

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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SAMSUNG ELECTRONICS CO., LTD.  
PETITIONER

V.

CM HK LIMITED  
PATENT OWNER

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Case No.: IPR2025-01071  
Patent No. 11,698,687

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**PETITIONER'S REPLY TO PATENT OWNER'S RESPONSE**

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| <b>Ex. No.</b> | <b>Description</b>                                                                                                                                                                                                                      | <b>Previously Submitted</b> |
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| Ex. 1001       | U.S. Patent No. 11,698,687 to Liou et al. (“the 687 patent”)                                                                                                                                                                            | X                           |
| Ex. 1002       | Declaration of Majid Sarrafzadeh, Ph.D.                                                                                                                                                                                                 | X                           |
| Ex. 1003       | Curriculum Vitae of Majid Sarrafzadeh, Ph.D.                                                                                                                                                                                            | X                           |
| Ex. 1004       | Prosecution History of U.S. Patent No. 11,698,687                                                                                                                                                                                       | X                           |
| Ex. 1005       | WO 2009/156499 to Bassompierre et al.                                                                                                                                                                                                   | X                           |
| Ex. 1006       | Certified Translation of WO 2009/156499 to Bassompierre et al. (“Bassompierre”)                                                                                                                                                         | X                           |
| Ex. 1007       | A. Kim and M. Golnaraghi, “A quaternion-based orientation estimation algorithm using an inertial measurement unit,” <i>PLANS 2004. Position Location and Navigation Symposium (IEEE Cat. No. 04CH37556)</i> , pp. 268-272, 2004 (“Kim”) | X                           |
| Ex. 1008       | <b>RESERVED</b>                                                                                                                                                                                                                         |                             |
| Ex. 1009       | U.S. Patent No. 8,441,438                                                                                                                                                                                                               | X                           |
| Ex. 1010       | U.S. Patent No. 8,552,978                                                                                                                                                                                                               | X                           |
| Ex. 1011       | IPR2018-01258, Paper 86 (Final Written Decision)                                                                                                                                                                                        | X                           |
| Ex. 1012       | IPR2019-00143, Paper 87 (Final Written Decision)                                                                                                                                                                                        | X                           |
| Ex. 1013       | IPR2018-01257, Paper 87 (Final Written Decision)                                                                                                                                                                                        | X                           |
| Ex. 1014       | Provisional Application No. 61/292,558                                                                                                                                                                                                  | X                           |
| Ex. 1015       | 3/7/2018 Deposition Trans. of Dr. LaViola in <i>CyWee Group Ltd. v. Samsung Elecs. Co., Ltd.</i> , 17-cv-00140 (E.D. Tx.)                                                                                                               | X                           |

|          |                                                                                                                                                 |   |
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| Ex. 1017 | 1/7/2025 Plaintiff's P.R. 3-1 & 3-2 Disclosures for <i>Samsung Electronics Co, Ltd. et al v. CM HK, Ltd.</i> (2:24-cv-00880 E.D. Tx.)           | X |
| Ex. 1018 | <i>Sotera</i> Stipulation Email From E. Brann to M. Shore on July 19, 2025                                                                      | X |
| Ex. 1019 | <i>CM HK, Ltd., v. Samsung Electronics Co. Ltd. and Samsung Electronics America, Inc.</i> , No. 2:24-cv-00880, Dkt. 28                          | X |
| Ex. 1020 | <i>CM HK, Ltd., v. Samsung Electronics Co. Ltd. and Samsung Electronics America, Inc.</i> , No. 2:24-cv-00880 ("the Texas Litigation"), Dkt. 55 | X |
| Ex. 1021 | 7/9/2018 Claim Construction Opinion and Order in <i>CyWee Group Ltd. v. Samsung Elecs. Co., Ltd.</i> , 17-cv-00140 (E.D. Tx.)                   | X |
| Ex. 1022 | 5/20/26 Deposition Trans. of Dr. Joseph LaViola in IPR2025-01023 and IPR2025-01071                                                              |   |
| Ex. 1023 | RealNav: Exploring Natural User Interfaces for Locomotion in Video Games", Williamson et al.                                                    |   |
| Ex. 1024 | Responsible Investment & Governance Report 2024, 16, <a href="https://fund.nps.or.kr/eng/main.do">https://fund.nps.or.kr/eng/main.do</a>        |   |
| Ex. 1025 | Declaration of Keunwoo Choi                                                                                                                     |   |

## **I. INTRODUCTION**

Samsung Electronics Co., Ltd. (“Petitioner”) submits this Reply concerning claims 1-7, 12, 14, and 25 (the “challenged claims”) of U.S. Patent No. 11,698,687 (“the ’687 Patent”) (Ex. 1001). Patent Owner’s arguments should be rejected and the claims found unpatentable for at least the reasons set forth in the Petition and accompanying exhibits, the Board’s decision to institute *inter partes* review (“Decision”), cross-examination testimony, and the additional reasons below.

