1 UNITED STATES PATENT AND TRADEMARK OFFICE

2 _____

3 BEFORE THE PATENT TRIAL AND APPEAL BOARD

4 _____

5 SAMSUNG ELECTRONICS CO., LTD.,

6 _____

7 Petitioner,
v.
8 CM HK LIMITED,
Patent Owner.
9 _____

10 Case IPR2025-01023
Patent No. 10,852,846
11 _____

12 DEPOSITION of
JOSEPH LaVIOLA, Ph.D.
13 taken on behalf of Petitioner

14

15 DATE: May 20, 2026

16 TIME: 8:59 a.m. to 3:02 p.m.

17 PLACE: The Celeste Hotel
4105 North Alfaya Trail
18 Orlando, Florida 32826

19 BEFORE: Dawn A. Hillier, RMR, CRR
Stenographic Reporter
20 Notary Public - State of
Florida, at Large
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22 JOB NO: 633869

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8 EXHIBITS

9 Samsung Exhibit 2040 Expert Declaration 6
of Joseph LaViola, Ph.D. in
10 Support of Patent Owner's
Response, Re: IPR2025-01023,
11 Patent 10,852,846

12 Samsung Exhibit 2040 Expert Declaration 6
of Joseph LaViola, Ph.D. in
13 Support of Patent Owner's
Response, Re: IPR2025-01071,
14 Patent 11,698,687

15 Samsung Exhibit 1001 US Patent 6
10,852,846
16

17 Samsung Exhibit 1001 US Patent 7
11,698,687
18

19 Samsung Exhibit 1006 Bassompierre 7
reference, International
20 Publication Number WO
2009/156499 A1
21

22

1 Samsung Exhibit 2038 Euler Angles, Quaternions, and Transformation Matrices 10
2
3 Samsung Exhibit 1022 RealNav: Exploring Natural User Interfaces for Locomotion in Video Games 28
4
5 Samsung Exhibit 1023 On Kalman Filtering With Nonlinear Equality Constraints 80
6
7
8 REPORTER'S KEY TO PUNCTUATION:
9 -- At end of question or answer references
10 interruption.
11 ... References a trail-off by the speaker.
12 No testimony omitted.
13 "Uh-huh" "Um-hum" References affirmative sound.
14 "Huh-uh" "Um-um" References negative sound.
15
16
17
18 CERTIFIED STENOGRAPHER'S NOTE: All quotations from exhibits are reflected in the manner in which they were
19 read into the record and do not necessarily denote an exact quote from the document.
20
21
22

1 JOSEPH LaVIOLA, Ph.D.,
2 was called as a witness and, having first been duly
3 sworn, was examined and testified as follows:
4 THE WITNESS: I do.
5 CERTIFIED STENOGRAPHER: Thank you.
6 EXAMINATION
7 BY MR. LAURENZI:
8 Q Good morning. Morning.
9 A Morning.
10 Q You've been deposed before; is that correct?
11 A Yes.
12 Q You understand you're under oath?
13 A Yes.
14 Q Are you under -- are you taking any
15 medications that might affect any answers you give
16 today?
17 A No.
18 Q At any time today if you need a break, just
19 let me know, otherwise we'll break about every 50
20 minutes or so.
21 A Okay.
22 Q I need to give you some documents. First, I

1 want to give you a copy of what is Exhibit 2040 in this
2 case. And I'm going to write Exhibit 2040 on the cover
3 here because the exhibit was submitted without any
4 marking.
5 (Samsung Exhibit 2040 was marked.)
6 MR. LAURENZI: Just for the record, this is
7 01023 IPR patent, the '846 patent.
8 And it's titled Expert Declaration of
9 Dr. Joseph LaViola, Ph.D. in Support of Patent
10 Owner's Response.
11 I'll also give you a copy of Exhibit 2040,
12 IPR2025-01071. It's for the '687 patent. This is
13 titled Expert Declaration of Dr. Joseph LaViola in
14 Support of Patent Owner's Response.
15 THE WITNESS: Thank you.
16 (Samsung Exhibit 1001 was marked.)
17 THE WITNESS: Okay.
18 MR. LAURENZI: I'll also provide you a copy of
19 Samsung Exhibit 1001 which is a copy of US Patent
20 10,852,846.
21 (Samsung Exhibit 1001 was marked.)
22 MR. LAURENZI: And provide you a copy of

1 Samsung Exhibit 1001. This is in the IPR for the
2 '687 patent and this is a copy of the '687 patent
3 which is 11,698,687.
4 (Samsung Exhibit 1001 was marked.)
5 MR. LAURENZI: I'll also provide you a copy of
6 what's been marked as Exhibit 1006 in both of the
7 IPR proceedings. This is a copy of the
8 Bassompierre reference.
9 (Samsung Exhibit 1006 was marked.)
10 THE WITNESS: Um-hum.
11 BY MR. LAURENZI:
12 Q Now, let's look at Exhibit 2040 for
13 IPR2025-10 -- I'm sorry -- 01023, which is your
14 declaration relating to the '846 IPR.
15 A Okay.
16 Q Do you have that?
17 A Yes.
18 Q And do you recognize the document?
19 A Yes.
20 Q That's your signature on page 52?
21 A Yes.
22 Q Did you prepare this declaration yourself?

1 A It was a collaborative effort between myself
2 and counsel.
3 Q How long did it take you to prepare this
4 declaration?
5 A I want to say probably around 20 hours. 18,
6 20, something like that.
7 Q And how about the other declaration, the one
8 from the '687 patent, how long did it take you to write
9 that declaration?
10 A It was basically -- I mean, for both of them,
11 it was about 18 to 20.
12 Q In total?
13 A In total, yeah.
14 Q Did you prepare for today's deposition?
15 A I did.
16 Q What did you do to prepare?
17 A So I reviewed my declarations for both of the
18 IPRs. I reviewed the Bassompierre patent. I reviewed
19 the '846 and '687 patents. So I reviewed -- I don't
20 know how to pronounce this person's name, your expert,
21 so...
22 Q Dr. Sarrafzadeh?

1 A Sarrafzadeh?
2 Okay. I looked at Dr. Sarrafzadeh's
3 deposition transcript and also his report.
4 Q Did you meet with counsel?
5 A Yes.
6 Q How long did you meet with counsel?
7 A I want to say four or five hours.
8 Q And that was yesterday?
9 A Yes.
10 Q If you would, turn to paragraph 36 of
11 Exhibit 2040 for the '846 patent.
12 A Thirty-six?
13 Q It's on page 10.
14 A Um-hum.
15 Q The paragraph starts "The basics of quaternion
16 math also includes the Euler-Rodrigues-Hamilton theorem,
17 which establishes that a vector can be rotated in
18 three-dimensional space by multiplying the vector by a
19 unit quaternion, and then multiplying the result by the
20 conjugate of the quaternion."
21 Do you see that paragraph?
22 A Yes.

1 Q And then the last sentence starts "This
2 transformation property forms the foundation for using
3 quaternions in motion tracking and sensor fusion
4 systems."
5 Do you see that?
6 A Yes.
7 Q And then you cite to this Exhibit 2038. I
8 want to show you a copy -- provide you a copy of
9 Exhibit 2038.
10 A Okay.
11 (Samsung Exhibit 2038 was marked.)
12 BY MR. LAURENZI:
13 Q What is this document, 2038?
14 A It's basically a document that talks about
15 ordering those quaternions and transformation matrices
16 and their relationships.
17 Q Had you ever seen this document before,
18 working on this matter?
19 A No. I've never seen this before, working on
20 this matter.
21 Q Does this document explain how to convert
22 Euler angles into quaternions?

1 A Yes.
2 Q If you look at the first paragraph on the
3 fourth page of the exhibit, the page that has the title
4 Euler Angles, Quaternions, and Transformation Matrices.
5 It says "1.0 Introduction."
6 Do you see that?
7 A Yes.
8 Q Looking at the first paragraph, the last
9 sentence, it says "Appendix A presents the 12 three-axis
10 Euler transformation matrices as functions of the Euler
11 angles."
12 Had you ever seen before the 12 three-axis
13 Euler transformation matrices, were you aware of what
14 they are before seeing this document?
15 A I have seen these before, a long time ago.
16 Q And in what context have you seen them?
17 A I saw them probably when I was working on my
18 Ph.D. I was working on a problem that required
19 conversion of quaternions to matrices, and matrices to
20 quaternions. So I don't remember all the details, but I
21 do recall seeing these at one point or another.
22 Q Did that work involve converting quaternions

1 to Euler angles or Euler angles to quaternions?
2 A Yes, it did.
3 Q And was this work performed before 2010?
4 A Yes, it was.
5 Q If you look at page B-3 of this exhibit, it's
6 titled Euler Angles to the Transformation Matrix.
7 Let me know when you're there.
8 A Okay.
9 Q What's being shown on this page? And the
10 following page?
11 A As best I can make out, it's -- it looks like
12 a computer code of some kind.
13 Q Is the computer code for converting Euler
14 angles to the transformation matrix?
15 A I mean, it could be. It doesn't -- it's kind
16 of hard to read so I really can't see everything in it
17 but since the title says Euler angles to the
18 transformation matrix, I would venture that that's what
19 it's doing.
20 Q If you look at paragraph -- page B-11 of this
21 exhibit, it's titled Transformation Matrix to the
22 Quaternion.

1 A Um-hum.
2 Q What is this page and the following page
3 describing?
4 A Well, I mean, once again, it's really hard to
5 read based on page B-11. I would suspect, given the
6 title, that it is either code in some language or
7 potentially a pseudocode that takes the transformation
8 matrix and converts it to a quaternion. On page B-12,
9 there is no code. I guess the code may be on the next
10 page, maybe. [Sotto voce.]
11 So page B-12 looks like the name of a function
12 and what it does, in which case it says "Generate
13 quaternions directly from the yaw, pitch, and roll Euler
14 angles." In this particular sequence, three, two, one.
15 Q Were you aware, prior to 2010, of the
16 existence of libraries for source code that facilitated
17 the conversion of Euler angles to quaternions?
18 A Yes.
19 Q Had you ever used such libraries in any work
20 that you've done prior to 2010?
21 A Yes.
22 Q In what context?

