axes of the chosen reference frame. In other words, while the type of acceleration may affect the magnitude and rates of change of the vectors, the total acceleration can nonetheless be represented by axial accelerations Ax, Ay, and Az in the associated reference frame at any instant.

Ex. 1021, 15. In *Revvo Tech., Inc. v. Cerebrum Sensor Techs., Inc.*,[9] the Director indicated that if a petitioner advances a construction in a district court that the court subsequently rejects, the petitioner would have sufficient reason to advance a different construction at the Board. *Revvo*, 5 (citing *Sun Pharm. Indus. Inc. v. Nivagen Pharm., Inc.*, IPR2025-00893, Paper 18 at 3

[9] IPR2025-00632, Paper 20 (Director Nov. 3, 2025) (precedential).

(Director Sept. 19, 2025)). We believe the same principle applies here. Because the district court determined "axial accelerations" (and by implication, "predicted axial accelerations") to be definite, Petitioner would have sufficient reason to contend here that "predicted axial accelerations" should be accorded its plain and ordinary meaning, even if it had previously argued that the term was indefinite.

D. Ground 1: Obviousness of Claims 1–7, 12, 14 and 25 over Bassompiere

Petitioner contends that Bassompiere would have rendered the subject matter of claims 1–7, 12, 14 and 25 obvious. Pet. 25–68. Patent Owner opposes. Prelim. Resp. 26–31.

1. Bassompiere (Ex. 1006)

Bassompiere is titled "Pointer with Motion Sensing Resolved by Data Merging," and relates to determining displacements—rotations and translations—of a "pointer," and converting the pointer's displacements into displacements of a "point" appearing on a two-dimensional screen. Ex. 1006, 1:1–4, 1:24–25, 8:14–16. The pointer may be, e.g., a television remote control device, and the point may be a cursor that selects "a program or a function to be chosen from a menu" appearing on the television. *Id.* at 1:7–9

Bassompiere's pointer comprises "at least one first sensor"—e.g., a two- or three-axis gyrometer—"for measuring the angular velocities (ω_Y, ω_Z) of said device about at least two of its orthogonal axes (Y,Z)," and "at least one second sensor"—e.g., a three-axis accelerometer—"for measuring the linear displacements" of the device along axes (X,Y,Z). Ex. 1006, 4:2–7, Fig. 1.

According to Bassompiere, applications using motion-sensor pointers must "take account of the manner in which the user holds the pointer." Ex. 1006, 2:16–17. Bassompiere teaches that "if the pointer is held, for example, at 45º instead of being held horizontally, a horizontal motion of the pointer will be translated on the screen at which it points by a diagonal motion." *Id.* at 2:18–20. "This phenomenon is known by the name of 'tilt' or torsion," and should "be corrected in order for the pointer to be usable." *Id.* at 2:20–22. Bassompiere's device does so by using a computer "sub-module" that "implements a data fusion algorithm"—preferably an "extended Kalman filter" (EKF)—"applied to the outputs of the first and second sensor." *Id.* at 4:9–12, 4:17. The device's "tilt compensation algorithm" compensates for the roll and pitch angles at which a pointer may be held, such that "the displacement of the cursor on the screen . . . becomes independent of the orientation of the device on the carrier [user]." *Id.* at 8:2–8, 14:16–19.

Figure 2 of Bassompiere, reproduced below, illustrates the various "transformation of reference frames making it possible to circumvent said torsion" (Ex. 1006, 10:28–29):