## **II. CLAIM CONSTRUCTION AND BASSOMPIÈRE’S APPLICABILITY TO THE CHALLENGED CLAIMS**

### **A. “quaternion” – Claims 1, 3, 12, 14, and 25**

Patent Owner fails to show that there is any confusion as to the plain meaning of “quaternion” as understood by a POSITA or by the experts in this matter. As explained below, the Board need not construe that term because it does resolve any dispute between the parties. *EmeraChem Holdings, LLC v. Volkswagen Grp. of Am., Inc.*, 714 F. App’x 995, 997 (Fed. Cir. 2017) (“Claim terms are construed to resolve a ‘controversy, and only to the extent necessary to resolve the controversy.’”).<sup>1</sup>

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<sup>1</sup> Patent Owner faults Petitioner for not construing any terms other than “spatial reference frame.” (Response, 36-37.) But, as explained in Section II of this Reply, Patent Owner has not shown that the terms not construed in the Petition warrant anything other than their plain and ordinary meaning.

Patent Owner argues that its proposed construction is dispositive because “Petitioner does not contend that Bassompierre discloses quaternions.” (Response, 21.) Wrong. As the Board recognized, Petitioner relied on, *inter alia*, Bassompierre’s teachings of “[a] first variant embodiment,” which involves “replacing the angles of torsion  $\theta$  and  $\psi$  by a quaternion formulation of the same torsion.” (Decision, 29; *see also id.*, 30-31 (discussing the Petition’s analysis of Bassompierre’s quaternion disclosures); Petition, 36-37 (discussing Bassompierre’s equation 26).) Patent Owner does not dispute that Bassompierre’s “first variant” embodiment discloses a quaternion under Patent Owner’s construction. Patent owner’s argument is that a POSITA would not have been motivated to use quaternions instead of Euler angles in Bassompierre’s EKF (Response, 40-41) but that does not turn on, and would not be resolved by, Patent Owner’s proposed construction of “quaternion.”

**B. “predicted axial accelerations” – Claims 1, 4, and 14**

Here too, Patent Owner proposes a construction that does not resolve any dispute between the parties and should therefore be rejected. Patent Owner contends that Bassompierre cannot satisfy Patent Owner’s proposed construction (“gravitational acceleration along the electronic device’s axes derived from the current quaternion”) because “Equation 22 [of Bassompierre] is written entirely in Euler angles and includes no quaternions.” (Response, 41-42.) But, as the Board

recognized at institution, this argument does not address Petitioner's analysis that a POSITA would have been motivated to use the Euler angle-based Equation 22 of Bassompierre in quaternion form. (Decision, 16-17, 32-34; Petition, 38-41.) For this reason alone, the Board should decline to adopt Petitioner's proposed construction. *EmeraChem Holdings*, 714 F. App'x at 997.

Patent Owner's construction is also not supported by the intrinsic evidence. Contrary to Patent Owner's assertion, the cited portions of the claims and the specification do not "define" predicted axial accelerations as gravitational acceleration. (Response, 22-23 (*citing* Ex. 1001, claim 1, 17:17-37, 45-60).) The other portion of the specification cited by Patent Owner in support of this narrowing merely states that "undesirable" axial accelerations are caused by forces other than gravity and that the described sensor fusion algorithm can serve to exclude such undesirable interferences. (*Id.*, 23-24 (*citing* Ex. 1001, 18:48-62).) Nothing in that portion of the specification excludes accelerations like linear or centrifugal accelerations from being part of the claimed predicted axial acceleration. Critically, the cited portion relates to "preferred embodiment[s]" and "example[s]" that are "provided for illustrative purposes only." (Ex. 1001, 18:31-19:2.) Patent Owner does not demonstrate that the statements herein limit claim scope. *IQRIS Techs. LLC v. Point Blank Enters.*, 130 F.4th 998, 1004 (Fed. Cir. 2025) (*citing Playtex Prods., Inc. v. Procter & Gamble Co.*, 400 F.3d 901, 907-08 (Fed. Cir. 2005) ("It is

the claims, not the preferred embodiments, that define the metes and bounds of the patentee's invention.”).

Patent Owner alleges that Petitioner and its expert have taken inconsistent positions regarding the meaning of “predicted axial acceleration.” (Response, 24-28.) The Board has already noted that Petitioner has sufficient reason to contend here that “predicted axial accelerations” should be accorded its plain and ordinary meaning. (Decision, 21-22.) Dr. Sarrafzadeh’s testimony that “predicted axial acceleration” is “a prediction of the axial acceleration, based on a prediction method” is wholly consistent with the plain and ordinary meaning, which is prediction of an axial acceleration. (Ex. 2035, 154:7-10, 84:15-21, 90:12-17, 124:12-19, 125:19-21.)