1 A I used them in the work that I did in virtual
2 reality. I was developing interaction techniques in
3 virtual reality and used quaternions and Euler angles to
4 move objects in 3D space, virtual space.
5 I also built a library of my own that had many
6 of these functions in them to use them and predicted
7 tracking.
8 Q In what language were they?
9 A C++.
10 Q What did you use as the basis of your
11 knowledge to implement that code?
12 A It's been a long time so -- because I was
13 doing this in 2000, 2001, 2002, 2003 time frame.
14 There was a C graph course that talked about
15 rotations in computer graphics. And the person that
16 wrote that had a lot of the functions in that -- those
17 course notes. And I also was able to take information
18 from the appendices of computer graphics books,
19 textbooks.
20 So that's basically where it came from.
21 Q Let's go back to your declaration --
22 A Okay.

1 Q -- which is Exhibit 2040. And if you would,
2 turn to paragraph 37, which is on page 11. So that
3 paragraph says "This knowledge would allow a POSITA to
4 generally understand a quaternion-based EKF."
5 A Okay.
6 Q And what's an EKF?
7 A Extended Kalman filter.
8 Q And then you go on to say, "But would not be
9 sufficient to allow a POSITA to convert an extended
10 Kalman filter written in Euler angles to an extended
11 Kalman filter that utilized quaternions as
12 Dr. Sarrafzadeh did in his declaration."
13 Do you see that?
14 A Yes.
15 Q Do you agree that Dr. Sarrafzadeh, in his
16 declaration, did convert an extended Kalman filter
17 written in Euler angles to an extended Kalman filter
18 that utilizes quaternions?
19 A Yeah. Based on what I saw, I believe he did
20 that.
21 Q Do you agree that Dr. Sarrafzadeh is a person
22 of ordinary skill in the art?

1 A I think Dr. Sarrafzadeh might be a person with
2 extraordinary skill in the art. I think his knowledge
3 goes beyond a POSITA.
4 Q In what way?
5 A I just think he's -- he has a lot more
6 knowledge than somebody with a undergraduate degree in
7 computer science or electrical engineering and a couple
8 years of experience. I mean, he's got a Ph.D. and he's
9 had N number years of experience where N is 10, 20.
10 So he's got a lot of experience, more than a
11 regular POSITA, in my opinion.
12 Q Do you consider yourself to be a person of
13 ordinary skill in the art?
14 A I do.
15 Q You don't consider yourself to be a person of
16 extraordinary skill in the art, as you do
17 Dr. Sarrafzadeh?
18 A Well, I -- I certainly have a lot of
19 experience, but my knowledge, at least when I was
20 working on this matter, I tried to keep it as a POSITA.
21 So I tried not to think about things that I had done,
22 starting from my graduate work to when I started, you

1 know, doing my undergraduate in computer science and
2 essentially getting a master's degree and spending a
3 couple of years working on these.
4 And everything after that, which I try not to
5 bring into this domain, because that was the idea.
6 Q Do you think you would have been capable of
7 doing the Euler angle to quaternion conversions that
8 Dr. Sarrafzadeh provided in his declaration?
9 A Yes. I could do that.
10 Q Do you teach master's-level students?
11 A Yes.
12 Q Have you ever taught master's-level students
13 quaternions?
14 A Let me think about this.
15 Yes, actually. We touch on it in my
16 3D-user-interface class and master students take that
17 class.
18 Q In what way do you touch on it?
19 A I talk about quaternions in terms of how they
20 can be used to rotate objects in 3D space and how they
21 can be used to perform non-isometric -- I'm sorry,
22 non-isomorphic rotations -- both isomorphic and

1 non-isomorphic rotations. So an isometric rotation
2 is -- or morphic rotation is just one to one, and you
3 rotate something 30 degrees and the virtual object
4 rotates 30 degrees.
5 If it's a non-isomorphic, typically there's a
6 gain associated with the quaternion. And so, for
7 example, I can say that that gain would be a value of
8 two. And I would take the object and rotate -- I'd say
9 I rotate my hand 30 degrees, it's being tracked. The
10 object rotates 60 degrees. Okay. And this is done.
11 So, for example, if I wanted to rotated an object
12 360 degrees, I wouldn't have to turn my arm all the way
13 around, right? It's a better interface than just using
14 an isomorphic rotation.
15 Q And those master students to whom you taught
16 this course and this information, would they have had
17 knowledge of Euler angles?
18 A Some.
19 Q What is the extraordinary skill that you
20 believe Dr. Sarrafzadeh used when preparing this
21 declaration?
22 A After reading his declaration and his

1 deposition transcript, it just seemed to me like he knew
2 a lot of things. Everything was -- was fairly easy for
3 him, at least based on the way that he portrayed himself
4 in his deposition. And not everything that he talked
5 about is -- is easy to do.
6 I think he also left out some details that I
7 think someone who has been doing this for a long time
8 would skip over. So it's not relevant -- or it's
9 obvious.
10 And there are certain things that I didn't
11 think were necessarily obvious that you would need to
12 know about or at least mention as part of someone, you
13 know, doing this.
14 Q Did you see any mistakes in his declaration?
15 A I did see one. He -- in his declaration, he
16 talked about Equations 2, 3, and 4 of the '846 and the
17 '687 patents, saying that those were part of the
18 extended Kalman filter. And if you're being specific,
19 that's not true. Okay. The extended Kalman filter, on
20 its own, has a series of equations.
21 And then there are other equations that you
22 would use that would go into it in order to make the

1 filter work, but they're not necessarily part of the
2 extended Kalman filter equations.
3 Q How about with regard to his calculations for
4 converting Euler angles to quaternions, did you see any
5 mistakes there?
6 A No. I don't believe so.
7 Q Let's turn to page 20 of your declaration, and
8 specifically paragraph 70.
9 A Okay.
10 Q First sentence says -- that's what I'm going
11 to ask you about, this first sentence. It says "By
12 comparing the predicted axial accelerations from the
13 current quaternion to the measured axial accelerations,
14 the '846 patent can distinguish gravitational
15 acceleration from nongravitational, i.e., dynamic motion
16 acceleration."
17 Do you see that?
18 A Yes.
19 Q Now, if the accelerometer of the '846 patent
20 measured only gravitational acceleration, would
21 Equations 1 through 11 of the '846 patent still be the
22 equations to use?

1 And you have a copy of the '846 patent.
2 A Yeah, I do. I'm just thinking.
3 Q Okay. Take your time.
4 A Yeah. I would still use the same equations.
5 Q Let's turn to paragraph 71 on the next page.
6 Let me just read the first two sentences. It says "The
7 '846 patent teaches how to get roll, pitch, and yaw
8 using a quaternion representation in an EKF. Due to
9 gravity, it is difficult to get yaw from a three-axis
10 accelerometer."
11 Do you see that?
12 A Yes.
13 Q And why is it that due to gravity, it is
14 difficult to get yaw from a three-axis accelerometer?
15 A So let's say this glass case was the
16 accelerometer. Okay. I'm holding it like this
17 (indicating). The yaw is going to be going this way,
18 okay, so you want to go around that axis.
19 Gravity is constantly in play. All right. So
20 it's always pulling the object down.
21 So if I go like this, (indicating) and like
22 this, gravity is still the same. So then you're going

1 to get the same number. It's the same acceleration for
2 yaw no matter what you do when you turn. So you can't
3 reliably get yaw with an accelerometer. That's what I
4 mean by that.
5 Q Then the next sentence says "However, yaw can
6 be obtained using a three-axis gyroscope because it
7 provides angular velocities for roll, pitch, and yaw."
8 Do you see that?
9 A Yes.
10 Q What do you mean by that? How does the
11 three-axis gyroscope allow yaw to be obtained?
12 A Well, the three-axis gyroscope, it measures
13 angle of velocity. So if you integrate the angle of
14 velocity, it gives you roll, pitch, and yaw. So you
15 have three axes, so it's three-dimensional, each one
16 representing rotation, speed of rotation around the
17 roll, pitch, and yaw axes.
18 And as I said, if you integrate angular
19 velocity, it will give you the orientation for roll,
20 pitch, and yaw.
21 Q So yaw can be obtained with only a three-axis
22 gyroscope; is that right?

1 A Yes.
2 Q And is that how yaw is obtained in the '846
3 patent, using only a three-axis gyroscope?
4 A Not quite. I mean, it does use the
5 gyroscope -- well, in this particular instance, it's
6 using the gyroscope's angular velocities as part of the
7 process model for the EKF, which is just describing how
8 the quaternion changes with respect to angle of
9 velocity.
10 So in this particular instance, it's using --
11 I guess as the primary source of the yaw information
12 would be from the gyroscope.
13 Q Other than the angular velocity, does the
14 process model of the '846 patent use any other
15 measurements?
16 A Measurements? The process model? No, it does
17 not.
18 Q Does it use any other predictions?
19 A Well, it does make a prediction. Yeah. It
20 makes a prediction what the next quaternion will be in
21 the sequence based on some amount of time. It's
22 basically Equation 1 in the '846 patent is the -- is the

1 process model that describes the motion. And in this
2 particular instance, it's using the gyroscope
3 information as input into the process model.
4 Q Does the EKF of the '846 patent use
5 information other than from the three-axis gyroscope?
6 A Yes.
7 Q What other information does it use?
8 A It uses the accelerometer.
9 Q Any other?
10 A Let's see. It can. It can also use a
11 magnetometer.
12 Q And what benefit would a magnetometer provide,
13 if any?
14 A A magnetometer would actually give you a
15 measurement for yaw.
16 Q And the absence of a magnetometer, is there
17 any measurement for yaw provided?
18 A I mean, well, in the EKF -- or in the patent,
19 yes. It's the gyroscope that's giving you a measurement
20 for yaw.
21 Q Well, how does providing a measurement for yaw
22 to the EKF provide any benefit to the output of the EKF?