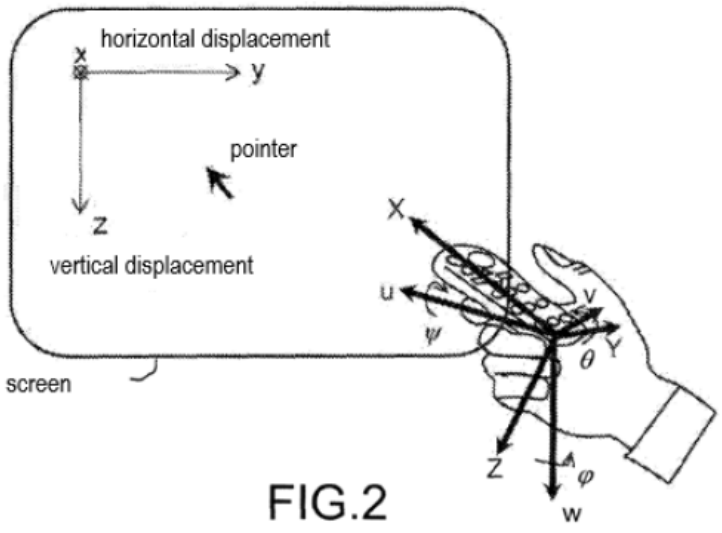

FIG.2

As shown in Figure 2, the displacement of the "mobile element" (point or cursor) appears on a two-dimensional reference frame defined by orthogonal axes y and z. Ex. 1006, 10:30–32. A second reference frame "corresponds to the reference frame of the device (XYZ), X being in the principal direction of pointing, Y toward the right and Z downwards from the device." *Id.* at 10:32–11:1. "The last reference frame (uvw), named the carrier reference frame, is associated with the part of the body which creates the pointing motion" and "is defined by referring to the reference frame (XYZ) back to the horizontal plane," such that the "switch" from the carrier reference frame to the device reference frame is "performed through two successive rotations (pitch θ, roll ψ)." *Id.* at 11:3–6. If the carrier is not directly facing the screen, the switch from the carrier reference frame (uvw) to the screen reference frame (xyz) "is performed through a rotation (yaw φ)." *Id.* at 11:6–8.

Bassompiere's "torsion compensation operation" uses an EKF to estimate the pitch angle θ and roll angle ψ of the pointing device. Ex. 1006, 15:3–7. A "first embodiment" of this process uses pitch and roll angles θ and ψ as the "variables representative of the state of the system"—i.e., the "state vector." *Id.* at 15:26–27, 17:5. In mathematical notation, the state vector is represented as x=[θ ψ]. *Id.* This process comprises a "sequence of computations" that begins with determining an "a priori estimation of the state vector" at time k—designated "$\hat{x}_k^-$"—based on pitch and roll angles determining previously at time k-1 ($\hat{\theta}_{k-1}$, $\hat{\psi}_{k-1}$) according to the following "equation 21":

$$\hat{x}_k^- = \begin{pmatrix} \hat{\theta}_k^- \\ \hat{\psi}_k^- \end{pmatrix} = \begin{pmatrix} \hat{\theta}_{k-1} \\ \hat{\psi}_{k-1} \end{pmatrix} + T_e \cdot \begin{pmatrix} \alpha \cdot \sqrt{\omega_Y^2 + \omega_Z^2} \\ \omega_x \end{pmatrix} \qquad \text{Eq. 21}$$

Id. at 18:20–19:3. In equation 21,the a priori estimation of the state vector $\hat{x}_k^-$, or $\begin{pmatrix}\hat{\theta}_k^- \\ \hat{\psi}_k^-\end{pmatrix}$, is derived from previously determined state vector $\begin{pmatrix}\hat{\theta}_{k-1} \\ \hat{\psi}_{k-1}\end{pmatrix}$ and angular velocities ω_x, ω_y, ω_z obtained from the gyrometer. *Id.* "T_e" is the sampling period. *Id.* at 19:4.