Patent Owner’s twisting and turning of *isolated* sentences from Dr. Mercer’s report in the *CyWee* litigation does not establish any inconsistency in Samsung’s positions. (Response, 25-28.) As an initial matter, Patent Owner did not submit a complete unredacted copy of Dr. Mercer’s report, thereby depriving the Board of the full context of Dr. Mercer’s statements.

Regardless, Patent Owner has not demonstrated that Samsung or Dr. Sarrafzadeh analyzed predicted axial acceleration as a “gravitational acceleration component *isolated from* [the] composite value” of acceleration output by the accelerometer. (*Contra* Ex. 2036, ¶203 (emphasis added).) Samsung relied on Bassompierre’s equation 22, which is derived by multiplying a rotation matrix by the

gravity vector (Ex. 2035, 99:7-100:7), not by isolating gravitational acceleration from a composite acceleration value. Significantly, Patent Owner ignores Dr. Mercer’s statement that the composite acceleration value can be just “gravitational” acceleration. (Ex. 2036, ¶203 (“composite acceleration value (linear, centrifugal, *and/or* gravitational”) (emphasis added).) Similarly, Patent Owner relies on two isolated sentences from Dr. Mercer’s report differentiating between the words “predicted” and “estimated” to suggest that his testimony conflicts with Samsung’s reliance on equation 22’s “a priori estimation.” (Response, 26; Ex. 2040, ¶¶ 98-100.) But there is *zero* context for Dr. Mercer’s statements as Patent Owner redacts significant portions of the surrounding statements. (*See* Ex. 2036, ¶¶204-206.) Moreover, those statements were made in the context of non-infringement (*see id.*, ¶207) and Patent Owner does not demonstrate that the algorithm in the accused products in that litigation is identical to Bassompierre’s EKF algorithm such that Samsung’s IPR positions conflict with its prior positions in the *CyWee* litigation.

### C. “spatial reference frame” – Claims 1, 2, 7, and 14

The Board need not construe the term because neither party’s construction is necessary to resolve the parties’ dispute.<sup>2</sup> There is no dispute that Bassompierre

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<sup>2</sup> Construction of the “spatial reference frame” while apparently not relevant to the ’687 patent appears relevant to the parties’ dispute in the related IPR2025-01023.

discloses the claimed “spatial reference frame” under either party’s construction. The parties dispute whether the spatial reference frame is associated with “a 3D pointing device,” as Petitioner contends, or “the electronic device” as Patent Owner posits. But that dispute has no relevance to Samsung’s prior art mapping because Patent Owner does not dispute that Bassompierre’s pointer is an “electronic device” (under its construction) and a 3D pointing device (under Samsung’s construction). (Petition, 25-26; Response, 39-45.) Nor does Patent Owner dispute that the pointer’s reference frame (X, Y, Z) is a “spatial reference frame,” as claimed. (*Id.*)

**D. “resulting deviation” – Claims 1, 7, 12, 14, and 25**

Patent Owner’s proposed construction should be rejected because it is contrary to express claim language and improperly seeks to limit the claims based on examples in the specification. (Response, 32-34.) Patent Owner incorrectly states that “the specification defined ‘resulting deviation’ with precision and consistency.” (*Id.*, 32.) The specification makes numerous references to the resulting deviation with no mention of yaw, pitch, and roll angles, confirming lack of the lexicography mandating Patent Owner’s proposed construction. (Ex. 1001, 11:38-43, 13:5-14, 13:60-14:5.)

Patent Owner’s inclusion of yaw angles in its construction is negated by the claims. Claims 1 and 14 expressly excludes yaw angle measurement and determination. (*Id.*, 31:36-39, 33:10-14 (“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”).) This express exclusion was added by amendment to overcome a prior art rejection. (Ex. 1004, 390-391.)

Moreover, the proposed construction’s inclusion of yaw is not supported by the claim language in view of the specification. In advocating for its proposed construction, Patent Owner contends that “the specification further explains that the resulting deviation is obtained and output in an ‘absolute’ manner, meaning it reflects the actual movements and rotations of the electronic device in the spatial reference frame rather than a relative or partial measurement.” (Response, 34 (*citing* Ex. 1001, 19:63-20:3, 22:55-62, 30:39-53).) These portions of the specification concern the use of a nine-axis motion sensor, which includes use of a rotation sensor (gyrometer) for detecting angular velocities, an accelerometer capable of detecting axial accelerations, *and a magnetometer capable of detecting magnetism*. (Ex. 1001, 5:45-55, 6:4-15.) The ’687 patent specification explains that readings from the magnetometer are used to provide more precise yaw angle readings. (*Id.*, 25:2-25 (equation 21).) Claims 1 and 14 recite a sensor for measuring angular velocity and axial acceleration, but not magnetism (again, the claims expressly exclude yaw), and do not therefore seek “absolute” orientation readings. (*Id.*, 31:18-20, 32:62-64.) Patent Owner’s expert confirmed that yaw-angle predictions drift and are generally

inaccurate in the absence of magnetometer readings. (Ex. 1022, 24:12-15, 26:14-27:6, 37:19-38:6, 107:21-109:3.)