1 A Well, the whole notion of an extended Kalman
2 filter is that it's a prediction/correction algorithm.
3 So what it does is, is it -- given the state,
4 something you're trying to understand about a system,
5 it's going to utilize the process model which describes
6 the behavior of the system. And it's going to make a
7 prediction. And so this is the next thing in turn.
8 And then the measurement model is going to
9 take whatever measurements you have available and is
10 effectively going to fuse them together with the output
11 of the process model. And it's going to do it in such a
12 way that it minimizes the variability of the
13 measurements.
14 So it just so happens that if you look at the
15 theory of what a Kalman filter is, it does a pretty good
16 job of being pretty accurate in doing that estimation.
17 So it predicts and then corrects.
18 And the main, I guess, component of the EKF is
19 the Kalman gain. And the Kalman gain is the matrix that
20 kind of figures out how much of the process model we
21 should believe and how much of the measurement model we
22 should believe. And it changes or iterates, as you move

1 along to try to get the best estimate possible.
2 Q Does the use of a magnetometer improve the
3 estimate?
4 A It would.
5 Q When you say "estimate," estimate of what?
6 What is it referring to?
7 A In this case, it's the estimate of the
8 orientation. That's what we're going for here, is
9 trying to get the orientation of the object.
10 Q Does orientation include pitch, roll, and yaw?
11 A Orientation is pitch, roll, and yaw.
12 Q Does use of a magnetometer improve the
13 estimate of pitch or roll or yaw --withdraw that.
14 Does use of a magnetometer improve any of
15 pitch, roll, and yaw over any other?
16 A I mean, so if we have an estimate, we make a
17 prediction for roll, pitch, and yaw. Okay. And then
18 we're going to correct it with the measurements, the
19 measurement model. And we know that the accelerometer
20 can give you pitch and roll. Okay. Those are known
21 equations. But it doesn't necessarily give you yaw. I
22 mean, you'll get a number from it but it won't be very

1 accurate.
2 If you add the magnetometer in, I can get the
3 measurement of yaw. So now I would have a measurement,
4 you know, of roll, pitch, and yaw, which I could compare
5 with the prediction of roll, pitch, and yaw than I did
6 with my processor.
7 Q I'm going to show you a document that's
8 mentioned in your declaration. I don't think it's been
9 marked as an exhibit so this will be Exhibit --
10 actually, let's take a break to get the exhibit number.
11 We can take a 10-minute break.
12 THE WITNESS: Okay.
13 (A brief recess is had from 9:44 a.m. to
14 9:52 p.m.)
15 CERTIFIED STENOGRAPHER: Okay. Back on the
16 record.
17 BY MR. LAURENZI:
18 Q Dr. LaViola, I'm showing you a copy of Samsung
19 Exhibit 1022. It's a document titled RealNav:
20 Exploring Natural User Interfaces for Locomotion and
21 Video Games. And you're listed as one of the authors
22 there, correct?

1 (Samsung Exhibit 1022 was marked.)
2 THE WITNESS: Correct.
3 BY MR. LAURENZI:
4 Q What is this paper?
5 A This was my master's students, I mean, Brian
6 Williamson's master's thesis. And the paper basically
7 was exploring how we could utilize a commercial
8 off-the-shelf tracking system to perform navigation in a
9 virtual environment as well as other movements that you
10 might do, like jumping or twisting or doing a -- I
11 forgot what it's called -- shake-and-bake-type thing.
12 Q Juke?
13 A Juke. Yes. Thank you.
14 I should know that. Yeah. So that's what it
15 explored. And it utilized a Nintendo Wiimote, which has
16 a very interesting set of properties along with
17 Kalman -- extended Kalman filters for computing the
18 position and orientation of the user.
19 Q You mentioned that it uses an off-the-shelf
20 tracking system. Are you referring to the Nintendo
21 Wiimote?
22 A Yes.

1 Q And what were the properties of the Nintendo
2 Wiimote?
3 A Well, I mean, the Nintendo Wiimote had an
4 accelerometer in it, the three-axis accelerometer. You
5 added the Wii MotionPlus. I'm pretty sure we did use
6 the Wii MotionPlus in this work.
7 Yes, we did.
8 So it has a gyroscope, a three-axis gyroscope.
9 It also had a camera in front of it that you could
10 utilize.
11 Q Okay. But it had an accelerometer and a
12 gyroscope and utilized the EKF; is that right?
13 A Yes. Um-hum.
14 Q And you said it also utilized the camera?
15 A We might have used the camera as well.
16 Honestly, I don't remember. We compared it to another
17 very simple tracking system. I believe it was the
18 natural point TrackIR device. And that was a 6-degree
19 of freedom tracker so that gave you a position of
20 orientation, using infrared technology.
21 The Wiimote doesn't give you 6 degrees of
22 freedom but we were trying to get -- it doesn't give it

1 to you as-is. So we were trying to get 6 degrees of
2 freedom with just the Wiimote device utilizing all of
3 its properties as well as a Kalman filter for the
4 translation and the extended Kalman filter for the
5 orientation.
6 Q You said the Wiimote doesn't give you a
7 6-degree of freedom; is that right?
8 A That's right.
9 Q So what is the Wiimote? Sorry.
10 A Oh, I'm sorry. It's a Nintendo Wii remote.
11 Q And does it have an accelerometer and
12 gyrometer in it?
13 A Yes.
14 Q And that doesn't provide 6 degrees of freedom?
15 A No.
16 Q How many degrees of freedom does it provide?
17 A Three. Orientation. Well, hold on. The
18 device, as is, all right, without any extra stuff, it
19 just gives you 6 degrees of freedom.
20 However, if you do what we did on paper, you
21 could get 6 degrees of freedom with the Wiimote device.
22 That was the whole point.

1 Q I think you said 3 degrees of freedom is
2 orientation, right?
3 A Yes.
4 Q And what does the extra 3 degrees that gets
5 you to 6 degrees give you?
6 A Well, that will give you the translation, X,
7 Y, Z positioning.
8 Q And what's the difference between translation
9 and orientation?
10 A Translation is your position in a -- you know,
11 in an environment. So it's actual, like, location, you
12 know, along -- if I had a big, you know, graph sitting
13 here and this was the X direction and this was the Y
14 direction and this was the Z direction, a point in
15 that -- in that graph would be a position, a position
16 that you could be in or an object could be in.
17 And then there's the other 3 degrees of
18 freedom, which is the orientation. So you're at a
19 particular position and then you're orientated a certain
20 way. Right? That's the 6 degrees of freedom that we're
21 talking about here.
22 Q So the 6 degrees of freedom that you're

1 talking about in the RealNav paper does not mean use of
2 a 6-axis sensor?
3 A No.
4 Q Is that right?
5 A Not in this context.
6 Q Could you turn to Section 5.1.4 in this
7 exhibit? It's on page eight. It's titled Yaw
8 Orientation Accuracy.
9 A Yeah.
10 Q What does yaw orientation accuracy mean here?
11 Take your time to review the document.
12 A So what we're showing here is we're
13 calculating your orientation, the yaw angle, all right,
14 with a Wii MotionPlus. The Wii MotionPlus has the
15 gyroscope in it so we're using the gyroscope and the
16 accelerometer as part of the algorithm to compute the
17 yaw.
18 And what this shows you is what the Wiimote
19 gave you, all right, compared to the ground truth, which
20 we got from the IR tracker that we mentioned in that
21 metric.
22 And you can see, as time goes on, there's a

1 drift. Okay. And that's, you know -- that can happen.
2 And what we did -- actually, let me rephrase that
3 because I misstated.
4 We used InterSense IS-900 tracker which is a
5 whole different type of tracking system. The details
6 aren't important. Just know that it gives you 6 degrees
7 of freedom, position orientation is very accurate. So
8 we used that as the ground truth because we wanted to
9 see how well we compared it to, you know, to what was
10 the truth. And this figure here shows you that there
11 was -- even with the MotionPlus, there was a drift on
12 the yaw axis, as you go through time.
13 Q And the MotionPlus had -- or was using a
14 gyroscope and an accelerometer?
15 A The motion plus was -- the motion plus device
16 connected into the Wiimote and that gave you an
17 accelerometer and a gyroscope.
18 Q And does this paper propose a solution to the
19 problem of yaw drift?
20 A Yeah. We -- in this particular instance, we
21 used the camera on the Wii MotionPlus in front of it to
22 figure out where it was and incorporated that into the

1 model. And then you can see in Figure 9, we were able
2 to get much more realistic yaw motion.
3 Q And how did information from the camera help
4 with regard to yaw drift?
5 A I believe the Wii Motion -- or the Wiimote
6 device, as I said, it has a sensor in front of it and it
7 detects infrared light. So if you were to put what was
8 known as the sensor bar in front of it, it would detect
9 two little dots.
10 And as you rotate it, the Wiimote, the dots
11 would move. So you could look at the dots, and
12 depending on how they moved, it could give you the yaw
13 information and then we could use that as part of the
14 filter to get you a better estimate.
15 Q A better estimate of yaw?
16 A Yes.
17 Q All right. Let's move on in your declaration.
18 A Um-hum.
19 Q Turn back to that, Exhibit 2040 for the '846
20 IPR.
21 A '846. Okay.
22 Q Let's look at paragraph 74, which is on

1 page 22. This is a section where you're talking about
2 the Bassompierre reference --
3 A Um-hum.
4 Q -- which I provided to you.
5 Paragraph 74, you say "A POSITA would
6 understand that Bassompierre's system moves the pointer
7 based on angular velocities, not based on pitch, roll,
8 or yaw angles."
9 And then you say, "The absolute orientation of
10 the device relative to the screen is therefore
11 immaterial to pointer control."
12 So I want to ask you about that second
13 sentence that I read.
14 A Um-hum.
15 Q What do you mean by "absolute orientation" in
16 that sentence?
17 A So there's such a thing as absolute
18 orientation and then something that can be considered
19 relative orientation.
20 Absolute orientation is the exact orientation
21 of an object. When I talk about relative orientation,
22 I'm often talking about the delta between measurements.