The a priori estimate of the state vector $\hat{x}_k^-=\begin{pmatrix}\hat{\theta}_k^- \\ \hat{\psi}_k^-\end{pmatrix}$ is then used to determine the "a priori estimation of the measurement," designated "$\hat{y}_k^-$," according to equation 22:

$$\hat{y}_k^- = \begin{vmatrix} -\sin\hat{\theta}_k^- \\ \cos\hat{\theta}_k^-.\sin\hat{\psi}_k^- \\ \cos\hat{\theta}_k^-.\cos\hat{\psi}_k^- \end{vmatrix} \qquad \text{Eq. 22}$$

Next, the process determines the "correction of the a priori estimated state vector" $\begin{pmatrix}\hat{\theta}_k \\ \hat{\psi}_k\end{pmatrix}$, designated "$\hat{x}_k$," based on the a priori estimate of the measurement $\hat{y}_k^-$ and axial accelerations measured at time k, $\begin{matrix}a_{x,k} \\ a_{y,k} \\ a_{z,k}\end{matrix}$, according to "equation 23," reproduced below:

$$\hat{x}_k = \hat{x}_k^- + K_k.\left(\begin{bmatrix} a_{X,k} \\ a_{Y,k} \\ a_{Z,k} \end{bmatrix} - \hat{y}_k^-\right) \qquad \text{Eq. 23}$$

Ex. 1006, 19:7–9.

In a "first variant embodiment" of this process, Bassompiere teaches "replacing the angles of torsion θ and ψ by a quaternion formulation of the same torsion." Ex. 1006, 20:10–11. According to Bassompiere, "[t]his variant exhibits the advantage of avoiding the computations of the sines and cosines of the pitch and roll angles that are greedy in terms of computational power." *Id.* at 20:11–13. The state vector in this first variant embodiment

would therefore be represented in quaternion form, $x=[q_0\ q_1\ q_2\ q_3]$. *Id.* at 20:13–19. The "state model" is set forth in "equation 26" of Bassompiere, reproduced below:

$$\dot{q} = \frac{1}{2}\begin{vmatrix} q_0 \\ q_1 \\ q_2 \\ q_3 \end{vmatrix} \otimes \begin{vmatrix} 0 \\ \omega_X \\ \omega_Y \\ \omega_Z \end{vmatrix} \qquad \text{Eq. 26}$$

Id. at 20:20–24.

2. Claim 1

Petitioner contends that Bassompiere teaches or suggests all of the limitations of claim 1. Pet. 25–52. The Petition contains a limitation-by-limitation analysis comparing the limitations of claim 1 to Bassompiere. *Id.*

a. Undisputed Limitations

Petitioner contends that Bassompiere teaches limitation [1.pre], an electronic device; limitation [1.a], the electronic device comprising a motion sensor module having sensor circuitry configured to generate measured angular velocities and measured axial accelerations; and limitation [1.b], the device further comprising a computing processor having processor circuity configured to calculate a resulting deviation associated with the movements and the rotations of the electronic device in the spatial reference frame. Pet. 25–32 (citing Ex. 1006, 4:1–21, 8:24–27, 9:15–20, 9:23–30, 10:14–22, 10:30–11:6, 11:21–12:9, 12:14–15, 15:3–7, 27:4–8, Figs. 1, 2; Ex. 1002 ¶¶ 44, 45 47–54).

At this stage of the proceeding, Patent Owner does not appear to dispute that Bassompiere teaches limitations [1.pre], [1.a], and [1.b].

Petitioner also asserts that Bassompiere teaches limitation [1.j], which recites that the processor circuitry is "configured to provide content based on the resulting deviation in the spatial reference frame." Pet. 51–52 (citing Ex. 1006, 11:25–12:9, 19:10–11; Ex. 1002 ¶¶ 28–30, 44, App. [1.j]). Patent Owner does not, at this preliminary stage, appear to dispute this assertion.