If Patent Owner intended that the recited resultant angles include pitch, roll and yaw angles, it could have said so in the claims. Indeed, non-challenged claims 9, 10, 22, and 23 recite use of a magnetometer and explicitly recite the yaw angle. These claims make clear that the magnetometer provides accurate yaw determinations that the mere use of only the rotation sensor and accelerometer of claims 1 and 7 cannot. Adoption of Patent Owner's construction of "resultant angles" would render those dependent claims meaningless under the presumption of claim differentiation. *Intel Corp. v. Qualcomm Inc.*, 21 F.4th 801, 810 (Fed. Cir. 2021) ("[i]t is highly disfavored to construe terms in a way that renders them void, meaningless, or superfluous"); *Phillips v. AWH Corp.*, 415 F.3d 1303, 1315 (Fed. Cir. 2005).

**E. Provide/Providing Content based on the Resulting Deviation in the Spatial Reference Frame – Claims 1, 14**

Here again, Patent Owner proposes a construction that does not resolve any dispute between the parties. Patent Owner proposes a construction where "content" must be provided "in the spatial reference frame," yet Patent Owner fails to clearly identify how such a construction would resolve the question of Bassompierre's

applicability to the challenged claims. (Response, 39-45.) For this reason alone, the Board need not construe the term.

Patent Owner's proposed construction should be rejected because it is contrary to the claim's plain meaning and improperly seeks to limit the claim's scope to specific embodiments in the specification.

As an initial matter, the construction makes little sense. Patent Owner argues that its construction specifies that the content is rendered or expressed in the device's own spatial reference frame. (Response, 36.) But content is rendered or expressed on a display, not in an imaginary reference frame. Patent Owner's construction makes little sense and is an improper attempt at reading into the claims a display into the electronic device whose reference frame is the spatial reference frame.

Patent Owner's construction is also not supported by the claim. Claim 1 recites a computing processor configured to "provide content based on the resulting deviations in the spatial reference frame." (Ex. 1001, 31:51-52.) No commas separate the words, thus each phrase modifies an immediately succeeding or preceding phrase such that the computing processor provides the content, that content is based on resulting deviation, and that resulting deviation is in the spatial reference frame. If patentee wished to claim that the *content* was provided in the spatial reference frame, patentee would have included commas at the beginning and end of the phrase "based on the resulting deviation" to signal that "in the spatial

reference frame,” is not modifying the phrase immediately before it (“based on the resulting deviation”) but by the phrase before the first comma (“provide content”). In other words, the claim would read: “provide content, based on the resulting deviations, in the spatial reference frame.” But the claim uses no such commas. Plain meaning dictates that the content “in the spatial reference frame” modifies “the resulting deviation,” not “provide content.”<sup>3</sup>

This plain meaning understanding is consistent with the ’687 patent’s split configuration of Figure 5, which describes an “electronic device” (500) with a pointer (560) that moves “in the spatial *pointer* reference frame” (Ex. 1001, 11:52-62, 13:5-12 (emphasis added)), where the content is displayed on a display (582) of laptop (580) that has its own display reference frame (*id.*, 13:5-14). Here, consistent with the plain meaning of claims 1 and 14, the content is not restricted to display on a component whose reference frame is the spatial reference frame. Adopting Patent Owner’s construction would exclude the embodiment of figure 5 and should therefore be rejected. *CUPP Computing AS v. Trend Micro Inc.*, 53 F.4th 1376, 1381 (Fed. Cir. 2022) (internal citation omitted) (“claim interpretation that excludes a preferred embodiment from the scope of the claim is rarely, if ever, correct”).

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<sup>3</sup> The same argument applies to claim 14, which recites the same limitation other than reciting “providing” instead of “provide.” (*Id.*, 33:24-25.)

Patent Owner's construction should be rejected and the term given its ordinary meaning.

### **III. BASSOMPIÈRE DISCLOSES OR SUGGESTS ALL OF THE CLAIM LIMITATIONS**

#### **A. Bassompierre discloses “quaternions”**

Patent Owner acknowledges that Petitioner relies on Bassompierre's Euler-based EKF equations in quaternion form. (Response, 40-41.) Patent Owner does not dispute that modifying Bassompierre's Euler-based EKF equations to use quaternions discloses the claimed “previous quaternion,” “current quaternion,” and “updated quaternion.” (*Id.*) Instead, Patent Owner contends that “a POSA would not have been motivated to make those modifications.” (*Id.*) Petitioner addresses Patent Owner's arguments against motivation in Section IV below.