1 Sometimes what we care about is just how much has
2 changed from T minus one to T. In this case, it is
3 talking about the actual orientation of the device,
4 90-degrees, 75 degrees in pitch or yaw, for example.
5 Q Is it your position that the '846 patent
6 describes a way of securing absolute orientation?
7 A Yeah. I believe that to be true.
8 Q Does every embodiment described in the '846
9 patent provide absolute orientation or only certain
10 embodiments?
11 A I think -- I think every embodiment, there's
12 absolute orientation. The claims, you know, point to an
13 absolute orientation.
14 Q In what way?
15 A Because they say, you know, that you can get
16 your roll, pitch, and yaw, and then use that to
17 manipulate content. It wouldn't -- and it would say,
18 you know, it -- it was a relative or it would say
19 something about being a delta or something like that if
20 it was just the difference between the two time periods.
21 Q So where does Claim 1 of the '846 patent say
22 that yaw can be had?

1 A Claim 1 refers to the result in deviation, or
2 the result in angles or result in deviation. I believe
3 the result in angles to be absolute angle, absolute
4 orientation.
5 Q For the reasons you described in your
6 declaration; is that right?
7 A Yes.
8 Q Is it your understanding that absolute
9 orientation can be found using the processes described
10 in the '864 patent with only a gyrometer and
11 accelerometer?
12 A It can.
13 Q And why is that?
14 A Because it's utilizing, you know, an extended
15 Kalman filter to -- to get the best estimate possible of
16 the absolute orientation using the accelerometer and
17 gyroscope along with the process model that's described
18 in Equation 1 earlier, and the algorithm works.
19 Q Could the absolute orientation be found with
20 using only a gyrometer without an accelerometer?
21 A It could but it will drift. So it will work
22 okay for a while and then eventually just go crazy.

1 Q Will it drift when using only a gyrometer with
2 an accelerometer?
3 A It won't drift as much if you have the
4 accelerometer built into it.
5 Q But it will drift eventually?
6 A Eventually, yeah.
7 Q And what is exactly that drift?
8 A It has to do with all the gyroscopic sensors
9 themselves. I don't recall all the details of the
10 hardware, the specific hardware of the gyroscope. I
11 just know that it tends to drift as you use it over
12 time, and depending on how you're using it, the drift --
13 you know, about certain angles, a drift for all three
14 angles or the drift from just one of the angles.
15 It really depends. And you just reset the
16 thing and it starts over again.
17 Q When you say "one of the angles," you're
18 referring to pitch, roll, or yaw?
19 A Yeah. Could be one of them, it could be all
20 three of them, could be two of them. Depends on how
21 you're using the device.
22 Q If you'd turn, please, to paragraph 111 in

1 your expert report.
2 A Um-hum.
3 Q So here, in the first sentence, you state what
4 I think you've already stated which is "I have reviewed
5 the claim language and specification of the '846 patent
6 and in my opinion, a POSITA would understand 'resulting
7 angles' to mean 'yaw, pitch, and roll angles'."
8 A Correct.
9 Q And then it says "This is the standard
10 technical meaning in the context of 3D orientation
11 estimation and it is consistent with how the term is
12 used throughout the patent."
13 Do you see that?
14 A Yes.
15 Q Does Bassompierre deal with the issue of
16 three-dimensional orientation estimation?
17 A No. It's dealing with 2D estimate -- or
18 orientation estimation.
19 Q Does the pointing device of Bassompierre
20 operate in three dimensions?
21 A Okay. So a person holding Bassompierre's
22 pointing device, or whatever it's called, could move it

1 in three dimensions. Okay. But the only information
2 that they're going to get, that Bassompierre gets from
3 that device is pitch -- all right? -- and roll. So
4 pitch, (indicating), and roll (indicating). That's it.
5 So Bassompierre is really only interested in
6 two degrees, pitch and roll.
7 Q And when you say 3D orientation information,
8 are you referring to 3D -- I'll withdraw that.
9 Do you agree that Bassompierre -- that the
10 pointing device in Bassompierre is moving, however, in
11 three dimensions?
12 A Physically, the device -- well, I mean,
13 technically, physically, the device can move in six
14 dimensions, right? It can move in position and
15 orientation. All right? But Bassompierre is only
16 interested in two dimensions, in the roll and pitch.
17 Q The gyrometer in Bassompierre records
18 information in three axes. Would you agree with that?
19 A It does.
20 Q And the accelerometer in Bassompierre records
21 information in three dimensions. Would you agree with
22 that?

1 A Yes.
2 Q Would you agree that Bassompierre employs an
3 extended Kalman filter that fuses gyroscope and
4 accelerometer measurements?
5 A Yes.
6 Q Do you agree that Bassompierre expresses no
7 preference for use in quaternions over Euler angles?
8 A Yes.
9 Q If you would turn to page -- sorry, paragraph
10 100 of your declaration, which is on page 29.
11 A Okay.
12 Q Here, you're talking about the petition for
13 the '846 patent IPR and you say that "The petition
14 identifies Bassompierre's a priori estimation of the
15 acceleration calculated using Equation 22 as the
16 predicted axial accelerations."
17 And you say that "Dr. Sarrafzadeh testified at
18 his deposition that Equation 22 calculates a
19 gravity-only value."
20 Do you see that?
21 A Yes.
22 Q Do you believe that Equation 22 of

1 Bassompierre calculates the gravity-only value for
2 acceleration?
3 A Let's look.
4 Yes, that is correct.
5 Q Does -- still looking at Equation 22 of
6 Bassompierre.
7 A Um-hum.
8 Q Does it show gravitational acceleration in
9 three axes?
10 A It's not really showing gravitational
11 acceleration. It's showing orientation derived from, in
12 this particular instance -- let's see.
13 Q Well, let me withdraw that. It was a bad
14 question.
15 Let me just ask you, does Equation 22 show a
16 predicted acceleration in three axes?
17 MR. EVANS: Objection to form.
18 THE WITNESS: It -- could you repeat the
19 question, please?
20 BY MR. LAURENZI:
21 Q Yes. Does Equation 22 of Bassompierre show a
22 predicted acceleration in three axes?

1 A Yes.
2 MR. LAURENZI: Just, that was "does" Equation
3 22.
4 THE WITNESS: Yes, that is correct.
5 BY MR. LAURENZI:
6 Q What would you understand the axes to be in
7 Equation 22?
8 A It's going to be roll, pitch, and yaw. I
9 just -- I'm not sure of the order in which it is. I'm
10 pretty sure it's roll -- it's probably roll, yaw, and
11 pitch, but I'm not 100 percent certain.
12 Q If you looks at Equation 23 of Bassompierre --
13 A Um-hum.
14 Q -- you see that the value of Equation 22,
15 which is Y hat K bar --
16 A Um-hum.
17 Q -- is being subtracted from vector AXKAYKAZK.
18 Do you see that?
19 A Um-hum. Yes.
20 Q So you think pitch, roll, and yaw axes are
21 being subtracted from the X, Y, Z axes shown in Equation
22 23?

1 A Well, it's taking the vector A, as you see
2 there, and subtracting it from Equation 22, which is
3 also three dimensions, so it's -- this is basically
4 taking the measured acceleration and subtracting it from
5 the predicted acceleration.
6 Q So it's comparing the two?
7 A Um-hum.
8 And you see that K there, so K right next to
9 it?
10 Q Yes.
11 A That's the Kalman gain. That's the thing that
12 helps determine how much to trust the measurement and
13 how much to trust the prediction.
14 Q Is Equation 23 of Bassompierre comparing two
15 sets of acceleration where each set of acceleration is
16 on one of three axes?
17 A I mean, what it's doing is it's comparing the
18 predicted acceleration versus the measured acceleration.
19 Q And the acceleration is along three
20 axes, correct?
21 A Yes.
22 Q Let's turn to paragraph 119 of your

1 declaration, which is on page 38.
2 A 119. Okay.
3 Q The second sentence, you say "Equations 25,
4 26, and 27 of Bassompierre address quaternion kinematics
5 and frame transformations for angular velocities but
6 none of them computes a predicted axial acceleration."
7 Do you see that?
8 A Um-hum.
9 Q So I'd like to focus on the term "quaternion
10 kinematics and frame transformations for angular
11 velocities"?
12 A Yes.
13 Q What does that phrase mean?
14 A So break it down into pieces here. Quaternion
15 kinematics basically is -- in other words, if we're
16 talking about quaternion motion, okay, and in this
17 particular instance, the process model in the patent
18 talks about a quaternion differential equation.
19 Differential equations can describe kinematic behavior,
20 movement.
21 So when I say it fails to address the
22 quaternion kinematics, as in terms of, you know, how you

1 actually go about figuring out what those kinematics
2 are, okay, that's -- that's one instance of it. Okay.
3 And what I'm saying here is Equations 25
4 through 27, they address that quaternion kinematics.
5 They show you what the differential equation is. And
6 they don't actually show you how to integrate it but
7 they show you what the equation is. And then you could
8 then integrate it and figure out what the next
9 quaternion would be in the sequence.
10 Another thing is it doesn't deal with frame
11 transformation. So there's frames of reference that are
12 being talked about in the patent and in Bassompierre
13 that have to do with basically how we describe where an
14 object lives, what space it lives in.
15 And so you could have, you know, the pointer
16 in Bassompierre and it would have its own frame of
17 reference, right? Meaning that no matter what happens,
18 wherever it goes, X is going to go out this way, Y is
19 going to go out this way, and Z is going to go out that
20 way, no matter if I rotate it all around; okay? So
21 that's its frame of reference. And that's considered a
22 local frame of reference.