Having reviewed the record and the parties' contentions, we are persuaded that Petitioner has a reasonable likelihood of showing that Bassompiere teaches limitations [1.pre], [1.a], [1.b], [1.c], and [1.j].

b. Disputed Limitations

The parties' dispute at this stage of the proceeding largely concerns limitations [1.c] through [1.i]. Petitioner characterizes limitations [1.c] through [1.g] of claim 1 as "the calculations performed for one loop, i.e., the present loop at time T, of the EKF algorithm described in the '687 patent," the output of which "is a quaternion, and related angular deviations, that describe how the electronic device is oriented in three-dimensional space." Pet. 32. Petitioner further submits that "[t]he output of any given loop at time T-1 becomes the input of the next loop, i.e., the present loop, at time T, as the previous quaternion." *Id.* (citing Ex. 1002, ¶ 49, 52, 53, App. 1[c]). As discussed below, Petitioner argues that Bassompiere teaches performing these calculations using Euler angles instead of quaternions to characterize the device's orientation in three-dimensional space, and further teaches that one may perform the calculations using quaternions in place of Euler angles.

Limitation [1.c] ("providing a previous quaternion")

For limitation [1.c], which recites providing a previous quaternion corresponding to time T-1 based on the measured axial accelerations and angular velocities at time T-1, Petitioner contends that Bassompiere "teaches

or suggests" this limitation because Bassompiere teaches "using the state vector $\hat{x}_{k-1}^{-}$ from the previous iteration k-1," which Bassompiere "represent[s] by the pitch and roll angles from the previous iteration $\begin{pmatrix}\hat{\theta}_{k-1}\\ \hat{\psi}_{k-1}\end{pmatrix}$," to "calculate an estimate of the state vector . . . at time k." Pet. 32–33 (citing Ex. 1006, 4:20–26,17:5–6, 19:1–3, 28:3–5, 9–13). Petitioner provides an annotated version of Bassompiere's equation 21, reproduced below, that illustrates the Euler-angle term that Petitioner contends corresponds to the claimed previous quaternion:

$$\hat{x}_k^- = \begin{pmatrix}\hat{\Theta}_k^-\\ \hat{\Psi}_k^-\end{pmatrix} = \begin{pmatrix}\hat{\Theta}_{k-1}\\ \hat{\Psi}_{k-1}\end{pmatrix} + T_e \begin{pmatrix}\alpha\sqrt{\omega_y^2 + \omega_z^2}\\ \omega_x\end{pmatrix}$$

Id. at 33. In Petitioner's annotated version of equation 21, Petitioner highlights in yellow the term $\begin{pmatrix}\hat{\theta}_{k-1}\\ \hat{\psi}_{k-1}\end{pmatrix}$, which it contends corresponds to the claimed "previous quaternion." *Id.* Petitioner acknowledges that this term "include[s] the pitch and roll angles in Euler angle form," but asserts that Bassompiere teaches that Euler angles can be replaced "by a quaternion formulation of the same torsion," and that replacing Euler angles with quaternions "exhibits the advantage of avoiding the computations of the sines and cosines of the pitch and roll angles that are greedy in terms of computational power." *Id.* at 33–34 (quoting Ex. 1006, 20:10–13). Petitioner refers us to an additional reference to support its contention that "the benefits of using quaternions over Euler angles was well-known." *Id.* at 34 (citing Ex. 1007, 269–270). Thus, according to Petitioner:

> [A] POSA would have been motivated to modify equation 21 to include quaternions instead of Euler angles. (Ex. 1002, ¶¶ 55–56). In such a modification, the state vectors . . . $\hat{x}_k^-$ and $\hat{x}_{k-1}^-$ would have been represented using quaternions.

Id. at 34.

Petitioner further contends that one of ordinary skill in the art would have had a reasonable expectation of success in using quaternions in place of Euler angles because "quaternions had been successfully used by persons of skill in the art with sensor fusion algorithms, such as extended Kalman filters, to achieve computations efficiencies in real time applications with gyroscopes and accelerometers." Pet. 34 (citing Ex. 1002 ¶¶ 24, 55–57, 65–66; Ex. 1007, 1–3).