#### **B. Bassompierre discloses “predicted axial accelerations”**

Patent Owner argues that Bassompierre's Equation 22 cannot provide “predicted axial acceleration” because it is “written entirely in Euler angles and includes no quaternions.” (Response, 42.) Yet, Patent Owner does not contest that Equation 22 of Bassompierre predicts acceleration along axes. (*Id.*) Further, the Board found that Patent Owner “acknowledges that Bassompierre predicts axial accelerations.” (Decision, 16.) As the Petition explains, Equation 22 of Bassompierre teaches determination of “predicted axial accelerations” in Euler angle

form and a POSITA would know to derive that equation in quaternion form to arrive at the exact same known Equations 2 through 4 of the '846 patent, taking the values of  $[q_1 \ q_2 \ q_3 \ q_4]$  from the current quaternion:

$$\begin{bmatrix} 2(q_1q_3 + q_0q_2) \\ 2(q_2q_3 - q_0q_1) \\ q_0^2 - q_1^2 - q_2^2 + q_3^2 \end{bmatrix}$$

(Petition, 38-41; Ex. 1002, ¶¶53, 72-75, App. [1.e].) Bassompierre thus teaches predicted axial accelerations, as claimed.

### **C. Bassompierre discloses “resulting deviation”**

In contending that Bassompierre fails to disclose the claimed “resulting deviation” (Response, 42-44), Patent Owner admits that Bassompierre “tracks pitch and roll within the state vector” (*id.*, 42-43). Bassompierre’s pitch angle  $\theta$  and roll angle  $\psi$  are “resulting deviation” associated with movements and rotations in the spatial reference frame because they represent the deviation in angular terms of the pointing device’s reference frame (XYZ) from a reference frame ( $uvw$ ) of the user’s limb, as the user moves and rotates the pointing device. (Petition, 31-32, 56-57.) Bassompierre setting of yaw to zero (Response, 43) is immaterial because, as already explained in Section II.D, the claims expressly exclude yaw. Bassompierre thus meets the claim limitation.

Patent Owner’s contention that the Petition did not analyze Bassompierre’s Equation 27 and that equation is the “one quaternion equation [that] actually provides for obtaining output” (Response, 43) is incorrect. The Petition explains that “ $\omega_v$  and  $\omega_w$  . . . give direct information on the horizontal displacements (rotation about the axis  $\omega$  represented by  $\omega_w$ ) and vertical displacements (rotation about the axis  $v$  represented by  $\omega_v$ ) and therefore the displacement of the mobile element on the screen ( $d_y$  and  $d_z$ ).” (Petition, 52.) Equation 24 discloses the calculation of  $\omega_w$  and  $\omega_v$  using the pitch and roll angles ( $\theta$   $\psi$ ) of the updated quaternion. (Ex. 1006, 19:10–11 (equation 24).) Petitioner does not allege that  $\omega_v$  and  $\omega_w$  are the resulting deviation, nor that Equation 27 is necessary for calculating resulting deviation. (Petition, 48-51.) Instead, Petitioner alleges that the output of Bassompierre’s equation 23 is a quaternion representing the pitch and roll angles and that a POSITA would have reason to convert that quaternion into pitch and roll angles (“resulting deviation”) in Euler angle format for use in equation 24 to calculate  $\omega_v$  and  $\omega_w$ , which in turn are used to move content on the display. (*Id.* (citing Ex. 1002, ¶¶81-82).)

Patent Owner assumes, incorrectly, that a POSITA motivated to use quaternions in Bassompierre’s EKF would necessarily use equation 27. (Response, 43-44 (Ex. 2040, ¶128).) Patent Owner provides no basis in Bassompierre for that assertion. A POSITA reading Bassompierre would not read it as requiring use of equation 27 if quaternions were used. Instead, Bassompierre states that “[s]everal

variants are possible” and that “it is advantageous to retain a *two-step algorithm*.” (Ex. 1006, 20:7-9 (emphasis added).) The two-step algorithm is the one described in figure 6 and which Samsung relies on in its petition. (Petition, 48-51; Ex. 1006, 15:3-7, FIG. 6.) Neither Patent Owner nor Dr. La Viola dispute this reading of Bassompierre. It is black-letter law that “a prior-art reference ‘must be considered for everything it *teaches* by way of technology and is not limited to the particular *invention* it is describing and attempting to protect.’” *Netflix, Inc. v. DivX, LLC*, No. 2022-1083, 2023 WL 2298768, at \*4 (Fed. Cir. Mar. 1, 2023).