1 Then you have something else like a display in
2 Bassompierre, okay? And the display had its own frame
3 of reference, right? You have the display and it's got
4 an X, a Y, and a Z. Okay. And what this is saying is
5 that Equations 25, 26, and 27, they address the frame
6 transformations for the angle of velocities going from
7 the frame of reference for the pointer in Bassompierre
8 to the display but they don't ever talk about their
9 predicted axial acceleration that is referred to in the
10 '846 and '687 patents.
11 Q And what kind -- when you say "the axial
12 acceleration referred to in the '846 and '687
13 patents" --
14 A Predicted axial accelerations.
15 Q But Bassompierre does talk about predicted
16 accelerations, correct? It's at Equation 22.
17 A Yes. Those are in Euler form.
18 Q And what's the difference between that and the
19 predicted acceleration discussed in the '846 patent?
20 A Well, if you go to the '846 patent -- where is
21 the '846 patent? -- the '846 patent, you go to page 21
22 of 29 and you look at Equations 2, 3, and 4, those are

1 predicted axial accelerations using quaternions.
2 Q You're looking at Equations 2 through 4?
3 A Yes. There's nothing about this in
4 Bassompierre.
5 Q Nothing about what, when you say "this"?
6 A Equations 2, 3, and 4.
7 Q Well, what's the -- so tell me, the only
8 difference between Equations 2, 3, and 4 in the '846
9 patent and the Equation 22 in the Bassompierre, is that
10 the '846 patent presents the equations in quaternion
11 form and Bassompierre presents them in Euler angle form;
12 is that right?
13 A That is correct.
14 Q Looking at paragraph 119 in your declaration,
15 that same parts we were talking about, you discussed
16 quaternion kinematics and how Equations 25, 26, and 27
17 address quaternion kinematics.
18 Let me ask you. Going back to in the '846
19 patent in Equation 1, does Equation 1 address quaternion
20 kinematics for angular velocities?
21 A Yes.
22 Q Does Equation 1 explain how to integrate

1 Equation 1 in order to get the solution?
2 A It mentions it as a solution -- a solution of
3 the differential equation, would be the second
4 quaternion, the result of it.
5 So if you saw that differential equation,
6 you'll get the updated quaternion, the second quaternion
7 that it's talking about.
8 Q Does the '846 solve the differential equation
9 of Equation 1?
10 A No, it does not.
11 Q Why not?
12 A I don't know.
13 Q Should it have?
14 A I mean, I don't have a strict yes-or-no answer
15 to that question.
16 If you think about someone of ordinary skill
17 in the art, one could say that -- that you would have --
18 as someone with ordinary skill in the art, you would
19 know how to do this, you would know how to solve that
20 differential equation.
21 On the other hand, you know, solving a
22 quaternion differential equation is not the most common

1 thing in the world and, you know, it may have been
2 helpful to show that. It really depends on the POSITA
3 that you're talking about.
4 Q Well, let's talk about the POSITA in this
5 case. Would a POSITA know how to solve the differential
6 equation of Equation 1 in the '846 patent?
7 A I believe that given everything that the
8 POSITA knows -- right? -- based on our definition of a
9 POSITA, I'm pretty confident in saying that the POSITA
10 should know how to solve that differential equation.
11 Q Even with the quaternion variables that were
12 involved in Equation 1?
13 A Well, a POSITA, in our definition, knows
14 quaternion mathematics. So you would expect that they
15 would understand how to deal with that. If you know
16 calculus and you know quaternions, you should be able to
17 figure that out. It's not easy but it can be done.
18 Q So the '846 patent in column 16, line 43 --
19 A Forty-three.
20 Q -- mentions a data conversion utility.
21 A Yes.
22 Q Could a data conversion utility be used to

1 solve the Equation 1?
2 A Yes. This says that the "Data conversion
3 utility, including such as an algorithm to convert the
4 angles and velocities and the first quaternion into the
5 second quaternion." Converting into the second
6 quaternion is equivalent to solving that differential
7 equation.
8 Q What do you understand the data conversion
9 utility to be, in essence a program of some kind?
10 Computer program?
11 A Could be anything. In this context, it would
12 be -- I would assume would be a program.
13 Q Is Equation 1 of the '846 patent a state
14 model?
15 A It's a process model. It's not necessarily a
16 state model. You don't really talk about a state model,
17 but a state vector. A state vector is just the elements
18 that you're trying to model, the variables, if you will.
19 Q So I'm sorry. I didn't understand your
20 answer. You're saying that Equation 1 -- you would not
21 consider Equation 1 of the '846 patent to be a process
22 model?

1 A No, I would. It is -- equation 1 would be
2 considered a process model in this patent. A state --
3 I'm not too familiar with the term "state model." I'm
4 more familiar with the term "state vector." A state
5 vector is the vector that holds the quantities that
6 you're trying to calculate or keep track of.
7 Q So Equation 1 holds the quantities they were
8 trying to calculate or keep track of, correct?
9 A Yes.
10 Q Now, if you look at Equation 26 of
11 Bassompierre?
12 A Um-hum. Hold on. Bassompierre Equation 26.
13 Yes.
14 Q Does that equation also hold the quantities
15 that you're trying to calculate or keep track of?
16 A Yes.
17 Q Is --
18 A It's just written differently.
19 Q So Equation 26 of Bassompierre is the same
20 state vector as shown in Equation 1 of the '846 patent?
21 A It's not the same state vector. It is -- it
22 could be, okay, but it is the same process model.

1 Right? So Equation 1 in the '846 patent is equivalent
2 to Equation 26 in Bassompierre. It's a known important
3 equation. It's been known for years.
4 MR. LAURENZI: Why don't we take a 10-minute
5 break.
6 THE WITNESS: Okay.
7 (A brief recess is had from 10:50 a.m. to
8 11:06 a.m.)
9 CERTIFIED STENOGRAPHER: Okay. Back on the
10 record.
11 BY MR. LAURENZI:
12 Q All right, Dr. LaViola. Let's look again at
13 the '846 patent. And if you would turn, please, to
14 column 17. And let's look at Equation 5.
15 A Yes.
16 Q What is Equation 5 doing or meant to do?
17 A Equation 5 is a generic process model
18 equation. What it's saying is that the state vector at
19 time T, given the previous time period is equal to some
20 function, some set of variables. And it's really just
21 kind of a way of saying, you know, okay, state vector is
22 propagated using this function. All right.

1 Q Okay. I'm sorry. Are you finished?
2 A No. It's just the Kalman filter and the
3 extended Kalman filter, they're frameworks. They're not
4 specific algorithms, per se. You just can't take an
5 extended Kalman filter equations and use them. You have
6 to, you know, put in what the process model is, what the
7 measurement model is, what the various parameters are
8 for various matrices and so on and so forth. And so
9 it's -- you can -- you know, you can make lots of
10 different instantiations of extended Kalman filters with
11 all types of process models and measurement models.
12 This Equation 5 is just representing the state
13 vector generally.
14 Q Okay. Where does the specification actually
15 show a substantiation of extended Kalman filter in
16 Equation 4?
17 A Well, it turns out that
18 Equation 5 -- right? -- is equivalent to Equation 1.
19 Q How so?
20 A Well, the F is essentially the differential
21 equation. Okay. And the state vector or state, in this
22 case, it's actually not with the -- the vector is with

1 the state would be the second quaternion, the updated
2 quaternion.
3 Q So am I correct in understanding that
4 Equation 5 could have many instantiations, but in the
5 '846 patent, it gives a specific example with
6 Equation 1?
7 A Correct.
8 Q And how about equation at line 65, column 17?
9 A Yeah.
10 Q What is that doing?
11 A Equation at line 65 is the covariance matrix
12 associated with the state vector. Covariance matrix
13 is -- basically tries to present some representation of
14 variability in data, right?
15 These are all kind of thought about
16 conicalistically. So you have a state
17 vector -- right? -- or a state that you're trying to
18 update but, you know, there's some noise or -- you know,
19 it not precise. So you tag along a covariance matrix
20 that's associated with the state vector. And that gives
21 you a sense of how reliable your estimate is.
22 Q Well, how do you know, looking at the equation

1 on line 65, column 17, that that relates to a covariance
2 matrix?
3 A Because it's a standard -- standard
4 nomenclature.
5 Q Standard to whom? A person of ordinary skill
6 in the art?
7 A Yes.
8 Q A person of ordinary skill in the art as
9 you've defined it in this case?
10 A I mean, as it's been defined in my report.
11 Q The equation at line 65, column 17 --
12 A Um-hum.
13 Q -- can be solved; is that right?
14 A Can it be solved?
15 Q Yes.
16 A Yes. I mean, you see here, covariance matrix
17 P for X of T given -- X and T minus one -- U over T --
18 let's not worry about U over T, that's a control
19 variable. That's not being used. Nobody hardly ever
20 uses it.
21 Is equal to this -- if we get rid of the U
22 part, it's equal to this capital F vex multiplied by the

1 previous covariance matrix which is multiplied by the
2 transpose of capital F vex.
3 Capital F vex is up in Equation 16, and that's
4 the Jacobian of the process.
5 Q Does the specification actually show an
6 example of solving the equation at line 65, column 17?
7 A No.
8 Q Why not?
9 A I don't know. I didn't write this patent.
10 Q Should it have?
11 A Once again, you know, someone of ordinary
12 skill in the art who understands Kalman filtering would
13 know what this means and would know how to solve it
14 because it is standard equation for extend -- or one of
15 the standard equations in the extended Kalman filter
16 framework.
17 Q Is there any reference to quaternion in the
18 equation of line 65, column 17?
19 A No. But it's implied.
20 Q Why is it implied?
21 A It's implied because the covariance matrix P,
22 all right, is the covariance of the elements in the

1 state vector. Okay? The elements in the state vector
2 from Equation 5 are related to Equation 1, which is the
3 quaternion, in that second quaternion.
4 So you take the first quaternion and the
5 current gyroscope information and you integrate it, you
6 get the second quaternion. And that second quaternion
7 is the quaternion that is being calculated in
8 Equation 5. And its corresponding covariance matrix is
9 in the equation next in line 65.
10 Q So if Equation 1 was in Euler angle form,
11 would the use of Euler angles be implied in the equation
12 of line 65, column 17?
13 A Yeah. I mean, if Equation 1 was Euler angle
14 based, then it would be implied that the Equation 5
15 would be representing a state that uses the Euler
16 angles. And the same thing for the equation on 65. Its
17 covariance would be -- it would be different sides.
18 Well, it depends on what your state vector is.
19 It could be just the quaternions, it could be
20 the quaternions and the accelerometer data. It could be
21 the quaternion and the gyroscope data. A lot of
22 different ways you can do it.