Patent Owner argues that "Petitioner concedes that Bassompiere's state vectors 'include the pitch and roll angles in Euler angle form," but asserts that "Euler angles are not quaternions." Prelim. Resp. 27. Patent Owner characterizes Petitioner's argument that one of ordinary skill in the art "would have been motivated to modify equation 21 to include quaternions instead of Euler angles" as the substitution of expert testimony for a missing limitation. *Id.* at 28; *see id.* at 31–33 (arguing that the Petition is defective for improper reliance on expert testimony to supply missing limitations).

We disagree with Patent Owner's characterization. The teaching to use quaternions instead of Euler angles comes from Bassompiere, not Dr. Sarrafzadeh. *See* Ex. 1006, 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."). Rather than supplying a missing limitation, we understand Dr. Sarrafzadeh to be explaining how a person of ordinary skill in the art would have implemented Bassompiere's teaching to use quaternions instead of Euler angles given that person's knowledge of quaternion mathematics.

Patent Owner also argues that "switching from Euler angles to quaternions is not a routine substitution but requires the reengineering of the EKF." Prelim. Resp. 28. Patent Owner similarly contends that Dr. Sarrafzadeh "devotes nearly twenty pages of his declaration to rewriting Bassompiere's Euler-based equations 'in quaternion form,' and explaining how to convert them back to Euler angles," and notes that "[a]s other researchers in the field have confirmed, '[w]hile implementing orientation tracking using quaternions provides advantages like avoiding gimbal lock, it is significantly more complex than the Kalman filer using Euler angles.'" Prelim. Resp. 32 (citing Ex. 1002, 31–51; quoting Ex. 2027, 1). Patent Owner thus contends that replacing Euler angles with quaternions "is not a 'trivial' substitution." *Id.* at 32.

But Petitioner does not appear to be arguing that replacing Euler angles with quaternions would have been "trivial" or simple, only that doing so was taught by Bassompiere and within the knowledge and capabilities of a person of ordinary skill in the art. Pet. 33–34. We determined above that a skilled artisan had knowledge of extended Kalman filters and quaternion mathematics, and we are required to consider the knowledge and capabilities of a person of ordinary skill in our analysis. Further, at this preliminary stage, Patent Owner's assertion that the Euler angle/quaternion switch would not have been a routine substitution is supported only with attorney argument, which is entitled to no weight. *Icon Health & Fitness, Inc. v. Strava, Inc*. 849 F.3d 1034, 1043 (Fed. Cir. 2017). As such, it does not outweigh Dr. Sarrafzadeh's contrary testimony. *See, e.g.*, Ex. 1002 ¶ 56.

Limitation [1.d] ("current quaternion")

Petitioner contends that Bassompiere teaches or suggests limitation [1.d], which recites, *inter alia*, converting the measured angular velocities into a current quaternion and predicted axial accelerations. Pet. 36–38. Petitioner contends that Bassompiere teaches adding the pitch and roll angles from the previous iteration at time k-1 (the previous state vector $\begin{pmatrix}\hat{\theta}_{k-1}\\ \hat{\psi}_{k-1}\end{pmatrix}$) to gyroscope readings at time k (ω_X, ω_Y, ω_Z) to obtain an "a priori estimate of the state vector, $\hat{x}_k^-$," (or $\begin{pmatrix}\hat{\theta}_k^-\\ \hat{\psi}_k^-\end{pmatrix}$), which Petitioner asserts is equivalent to the claimed "current quaternion" in Euler angle form, as set forth in equation 21. *Id.* at 36–37. Again acknowledging that equation 21 uses Euler angles instead of a quaternion to represent the state vector, Petitioner reasons, as it did for limitation [1.c], that it would have been obvious to one of ordinary skill in the art to use quaternions in place of Euler angles for this step. *Id.* at 37. Petitioner contends that "[o]ne way of utilizing the current angular velocities and a previous quaternion . . . to estimate a current quaternion is set forth in Bassompiere in short-hand form in equation 26," reproduced below:

$$\dot{q} = \frac{1}{2}\begin{vmatrix} q_0 \\ q_1 \\ q_2 \\ q_3 \end{vmatrix} \otimes \begin{vmatrix} 0 \\ \omega_x \\ \omega_y \\ \omega_z \end{vmatrix}$$