In fact, the prior art (such as Kim (Ex. 1007)) expressly recognizes that a POSITA would execute an EKF using quaternions and then decompose the output quaternion “into the more intuitive representation of roll, pitch, and yaw.” (Petition, 50-51 (citing Ex. 1007, 271); *see also* Ex. 1002, ¶282.) Dr. La Viola does not address Petitioner’s showing regarding Kim and his conclusory and narrow reading of Bassompierre should be rejected as it does not consider the prior art’s teachings as a whole. Moreover, the ’687 patent itself converts the updated quaternion back into pitch, roll, and yaw angles in Euler angle format. (*See* Ex. 1001, 19:46-55; Ex. 2040, ¶108.) To the extent Patent Owner is suggesting that conversion back from quaternion to Euler angle format would have been inefficient, Patent Owner cannot claim a patentable distinction over Bassompierre merely because it claimed an inefficient computational method. As Samsung explained in the Petition, converting

the quaternion output of equation 23 into Euler angles would have been one of two available choices for a POSA, and thus obvious. (Petition, 50-51.) *Uber Techs., Inc. v. X One, Inc.*, 957 F.3d 1334, 1339 (Fed. Cir. 2020) (holding that when there are “only two possible methods,” the use of each method is obvious).

**D. Bassompierre discloses a “data association model”**

Without invoking any claim construction dispute, Patent Owner argues that Bassompierre fails to disclose a “data association model” because Equation 23 is in Euler angle form, not quaternion form. (Response, 44-45.) Patent Owner apparently concedes that Equation 23 includes a model for comparing measured acceleration and predicted acceleration  $\hat{y}_{\bar{k}}$  data by subtracting one from the other, but lacks only the utilization of a quaternion-based state vector to perform such comparison in the overall context of the EKF equation. (*Id.*) Based on Bassompierre’s teaching, a POSITA would readily know to implement Equation 23 with a four-dimensional current quaternion  $\hat{q}_{\bar{k}}$  in view of Bassompierre’s teaching that the Kalman gain  $G$  is multidimensional. (Petition, 46-47; Ex. 1002, ¶79.) Patent Owner does not dispute the correctness of Petitioner’s derivation of the Kalman gain equivalent requiring a 4x3 matrix to project Euler to quaternion space, only the motivation of a POSITA to

implement the EKF in quaternion form (Ex. 2040, ¶131), which is addressed in the next section. Bassompierre teaches the data association model.<sup>4</sup>

#### IV. A POSITA WOULD HAVE BEEN MOTIVATED TO MODIFY BASSOMPIÈRE

Patent Owner’s six arguments for why a POSITA would not have been motivated to modify Bassompierre’s Equation 21 to substitute quaternions for Euler angles fail for the following reasons.

*First*, Patent Owner’s admission that quaternions are more computationally efficient than Euler angles is support for, not against, the notion of a POSITA implementing the EKF equation of Bassompierre, including Equation 21, in quaternion form. (*Id.*, 46 (“the computational efficiency advantage of quaternions over Euler angles was well known to a POSA long before Bassompierre.”).) Bassompierre indisputably recognized the computational efficiency of quaternions over Euler angles. (*Id.*)

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<sup>4</sup> The petition mistakenly refers to the current quaternion as  $\hat{x}_k$  instead of  $\hat{x}_k^-$  in the discussion of the data comparison model. (Petition, 63.) This is a clear typographical and notational error where the petition should have used  $\hat{x}_k^-$  for the current quaternion as it does in every other location in the Petition. Patent Owner’s Response articulates no clear reason why this typographical error supports the notion that Bassompierre does not include a data association model. (Response, 45.)

*Second*, though Patent Owner alleges that Bassompière “first variant embodiment” is not *preferred* over its Euler angle embodiment (*id.*, 46-47), Patent Owner cites no authority that reliance on the “first variant embodiment” requires such embodiment to be the preferred one. *Bayer Pharma AG v. Watson Labs., Inc.*, 874 F.3d 1316, 1328 (Fed. Cir. 2017) (“[O]bviousness does not require that the motivation be the *best* option, only that it be a *suitable* option from which the prior art did not teach away.” (original emphasis) (cleaned up)).

*Third*, Patent Owner does not dispute that Bassompière teaches an EKF filter or the accuracy of Petitioner’s quaternion calculations and derivations. (Ex. 1022, 18:19-20:6.) Patent Owner argues only that such calculations would be complex and require application of mathematical techniques like kinematic differential equations, normalization, and large matrix calculations. (Response, 47-48, 53.) But Patent Owner does not dispute the benefits of using quaternions instead of Euler angles. Patent Owner’s argument that a POSITA would see no benefit in using quaternions instead of Euler angles in a system with only two degrees of freedom (i.e., pitch and roll) is addressed by Bassompière’s own teaching that use of quaternions “exhibits the advantage of avoiding computations of the sines and cosines of the *pitch and roll angles* that are greedy in terms of computation power.” (Ex. 1006, 20:10-13 (emphasis added).) Moreover, Dr. La Viola’s testimony in support of Patent Owner’s argument is conclusory as he never explains why a quaternion

implementation would not provide a computational advantage for a two-degree-of-free system. (*See* Ex. 2040, ¶137.)