1 Q But if Equation 1 is in Euler angle form, am I
2 correct that a person of ordinary skill in the art would
3 know how to solve the equation at line 65, column 17?
4 A Yes.
5 Q You said Equation 6 and 7 are Jacobian
6 matrices; is that right?
7 A Correct.
8 Q If the Equation 1 was in Euler angle form,
9 would a person of ordinary skill in the art know how to
10 solve Equations 6 and 7?
11 A Yes. Equations 6 and 7 are just matrices of
12 partial derivatives. So if you know the state, then you
13 would know how to compute the partial derivative of the
14 state with respect to each of the variables in the
15 state.
16 Q Whether the state is in Euler angle form or
17 quaternion form?
18 A Correct.
19 Q Same question with regard to Equation 8.
20 A Um-hum.
21 Q If Equation 1 was in Euler angle form, would a
22 person of ordinary skill in the art be able to solve the

1 Equation 8 in the '846 patent?
2 A Yeah. Equation 8 is the measurement model.
3 So it's basically saying, what do we have that's a
4 measurement. And then they put it into some vector
5 quantity that H function would be the function that
6 would be used to describe how this measurement was being
7 propagated.
8 And then, you know, so you would -- you would
9 know -- in this case, you know, it could be a number of
10 different things. It could be -- although it's probably
11 just the acceleration from the accelerometer in this
12 case.
13 Q And how do you know that?
14 A I mean, I don't know for sure. They leave it
15 quite general. But that is -- you know, if I was doing
16 this, that's probably what I would do.
17 Q Why is that?
18 A It makes things simpler. You know.
19 See, this particular implementation or
20 embodiment of an extended Kalman filter is somewhat
21 different from any other Kalman filter -- extended
22 Kalman filter that I've seen in that it actually takes a

1 measurement, namely the gyroscope data and puts it into
2 the process model. That's typically not done.
3 The process model is, you know, done. It's
4 for the -- it's for the dynamics. It doesn't
5 necessarily -- supposed to take a measurement. The
6 measurements are put into the measurement model. But
7 this particular pattern in the '687, they do it a little
8 differently so it's a little unique in that sense
9 because, you know, they're taking the gyroscope
10 information and putting it into the process model in
11 Equation 1. And then where you would think you would
12 put the gyroscope data in the measurement model is not
13 necessarily there. All right. Just the accelerometer
14 measurement would be there.
15 Now, you could, in theory, put the gyroscope
16 data into the measurement model as well. That would
17 give you a measurement vector of six -- or in this case,
18 I would be seven. No, six. It would be the three axis
19 accelerometer, three axis gyroscope. And then you would
20 just have to figure out the mathematics to determine
21 what the covariance matrix of that is and the Jacobian
22 matrix of it as well.

1 Q And all that you described you believe is
2 something that a person of ordinary skill in the art
3 would read, understand, and be able to implement based
4 on the equation?
5 A Yeah. Based on our definition of a POSITA, if
6 they understand Kalman filters, extended Kalman filters,
7 they would know.
8 Q The somewhat unique calculation that you just
9 described, do you think that's part the novelty of this
10 patent?
11 A That's one of the parts of the novelty of the
12 patent, in my opinion.
13 Q What are the other parts?
14 A The other novelty is Equations 2, 3, and 4,
15 the ability to do -- to predict the axial accelerations
16 using quaternions. I had never seen that before until I
17 saw this patent. So that's kind of a nice novelty
18 that's being put in this patent.
19 Q So you think Equation 2 through 4 were not
20 known prior to this patent?
21 A To the best of my knowledge, I have not come
22 across those equations.

1 Q Well, you hadn't come across these equations,
2 but do you believe that those equations were not known
3 prior to this patent?
4 A I mean, it's hard to say. I don't think I can
5 really comment on that.
6 Actually, there is one more unique thing I'll
7 mention. Equation 11. Equation 11 is not part of
8 necessarily the standard of extended Kalman filter
9 equations. It's an error minimization term that you
10 typically don't see with a EKF. So that's also kind of
11 a novelty here as well.
12 Q So what does the minimization term do with
13 respect to an EKF with regard to Equation 11?
14 A Yeah. What it's effectively doing is trying
15 to minimize the distance between measurement and the --
16 and the state or process. So take the measuring vector
17 and the state vector and it's trying to minimize them
18 using the covariance of the measurement data given the
19 process part.
20 And it's similar to what the Kalman gain is
21 trying to do. But it's not using the Kalman gain to do
22 it.

1 Q So in order to infringe this patent, do you
2 believe that the infringing product must be using
3 Equation 11?
4 MR. EVANS: Objection, outside the scope.
5 THE WITNESS: Well, not necessarily. This is
6 just one embodiment of the -- of the invention. I
7 mean, there are certainly other embodiments that
8 could utilize, you know, different process models
9 or different measurement models and ultimately use
10 the extended Kalman filter in the way that it's
11 traditionally used.
12 BY MR. LAURENZI:
13 Q In order to invalidate this claim, do you
14 think the prior art must be using this equation?
15 MR. EVANS: Objection to form.
16 THE WITNESS: I would say it's a necessary but
17 not necessarily sufficient condition.
18 BY MR. LAURENZI:
19 Q Explain that, please.
20 A What I mean is that in order to invalidate the
21 patent, you probably would have to -- you would have to
22 show that it doesn't do what this does -- or does what

1 this does but that's not all. You would have to show
2 that something -- another thing could also do what this
3 does outside of this particular embodiment.
4 Q Let me just ask again. Is it your opinion
5 that in order to invalidate the asserted claims, the
6 prior art must be practicing Equation 11 in '846?
7 MR. EVANS: Objection, beyond the scope.
8 THE WITNESS: I would -- I guess I would say
9 that you don't necessarily -- I don't think you
10 necessarily have to, right? You could -- you could
11 come up with another Kalman filter that utilized
12 this premise that didn't necessarily use all that I
13 think because there are multiple embodiments in the
14 patent -- right? -- so you could choose one.
15 Obviously, the one that's here, the one people
16 will look at and say, well, yeah, I'll just do that
17 one, and they'd be like, it's there. But you could
18 certainly do a different embodiment and how you
19 value.
20 BY MR. LAURENZI:
21 Q You said you could come up with another Kalman
22 filter that utilized this premise. What do you mean by

1 "this premise" with regard to the equation?
2 A Well, that utilized this process model, the
3 measurement model, the velocity and the gyroscope, and
4 the magnetometer if you're so inclined.
5 There's a couple different ways -- several
6 different ways that you could define an extended Kalman
7 filter with these parameters.
8 Q Let's go up to Equation 9 --
9 A Um-hum.
10 Q -- in the '846 patent.
11 A Yeah.
12 Q What's this equation doing?
13 A That equation is the covariance equation for
14 the measurement. So not only do we have a covariance
15 for the process, we have a covariance for the
16 measurement because the measurement we're taking has
17 nothing associated with it, in a variety of sources.
18 Some of them we can't even see. So we provide a
19 covariance that tells us something about, you know, is
20 this a good measurement, is this not such a good
21 measurement.
22 What's the covariance really tell you? A

1 small covariance would say, you know what, this
2 measurement's pretty good, it's within the small, you
3 know, little delta here. The large covariance says, oh,
4 well, this measurement is not very accurate because it
5 could be all over the place, based on the covariance.
6 The covariance matrix includes the Jacobian of the
7 measurement model, which is Equation 10, which is just
8 the posture of the H function which is the measurement
9 function.
10 Q Would a person of ordinary skill in the art
11 know how to implement Equations 9 and 10?
12 A Yes.
13 Q Why?
14 A Standard Kalman filter equations.
15 Q If --
16 A Excuse me, extended Kalman filter equations.
17 Q Would a person of ordinary skill in the art
18 know how to solve Equations 9 and 10 if Equation 1 is in
19 Euler angle form?
20 A Yes.
21 Q Can Equations 2, 3, 4 -- withdraw that.
22 Can Equations 2 through 4 be used if

1 Equation 1 is in Euler angle form?
2 A Well, you would have to use it one of two
3 ways. You could use them if you were to take the Euler
4 angles and convert them to a quaternion, and then you
5 can get 2, 3, and 4. Or you could try to convert the
6 equations themselves to be Euler angle based.
7 Q And could a person of ordinary skill in the
8 art convert Equations 2 through 4 to be Euler angle
9 based, for example, using the processes that we talked
10 about earlier with regard to Exhibit 2038?
11 A I mean, you might be able to. I've never seen
12 it done. But it -- I could say it's possible.
13 Q Let's switch gears a bit and turn to Figure 5
14 of the '846 patent.
15 A Figure 5. Yep.
16 Q What is Figure 5?
17 A Figure 5 is a schematic diagram showing
18 another embodiment of an electronic device of the
19 present invention such as a pointing device utilizing a
20 nine-axis motion sensor module as well as an external
21 processor.
22 Q So Figure 5 shows the electronic device; is

1 that right?
2 MR. EVANS: Objection, form.
3 THE WITNESS: It says an electronic device.
4 BY MR. LAURENZI:
5 Q Where is the spatial reference frame in
6 Figure 5?
7 A The spatial reference frame would be this
8 Wiimote-like thing, 560, (indicating).
9 Q And where is the display reference frame in
10 Figure 5?
11 A It would be 580, or 582, I guess. 582.
12 Q And where is the pointing device in Figure 5?
13 A That would be 560.
14 Q I'm going back to the equations that we were
15 talking about.
16 A Um-hum.
17 Q And specifically Equation 1.
18 A Um-hum.
19 Q How can equation -- how is Equation 1 used
20 with respect to the electronic device at Figure 5?
21 A Equation 1 specifically is modeling potential
22 motion of this 560 here. That's where all the sensors

1 are.
2 Q And how does Equation 2 through 4 apply to the
3 electronic device in Figure 5?
4 A Equation 2 through 4?
5 Q Yes.
6 A Well, there is -- that would be predicting the
7 axial acceleration of 560.
8 Q And how does Equation 5 through 11 apply to
9 the electronic device in Figure 5?
10 A I mean, it's basically the same thing. You're
11 taking the data that you get from the 560 and you're
12 feeding it into the measurement model. You're also
13 taking data from 560 and feeding it into Equation 1.
14 And that gives you the various second quaternion, third
15 quaternion, and so on, related to 560.
16 Q If you look at the Element 580 in Figure 5,
17 what is that element?
18 A It looks to be like a computer of some kind.
19 Q Is that screen movable, 582?
20 A Is the screen movable?
21 Q Yes.
22 A Could be.