Id. Petitioner asserts that ω_X, ω_Y, and ω_Z in equation 26 "are the current angular . . . velocities in three dimensions (X, Y, Z) in the sensor frame," that the "previous quaternion" is "represented by the vector q = (q0, q1, q2, q3)," and that "[t]he solution thus yields the "**current quaternion**." *Id.* at 37–38 (citing Ex. 1002 ¶¶ 66–71).

Patent Owner responds that "equations 21 and 26 are clearly not equivalent." Prelim. Resp. 28. Patent Owner states that "[a]s discussed in their own expert declaration, $\dot{q}$ 'is the time derivative of the quaternion,'" whereas "$\hat{x}_k^-$ is 'a prior estimation of the state vector by numerical integration of the chosen dynamic model.'" *Id.* (quoting Ex. 1002 ¶ 66, Ex. 1006, 19:1–2). According to Patent Owner, "[n]either the Petition nor the expert declaration explain how a 'time derivative' is equivalent to an 'estimation' of a 'state vector,'" and therefore the Petition "does not provide a coherent argument that Bassompiere discloses a 'current quaternion' as recited in the claims." *Id.* at 28–29.

We disagree that neither Petitioner nor Dr. Sarrafzadeh explains how Equation 26 is an expression of Equation 21 in quaternion form. Petitioner cites to paragraphs 66–71 of Dr. Sarrafzadeh's declaration for this explanation. Pet. 37–38. At this preliminary stage, Patent Owner does not address this testimony or explain why it is erroneous. Patent Owner also does not dispute Petitioner's assertion that Equation 1 of the '687 patent, although "written in expanded form," is "a similar equation [to Bassompiere's Equation 26] for deriving the current quaternion from the previous quaternion using the measured angular velocities at time T." Pet. 38.

Limitation [1.e] ("predicted axial accelerations")

Petitioner contends that Bassompiere teaches converting the measured angular velocities into predicted axial accelerations, because "Bassompiere determines an '*a priori* estimation of the [acceleration] measurement' ('**predicted axial accelerations**')," represented by $\hat{y}_k^-$, based on the *a prior*

estimation of the state vector $\hat{x}_k^- = \begin{pmatrix} \hat{\theta}_k^- \\ \hat{\psi}_k^- \end{pmatrix}$, which, as indicated by equation 21, is determined from measured axial accelerations. Pet. 38–39. According to Petitioner, equation 22 of Bassompiere, reproduced below, illustrates this calculation:

$$\hat{y}_k^- = \begin{vmatrix} -\sin \hat{\theta}_k^- \\ \cos \hat{\theta}_k^- . \sin \hat{\Psi}_k^- \\ \cos \hat{\theta}_k^- . \cos \hat{\Psi}_k^- \end{vmatrix}$$

Id. (citing Ex. 1006, 19:4–5). Petitioner again asserts that Bassompiere teaches one of ordinary skill in the art to replace the Euler angles with quaternions. *Id.* at 39–40 (citing Ex. 1006, 20:10–19). Petitioner submits that "[a] person of ordinary skill in the art would know how to derive the predicted acceleration of Bassompiere in quaternion form using $\hat{x}_k^-$ in quaternion form," because "the formulas for doing so were already known in the art" and "could be readily derived using quaternion rotation, a basic mathematical operation used with quaternions." *Id.* at 41 (citing Ex. 1002 ¶¶ 72–75).