Patent Owner relatedly argues that Dr. Sarrafzadeh’s use of complex math to show the equivalency of EKF calculations in Euler and quaternion form means that Petitioner engaged in gap-filling. (Response, 51-55.) Patent Owner acknowledges that Bassompierre presents related Euler angle and quaternion equations, such as Equation 21 and 26, both of which concern the orientation determination. (Response, 52-53.) That one equation is discrete and one in derivative form requiring discretization is immaterial. The application of complex, but well-known, mathematical concepts to convert from one space to another is not gap-filling, but mere application of a POSITA’s knowledge and skill.

*Fourth*, there is no hindsight bias in Petitioner’s analysis of the EKF equations of Bassompierre. As explained in Section III.C, Patent Owner’s argument fails to consider Bassompierre’s teachings as a whole. Bassompierre discloses an embodiment with  $\hat{x}_{\bar{k}}$  as a *quaternion* state vector, i.e., using  $[q_0 \ q_1 \ q_2 \ q_3]$  rather than Euler angle pitch/roll  $[\theta \ \psi]$ . (*Id.*, 20:18-20.) From this substitution (and equation 26, which is a quaternion form of equation 21 for finding the “current quaternion” (Petition, 35, 37-38)) a POSITA would work *forward* (not backward (Response, 49)), as explained in Samsung’s Petition and Dr. Sarrafzadeh’s declaration. (Petition, 32-47; Ex. 1002, ¶¶65-79.) For example, a POSITA would use the

“current quaternion” at time T to calculate the “predicted acceleration” at time T, and “updated quaternion” at time T in Bassompierre’s EKF equations:

| Euler Angle Form                                                                                                                                                                                                                                                              | Quaternion Form                                                                                                                                                                                          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| “previous quaternion” and “current quaternion”                                                                                                                                                                                                                                |                                                                                                                                                                                                          |
| $\hat{x}_k^- = \begin{pmatrix} \hat{\theta}_k^- \\ \hat{\psi}_k^- \end{pmatrix} = \begin{pmatrix} \hat{\theta}_{k-1} \\ \hat{\psi}_{k-1} \end{pmatrix} + T_e \begin{pmatrix} \alpha \sqrt{\omega_y^2 + \omega_z^2} \\ \omega_x \end{pmatrix}$ <p>(Ex. 1006, equation 21.)</p> | $\dot{q} = \frac{1}{2} \begin{bmatrix} q_0 \\ q_1 \\ q_2 \\ q_3 \end{bmatrix} \otimes \begin{bmatrix} 0 \\ \omega_x \\ \omega_y \\ \omega_z \end{bmatrix} ;$ <p>(Solution to Ex. 1006, Equation 26.)</p> |
| “predicted acceleration”                                                                                                                                                                                                                                                      |                                                                                                                                                                                                          |
| $\hat{y}_k^- = \begin{bmatrix} -\sin \hat{\theta}_k^- \\ \cos \hat{\theta}_k^- \cdot \sin \hat{\psi}_k^- \\ \cos \hat{\theta}_k^- \cdot \cos \hat{\psi}_k^- \end{bmatrix}$ <p>(Ex. 1006, equation 22.)</p>                                                                    | $\begin{bmatrix} 2(q_1 q_3 + q_0 q_2) \\ 2(q_2 q_3 - q_0 q_1) \\ q_0^2 - q_1^2 - q_2^2 + q_3^2 \end{bmatrix}$ <p>(Petition, 38-41.)</p>                                                                  |
| “updated quaternion”                                                                                                                                                                                                                                                          |                                                                                                                                                                                                          |
| $\hat{x}_k = \hat{x}_k^- + K_k \left( \begin{bmatrix} a_{X,k} \\ a_{Y,k} \\ a_{Z,k} \end{bmatrix} - \hat{y}_k^- \right)$ <p>(Ex. 1006, equation 23.)</p>                                                                                                                      | $\hat{q}_k = \hat{q}_k^- \otimes (K_k(z_k - h(\hat{q}_k^-)))$ <p>(Petition, 46-47.)</p>                                                                                                                  |

(Ex. 1002, ¶¶76-79.) Again, Patent Owner does not dispute the correctness of the above equivalent quaternion equations.

*Fifth*, Patent Owner’s argument that “even if a POSA substituted quaternions for Euler angles throughout Bassompierre, the modified system would still not disclose the limitations the challenged claims require” (Response, 49) is wrong. Bassompierre and the asserted claims pursue the same objectives, namely, render movement on a display. Patent Owner’s discussion of Bassompierre’s carrier

reference frame and the supposed decoupling of the pointer's absolute spatial orientation from cursor movement is a distraction. (*Id.*, 12-16, 10-11.) Equation 24 and Bassompierre's own teaching that " $\omega_v$  and  $\omega_w$  . . . give direct information on the horizontal displacements (rotation about the axis  $\omega$  represented by  $\omega_w$ ) and vertical displacements (rotation about the axis  $v$  represented by  $\omega_v$ ) and therefore the displacement of the mobile element on the screen ( $dy$  and  $dz$ )."