1 Q How would you need to modify any of the
2 Equations 1 through 11 that we've been talking about in
3 order to display whatever is being controlled by the
4 device 560, if that screen is moved, let's say along the
5 hinge?
6 A So you're asking me how I would change
7 Equations 1 through 11 if the screen 582 moved in some
8 way?
9 Q Yes. But, actually, let me ask a preliminary
10 question, which is would you need to change anything in
11 Equations 1 through 11 to accommodate the instance where
12 the screen is being moved along a hinge?
13 A I don't believe so.
14 Q Where does the specification describe how to
15 display whatever's being controlled by movement of 560
16 on a display that is moving relative to Element 560?
17 A Well, I don't think you would move 580 or 582
18 when you're using 560. You might move it at the start
19 but while you're using it, you wouldn't.
20 Q There's no possibility that a user would move
21 that screen, perhaps, to get better line of sight?
22 A Well, I suppose it's possible that, you know,

1 it could be bumped or something. Let's see.
2 Figure 5 talks about that it's got two pieces,
3 560 and 570. 560 is the -- is the part where the sensor
4 is and it's got a PCB and so on. It's got a top, which
5 isn't shown.
6 And then 546 -- let's see -- is a transmitting
7 unit to 570. Yeah. That's just really just a wireless
8 communication that's using Wi-Fi or Bluetooth or
9 something.
10 So I don't believe that when this patent
11 refers to electronic device, it's not necessarily
12 referring to Equation 5. It's referring to this screen,
13 580. It says, referring to electronic devices 560 and
14 then 570.
15 Q What part of the specification are you reading
16 from?
17 A I am reading page 18, column 11, starting at
18 line 41.
19 If you're getting a orientation from this 560
20 device, okay, you're getting it in the spatial reference
21 frame. Okay. And then what you would do, then, is you
22 could take those angles and translate them into the

1 display reference frame. And then they would show up
2 appropriately.
3 So depending on how you move the display, the
4 display reference frame might change. Okay. And then
5 you would ultimately -- and then, by moving it into that
6 frame of reference, it would be in the correct frame of
7 reference to display whatever content you want it to.
8 Q And where does the specification describe the
9 process of translating angles in the spatial reference
10 frame to the display reference frame so that whatever's
11 being controlled shows up appropriately, as you said?
12 A It says that the movement pattern may be
13 displayed on the screen, on page 19 under column 13. So
14 it says "resulting deviation of the electronic device in
15 a spatial reference frame, preferably about each of the
16 three orthogonal coordinate axes of the spatial -- to a
17 movement pattern display reference frame associated with
18 another computer."
19 Q Okay. That's describing the result. I'm
20 asking you where does the specification describe that?
21 A Yeah. I think that would be something with
22 ordinary skill in the art, that somebody would be able

1 to know how to do if they knew how to do coordinate
2 transforms. You would just take it and do the
3 coordinate transformation and it would be in the right
4 reference frame for you to display.
5 Q And would a person of ordinary skill in the
6 art know how to do coordinate transfers?
7 A Um-hum.
8 Q Yes?
9 A Yes.
10 Q Let's take a look at Figure 6 of the '846
11 patent.
12 A Um-hum. Okay.
13 Q What is being illustrated in Figure 6?
14 A Figure 6 is illustrating the electronic
15 device. In this particular figure, the screen is
16 attached to the electronic -- or it's part of the
17 electronic device. I think 614 is the -- represents the
18 screen.
19 This, in and of itself, represents a cell
20 phone or an iPad or something.
21 Q When you say "this," what are you referring
22 to?

1 A Figure 6.
2 Q Element 600?
3 A Yes.
4 Q Where's the spatial reference for the device
5 at Figure 6?
6 A It could be really anywhere on the device.
7 But for -- to make things easier, I would have it at the
8 center of the device. So if you were to, like, look at
9 620 and draw lines to the center here, (indicating),
10 here, and then somewhere right in the middle.
11 Q That's where you would center the spatial
12 reference frame?
13 A Yes.
14 Q Where would you center the display reference
15 frame?
16 A The display reference frame would probably --
17 I mean, it could be put as the same as the spatial
18 reference frame. Could be done that way.
19 You could have basically the center of the
20 screen be the spatial reference frame and the display
21 reference frame. You could do that. Or you could have
22 the display reference frame being the center of the

1 screen on the surface of the screen, and the spatial
2 reference frame would be basically the same X, Y
3 position on the surface or in the center of the display
4 and then in the device a little bit, like in the middle.
5 Q What would the specification tell the reader
6 to do with regard to placement of the spatial reference
7 frame and the display reference frame?
8 A I mean, the patent itself talks about Figure 6
9 and it mentions the spatial reference frame and it says
10 "The above-mentioned display reference frame associated
11 with the display may need not to be external to the
12 spatial reference frame in terms of the hardware
13 configuration of the present invention."
14 So this is actually saying that they could be
15 the same -- in the same location, but it doesn't have to
16 be.
17 Q So you just read from column 13, lines 12
18 through 15?
19 A Yes. Regardless, you would do the same type
20 of thing. You would take the orientation angles in the
21 display -- or in the spatial reference frame and could
22 convert them into the display reference frame. If

1 they're the same, then you don't have to do the
2 conversion. If they're different, you would do it a
3 little bit -- move it a little bit lower, I guess, but
4 it would be -- for simplicity, it would be the same.
5 Q And what you just explained, does the
6 specification describe that?
7 A It doesn't describe it specifically, at least
8 based on what I'm looking at here. But once again, you
9 know, if you -- if you know mobile devices and mobile
10 devices are a part of a person of ordinary skill in the
11 art that we've defined here, then you would understand
12 that, you know, there's going to be a display reference
13 frame and it's going to be somewhere on the display.
14 And there's a spatial reference frame, that's going to
15 be somewhere in the device. Okay. And to make it
16 easier on yourself, you could have them be in the same
17 location. So the conversion from spatial reference
18 frame to display reference frame would be -- there --
19 you wouldn't need one.
20 But if for some reason you wanted it to be
21 different, you could make it different and just do the
22 transformation.

1 I mean, it says the map -- the "resultant
2 deviation from or in said spatial reference frame or 3D
3 reference frame to display reference frame such as a 2D
4 reference frame by translating the resultant angles of
5 the resulting deviation of the electronic device in the
6 spatial reference frame, preferably about each of the
7 three orthogonal axes of the spatial reference frame to
8 a movement pattern in the display reference frame
9 associated with the electronic device."
10 Q Where are you reading from?
11 A Thirteen -- column 13, starting around 51 or
12 52.
13 Q So a person of skill in the art, with regard
14 to the device in Figure 6 would know how to make that
15 conversion from the 3D reference frame to the 2D
16 reference frame, correct?
17 A Yes.
18 Q Let's look again at Equation 1 of the '846
19 patent.
20 A Um-hum.
21 Q Is this the equation that would be used with
22 an implementation for Figure 6?

1 A Well, it's one embodiment, right?
2 I personally would use it. It's the -- it's
3 the main -- it's the fundamental equation for describing
4 change in quaternions as a function of angular velocity.
5 Q And it's the same equation you would use for
6 the device of Figure 5; is that right?
7 A Yes.
8 Q While looking at Equations 2 through 4, are
9 these the equations that are used for the device in
10 Figure 6?
11 A It's one embodiment.
12 Q So Equations 2 through 4 could be used with
13 the device in Figure 6?
14 A If you're using this embodiment, then, yes.
15 Q Okay. And these are the same equations that
16 could be used with the embodiment in Figure 5, correct?
17 A Correct.
18 Q And let's look at Equations 5 through 11.
19 A Um-hum.
20 Q Can these equations be used with the
21 embodiment of Figure 6?
22 A Yes.

1 Q And these are the same equations that can be
2 used for the embodiment of Figure 5?
3 A Yes.
4 MR. LAURENZI: Let's go off the record.
5 CERTIFIED STENOGRAPHER: Okay. Off the
6 record.
7 (A luncheon recess is had from 11:59 a.m. to
8 1:05 p.m.)
9 CERTIFIED STENOGRAPHER: Back on the record.
10 BY MR. LAURENZI:
11 Q Dr. LaViola, I've placed in front of you a new
12 exhibit that's Samsung Exhibit 1023. It's titled On
13 Kalman Filtering with Nonlinear Quality Constraints.
14 You're listed as an author.
15 (Samsung Exhibit 1023 was marked.)
16 THE WITNESS: Yep.
17 BY MR. LAURENZI:
18 Q I read that in for the record. I'm going to
19 come back to that exhibit. But right now, I would like
20 you to open Exhibit 2040. Again, it's your declaration,
21 the 847 IPR matter.
22 A 847?

1 MR. EVANS: '846.
2 BY MR. LAURENZI:
3 Q '846. And if you turn to page 49, paragraph
4 153, please. Let me know when you're there.
5 A Okay.
6 Q Go ahead and just reads it to yourself. I'll
7 ask you some questions about it.
8 A Okay.
9 Q So this paragraph is talking about Equation 26
10 of Bassompierre. We discussed Equation 26 earlier a
11 bit.
12 A Um-hum.
13 Q And you state here that "To convert Equation
14 26 of Bassompierre into something like Equation 21 of
15 Bassompierre with an EKF, a POSITA would need to perform
16 three additional steps that Bassompierre never teaches:
17 The first step is discretize the continuous-time
18 equation into a finite update suitable for digital
19 implementation."
20 Do you see that?
21 A Yes.
22 Q Under your understanding of what POSITA is in

1 this matter, would a POSITA be able to perform that
2 first step?
3 A I would say that -- a POSITA should be able
4 to, to do that.
5 Q The second step says "Numerically integrate
6 the discretized equation over a timestep delta T."
7 Do you see that?
8 A Yes.
9 Q Is that something a POSITA, under your
10 understanding of what a POSITA is in this matter, would
11 be able to do?
12 A Yeah. That goes kind of with the finite
13 difference update, get another timestep that you'd be
14 using to move through the sequence, so, yeah, some
15 people, they would -- a POSITA would understand how to
16 do that.
17 Q And finally, third, "Normalize the result
18 after every integration step to maintain the unit-norm
19 constraint and prevent floating-point drift."
20 Do you see that?
21 A Um-hum.
22 Q Is that something a POSITA would be able to