Patent Owner argues that "the Petition relies exclusively on the simplified Euler angle embodiment of Bassompiere without pointing to a corresponding counterpart in the quaternion embodiment of Bassompiere." Prelim. Resp. 29 (citing Pet. 39–46). According to Patent Owner, Petitioner relies instead on Dr. Sarrafzadeh "to arrive at an equation that they allege . . . 'would yield the exact same formulas as Equations 2 through 4 in the challenged '687 Patent.'" *Id.* (quoting Pet. 41).

Patent Owner does not clearly explain what it understands Bassompiere's "Euler angle embodiment" and "quaternion embodiment" to be, and therefore this argument is not entirely clear. In our view,

Bassompiere's "Euler angle embodiment" is its "first embodiment" for determining a device's 3D orientation, in which a series of calculations are performed using Euler angles to mathematically express the device's orientation. Ex. 1006, 17:5–20:9. Bassompiere's "quaternion embodiment" is its "first variant embodiment" of the "first embodiment" that "replac[es] the [Euler] angles of torsion θ and ψ by a quaternion formulation of the same torsion." *Id.* at 20:10–21:7. Bassompiere thus implies that its "first variant embodiment" includes each calculation in the "first embodiment," with quaternions replacing Euler angles. To the extent that this conflicts with Patent Owner's understanding of Bassompiere's first variant embodiment, Patent Owner has not, at this preliminary stage, set forth that understanding.

With the understanding that Bassompiere's "first variant embodiment" includes all of the calculations in the "first embodiment" with Euler angles replaced by quaternions, the "corresponding counterpart [of equation 22] in the quaternion embodiment" is Bassompiere's equation 22 from the first embodiment, combined with Bassompiere's teaching in the first variant embodiment to replace Euler angles with quaternions. Because this is what Petitioner relies on (Pet. 38–41), we are not persuaded that Petitioner failed to identify a "corresponding counterpart in the quaternion embodiment" of a predicted-axial-acceleration calculation.

Limitation [1.f] ("first comparison result")

Petitioner contends that Bassompiere teaches or suggests limitation [1.f]. Pet. 42–44. Petitioner first asserts that equation 23 of Bassompiere teaches comparing the predicted axial accelerations $\hat{y}_k^-$ with the measured axial accelerations $a_{x,k}$, $a_{y,k}$, $a_{z,k}$, corresponding to time k to obtain a first comparison result. *Id.* at 42. According to Petitioner, the predicted axial

accelerations are subtracted from the measured axial accelerations, the subtraction constituting a comparison of predicted axial acceleration and measured axial accelerations at time T "as part of the EKF process equation [equation 23]." *Id.* (citing Ex. 1006, 19:8–9). Petitioner provides an annotated version of equation 23, reproduced below, to illustrate this calculation:

$$\hat{x}_k = \hat{x}_k^- + K_k \left(\begin{bmatrix} a_{x,k} \\ a_{y,k} \\ a_{z,k} \end{bmatrix} - \hat{y}_k^- \right)$$

In its annotated version of equation 23, Petitioner highlights the alleged predicted-axial-accelerations term $\hat{y}_k^-$ subtracted from measured-axial-accelerations $a_{x,k}$, $a_{y,k}$, $a_{z,k}$,, and asserts that the difference between these terms constitutes the claimed "first comparison result." Pet. 42. This difference is multiplied by a gain (K_k), which is determined using equations 5 through 9 of Bassompiere. *Id.* (citing Ex. 1006, 19:6–9, 16:10–17:4). Petitioner again submits that "[w]hile Bassompiere's equation 23 involves Euler angles, a POSA would have found it obvious to utilize quaternions in place of Euler angles." *Id.* at 44.

At this preliminary stage, Patent Owner does not specifically address Petitioner's analysis of limitation [1.f].