(Petition, 51-52; Ex. 1006, 11:25–12:9.) Bassompierre thus provides the necessary teaching for the claimed translation of pointer movement (spatial reference frame) to the display. Patent Owner's argument that "pitch, roll, and yaw are not used to determine pointer orientation" in Bassompierre (Response, 49) is immaterial. As discussed above in Sections II.D, yaw determination is not required by the challenged claims.

*Sixth*, Patent Owner's argument that by starting "from the Euler angle embodiment, rather than Bassompierre's first variant embodiment, Dr. Sarrafzadeh demonstrates that Bassompierre does not provide enough information for a POSITA to develop a quaternion EKF" (*id.*, 50) ignores the knowledge of a POSITA. Bassompierre provides only Equations 25 through 27 in quaternion form because it assumes that a POSITA knows how to implement the EKF equations in quaternion form. *Kim* confirms this, showing the determination of the predicted acceleration from quaternions as part of the measurement model of the EKF, but leaving to the POSITA the remaining details of the full EKF implementation. (Ex. 1007, 270,

Section III.B.) Similarly, Patent Owner’s expert published papers describing the use of EKFs in quaternion form without detailing the relevant equations and operations in quaternion form. (Ex. 1023.)

## V. NPS IS NOT AN RPI

NPS did not control, fund, or influence this IPR in any way. (*See* Ex. 1025, ¶¶1-4.) NPS cannot be an RPI for this reason alone. NPS’s alleged 7.8% ownership stake does not warrant a different conclusion. *Tianma* itself notes that a percentage ownership is “not necessarily dispositive.” *Tianma Microelectronics Co. v. LG Display Co.*, IPR2025-01579, Paper 12, 8 n.6 (March 18, 2026) (precedential). Here, NPS is merely a passive pension fund no different from other passive owners (e.g., Vanguard) of U.S. publicly traded companies. Patent Owner has not shown otherwise. It’s speculation that “NPS possesses the ability to influence Samsung’s...litigation” (Paper 28, 3–4) is baseless because NPS’s responsible-investment materials treat “litigation” as NPS’s own shareholder derivative suits or damages claims and state that, in that context, NPS “does not exercise any influence on investee companies or directors.” (Ex. 1024, 16; *see also* Paper 33, 5–6 (Board finding it “at least as likely, if not more so,” that “litigation” refers to NPS initiating litigation on its own behalf); Ex. 2044, 53, 60.)

## **VI. PATENT OWNER’S OTHER ARGUMENTS ARE MERITLESS**

Contrary to Patent Owner’s arguments, the absence of quaternions from the provisional application does not conflict with Petitioner’s obviousness position that Bassompierre teaches the use of quaternions. (Response, 58-59.) Unlike Bassompierre, the provisional application indisputably does not once mention quaternions, let alone suggest to a POSITA that quaternions ought to be utilized. (Petition, 68-70.)

Patent Owner again argues for §325(d) discretionary denial by alleging that Petitioner failed to carry its burden under *Ecto World*. (Response, 38.) That argument was raised as part of discretionary denial briefing and rejected.

Patent Owner’s argument that Dr. Sarrafzadeh’s testimony is not credible is meritless. (*Id.*, 55-58.) In a seven-hour deposition and in a rebuttal expert declaration, Patent Owner could not identify any substantive errors in Dr. Sarrafzadeh’s declaration. That Dr. Sarrafzadeh could not remember on the spot the exact number of hours spent preparing the declaration or the source of the references raised in his declaration do not go to the credibility of his technical opinions, which remain undisturbed. Patent Owner’s incorrect construction of “predicted axial accelerations” and mischaracterizing of the record relating to that term cannot be the basis for Dr. Sarrafzadeh’s supposed failure to articulate or consistently apply claim construction. (*Supra*, Section II.B.)

## **VII. CONCLUSION**

The Board should find claims 1-7, 12 and 14 of the '687 patent unpatentable and cancel them.

Respectfully submitted,

Dated: July 17, 2026

By: /Naveen Modi/  
Naveen Modi (Reg. No. 46,224)

Counsel for Petitioner

**CERTIFICATE OF COMPLIANCE**

Pursuant to 37 C.F.R. § 42.24(d), the undersigned certifies that the foregoing Petitioner's Reply to Patent Owner's Response contains, as measured by the word-processing system used to prepare this paper, 4,780 words. This word count does not include the items excluded by 37 C.F.R. § 42.24 as not counting towards the word limit.

Respectfully submitted,

Dated: July 17, 2026

By: /Naveen Modi/  
Naveen Modi (Reg. No. 46,224)  
Counsel for Petitioner

**CERTIFICATE OF SERVICE**

I certify that I caused to be served on the counsel identified below a true and correct copy of the Petitioner's Reply to Patent Owner's Response and supporting exhibits by electronic means on July 17, 2026:

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