Limitation [1.g] ("obtaining an updated quaternion")

Petitioner asserts that Bassompiere teaches or suggests limitation [1.g]'s requirement of obtaining an updated quaternion associated with time T based on the current quaternion and the first comparison result. Pet. 44. Petitioner again refers to equation 23, which determines the value "$\hat{x}_k$." *Id.* at 45 (citing Ex. 1006, 19:8–9). Petitioner contends that $\hat{x}_k$, which

Bassompiere refers to as the "correction" of the *a priori* estimated state $\hat{x}_k^-$, corresponds to the "updated quaternion" associated with time T, and is based on the parameter corresponding to the current quaternion, $\hat{x}_k^-$, because $\hat{x}_k^-$ "is an explicit part of the equation for calculating $\hat{x}_k$." *Id.* at 45 (citing Ex. 1006, 19:8–9, 29:2–5). Petitioner further contends that equation 23 demonstrates that $\hat{x}_k$ is also based on the "first comparison result"—the difference between the measured axial accelerations and the predicted axial accelerations $\hat{y}_k^-$. *Id.* Petitioner again submits that one of ordinary skill in the art "would have found it obvious to perform the calculations of equation 23 using quaternions instead of Euler angles." *Id.*

Patent Owner argues that the Petition "relies exclusively on the simplified Euler angle embodiment of Bassompiere without pointing to a corresponding counterpart in the quaternion embodiment." Prelim. Resp. 29. This argument is similar to that presented for limitation [1.e]. For reasons discussed above in connection with that limitation, we find this argument unpersuasive.

Limitation [1.h] ("using the updated quaternion as a next occurrence of the previous quaternion")

Petitioner contends that Bassompiere teaches this limitation. Pet. 47 (citing Ex. 1006, 19:3, 20:21; Ex. 1002, App. [1.h]). Patent Owner does not specifically address Petitioner's analysis.

Limitation [1.i] ("providing the resulting deviation")

Petitioner contends that Bassompiere "discloses or suggests this limitation. Pet. 48–51. Patent Owner does not specifically address Petitioner's analysis.

c. Conclusion as to Claim 1

Having reviewed the record and the parties' arguments, we determine that Petitioner has a reasonable likelihood of prevailing with respect to claim 1, and therefore has satisfied the threshold requirement for institution of *inter partes* review on the basis of Ground 1.

3. Claims 2–7, 12, 14, and 25

Petitioner contends that Bassompiere teaches the limitations of claims 2–7, 12, 14, and 25, and supports its contentions with citations to Bassompiere and to Dr. Sharrafzadeh's declaration. Pet. 53–68. At this stage of the proceeding, Patent Owner does not raise any arguments specifically directed to these claims.

"When instituting *inter partes* review, the Board will authorize the review to proceed on all of the challenged claims and on all grounds of unpatentability asserted for each claim." 37 C.F.R. § 42.108(a). We must "either (1) institute as to all claims challenged in the petition and on all grounds in the petition, or (2) institute on no claims and deny institution." CTPG at 5–6, 64; *see also PGS Geophysical AS v. Iancu*, 891 F.3d 1354, 1359–60 (Fed. Cir. 2018) (stating a decision to institute is "a simple yes-or-no institution choice respecting a petition, embracing all challenges included in the petition"). Thus, because we have decided to grant institution on Ground 1 with respect to claim 1, we must do the same for claims 2–7, 12, 14, and 25.

III. CONCLUSION

For the foregoing reasons, we determine that Petitioner has shown that there is a reasonable likelihood that it would prevail with regard to at least

one of the claims challenged in the Petition. Accordingly, we institute *inter partes* review of claims 1–7, 12, 14, and 25 of the '687 patent on all asserted grounds.

IV. ORDER

For the reasons given, it is

ORDERED that the Petition for *Inter Partes* Review is instituted with respect to the grounds asserted in the Petition; and

FURTHER ORDERED that, pursuant to 35 U.S.C. § 314(c) and 37 C.F.R. § 42.4, notice is hereby given of the institution of a trial, which shall commence on the entry date of this Decision.

PETITIONER:

Naveen Modi
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