1 do, under your understanding of POSITA?
2 A Yes.
3 Q If you turn now to that Exhibit 1023.
4 A Yes.
5 Q What is this document?
6 A This is a paper that I wrote a number of years
7 ago. This one, I'm not as familiar with as some of the
8 other ones. I was not -- Simon Julier was -- kind of
9 led the effort. And I sort of assisted with him.
10 Q But you did identify this --
11 A Yeah. Yeah.
12 Q -- paper in paragraph 10 --
13 A Um-hum.
14 Q -- of your declaration? Yes?
15 A Yeah. So, I mean, it basically is -- there
16 can be constraints that -- that can occur in some
17 physical systems. And the question is, how do you deal
18 with those constraints or if there's some connection
19 between the state variables.
20 This paper we did was basically categorize
21 previous approaches and identify two different types of
22 constraints and ultimately create a new method that uses

1 something called "projection" to sort of make the
2 distribution to handle these constraint issues.
3 And then we actually tested it out in a
4 real-time tracking system.
5 Q You mentioned Simon Julier. Who is he?
6 A He's a professor in England. When I did this
7 work with him, he was working for a naval research lab,
8 I believe.
9 Q Is he a Ph.D.?
10 A Oh, yeah.
11 Q Does this paper describe quaternion
12 mathematics?
13 A It does. Not till the very end.
14 Q Where?
15 A Well, it doesn't just describe quaternion
16 mathematics. It uses quaternion representation in the
17 example starting in Section 6.
18 Q In what kind of industry would the system that
19 you describe here be used?
20 A It could be used in orientation tracking for
21 people or objects.
22 Q When you write a paper -- well, withdraw that.

1 When you wrote this paper, did you have it in
2 mind that people in the industry would read it and be
3 able to understand it?
4 A No.
5 Q Why not?
6 A Because I don't typically write for people in
7 the industry. They don't really care about much what I
8 do.
9 Q Did anybody care about this paper?
10 A Some people.
11 Q Who cared?
12 A Other academics. And it's been cited several
13 hundred times.
14 Q You don't think anybody in industry has ever
15 read it?
16 A It's possible. This was more theoretical work
17 than anything else. And it did provide a concrete
18 example.
19 Q It did provide a concrete example?
20 A Well, it did, the tracking of the platform.
21 But I would -- you know, I wouldn't say that
22 there's a lot of material here that would help you

1 understand quaternions.
2 Q Because you've assumed that the reader would
3 understand quaternions?
4 A Well, that's part of it. The other part of it
5 is that it's -- the quaternion part is not really the
6 most important part. It's the beginning part where we
7 identify the constraints and how to mitigate them that's
8 more important.
9 Q And quaternions was just a tool to address
10 that issue?
11 A It was just a tool to use as a representation
12 that we were familiar with.
13 So one of the -- now that I'm familiarizing
14 myself with it a little bit because it's been a long
15 time since I've looked at this, so it turns out with
16 quaternions, you know, one of the steps that you have to
17 do is you have to normalize them -- right? -- because
18 quaternions that are not normalized. They're not
19 rotations. They're some other crazy thing.
20 In order to do that, there's this constraint
21 you have to satisfy. Some of the individual pieces of
22 the quaternion need to be -- some of the squares need to

1 be one. And so that's a non-linear constraint.
2 And so that's why we used quaternions here in
3 order to see if we could make some improvements in the
4 process of doing the estimation, because when you --
5 when you integrate the quaternion, you're moving it a
6 little bit off of being a unit quaternion. So that
7 means you have to project it back on to the unit sphere
8 so there is a unit quaternion available for rotation.
9 But you see, when you do that, you kind of --
10 there's a little bit of noise there. And so what this
11 tried to do is to try to better integrate this
12 constraint that you have to satisfy within the context
13 of the filter in order to improve upon the accuracy.
14 And as I recall, some of them performed okay
15 and some of them performed really bad.
16 Q And those results are shown in figures --
17 A Table 1.
18 Q All right. Have the results of this paper
19 ever been used in industry?
20 A Not that I'm aware of.
21 Q If they were used, how would they be used?
22 A I mean, if they applied the constraint to

1 the -- to the quaternion normalization, I suppose that's
2 how they would have been able to take -- taken this and
3 actually implemented it from the paper.
4 Q So it could have been implemented in any
5 product that's utilized in the quaternion?
6 A Could be. I'd be really upset if it did and I
7 didn't know about it.
8 Q What do you mean by that?
9 A Well, its nice to know if your work's being
10 used out there in the world. It would have some meaning
11 for what you do, outside of just advancing science.
12 Q Are you aware of any products that have
13 acknowledged your work?
14 A Yeah, I am. Microsoft used a filter that I
15 wrote up as part of their -- one of their interfaces,
16 one of their hardware interfaces, the connect --
17 Microsoft Connect.
18 And some -- I don't know -- some virtual
19 reality companies have used interaction techniques that
20 I have produced, developed. They didn't tell me that
21 they did it but when I saw what the interaction
22 technique was, I was like, yeah, okay, this is what we

1 do.
2 Q Did those techniques use quaternions?
3 A I can't recall if they did.
4 Q Would you turn, please, to the other
5 Exhibit 2040, which is --
6 A Sure.
7 Q -- your declaration for the '687 patent?
8 A Okay.
9 Q Let's go to page 34. Actually, 33, please.
10 Section E, starting at paragraph 109.
11 A Um-hum.
12 Q So I'm a little confused by this section.
13 A Okay. I'll read it.
14 Q Can you give me a high-level overview of what
15 it is you're saying here? And take your time to read
16 it.
17 A Okay.
18 Q It goes through to the top of page 37.
19 A So this section is essentially talking about
20 how a POSITA would understand the natural progression of
21 the claims being discussed in the '687 patent,
22 specifically Claims 1 and 7 and 8. And basically says

1 that -- is that typically a POSITA, when they see
2 something that's written that's new, they assume that
3 that is actually some new piece of information. And if
4 it's not new, then it's simply already stating an
5 already established fact.
6 And so in this case, you know, a POSITA would
7 read the phrase at the end of the wherein clause as
8 doing new technical work, which is specifying that the
9 content the processor provides is expressly measured
10 with the same spatial reference frame, rather than being
11 transformed into or presented in some other reference
12 frame.
13 This was kind of like what I was talking about
14 with Figure 6 in the '846 patent where you have this
15 device and it's kind of like a tablet, PC, or a phone,
16 whichever thing, and it's got a display sort of attached
17 to the rest of the device.
18 And the spatial reference frame and the
19 display reference frame could be the same thing. And
20 so, you know, if you -- if the claims made -- made the
21 statement that it used the spatial reference frame, then
22 you kind of understand that that spatial reference frame

1 was the same reference frame as the display reference
2 frame without actually specifying it specifically.
3 But if it did specify it specifically, which
4 it does, when you go from Claims 1 to 7 to 8, it's
5 showing you how the fact that there's a nice progression
6 that sort of fits in with the discussion that we're
7 having here -- right? -- that basically specifying the
8 frame in which content is provided is not going to
9 necessarily be redundant.
10 And so in Claim 1, we talk about electronic
11 device comprising both motion sensor and the processor,
12 and the spatial reference frame is fixed to that device.
13 Okay. And because of the device's display,
14 it's supposed to be part of the device, then you
15 wouldn't need to necessarily do any translation. Okay?
16 Even though it's -- there's several frames of reference,
17 they're basically the same.
18 Claim 7 then says, oh, okay, wait a minute,
19 there's a display reference frame, or there could be.
20 And if there is, then you would need to translate that
21 into the quaternions or whatever the result into that
22 reference frame. And then Claim 8 adds just the

1 physical hardware associated with the display, which is
2 a way of saying that there's a actual display device
3 associated with the display reference frame.
4 So basically, it's just talking about there's
5 a nice, natural progression between Claims 1, 7, and 8
6 that shows a technical -- a technical progression of
7 what one would need to do as part of the claims in order
8 to, I guess, instantiate.
9 From a systems engineering perspective, you
10 know, that's kind of what you want to have. It makes it
11 clear as to how you do things.
12 Q All right. Let me try to unpack that. Do you
13 understand Claim 1 to cover the embodiment in Figure 5
14 of the '687 patent, which is the same figures as --
15 A Yeah.
16 Q -- 847 or '846?
17 A I don't believe that Claim 1 is associated
18 with Figure 5. It doesn't mention anything related to
19 that figure. The figures for Claim 7 does. Claim 7 --
20 I mean, Claim 7 is a dependent claim so, you know, it's
21 the electronic device of Claim 6, which is the
22 electronic device of Claim 1. So if you look at it like

1 that, then you take Claims 1, 6, and 7 and it would
2 cover Figure 5.
3 Q Do you think Claim 1 standing alone does not
4 cover Figure 5?
5 A Well, Claim 1 does not say anything about
6 translating -- resultant deviation in the spatial
7 reference frame to a real-time movement pattern and
8 display reference frame.
9 There's nothing in there that says that. The
10 only thing it says is that it's content based on the
11 resultant deviation in the spatial reference frame.
12 So Claim 1 kind of assumes that -- Claim 1 is
13 more geared towards Figure 6, in my opinion, where you
14 wouldn't necessarily have the need to discuss the
15 display reference frame or doing a transformation to the
16 display reference frame because it's essentially the
17 same thing as the spatial reference frame.
18 Q The device in Figure 5 has a display reference
19 frame and a spatial reference frame; is that right?
20 A I believe so.
21 Yes, it does. It has a display reference
22 frame.

1 Q And it has a spatial reference frame?
2 A Yes.
3 Q So would Claim 1 cover that embodiment?
4 A I mean, according to Claim 1, if the display
5 reference frame is not the same as the spatial reference
6 frame, then it would not fit under the claim, as far as
7 I can tell.
8 Q And, again, tell me why.
9 A Because it does not mention display reference
10 frame. It would -- it would only work if the display
11 reference frame was the same as the spatial reference
12 frame because once you provide content, the resultant
13 deviation in the spatial reference frame automatically
14 put it into display reference frame if those two
15 reference frames are the same. Figure 5 doesn't have
16 that. Figure 6 does.
17 Q In Figure 6, what is the content?
18 A The content could be anything. It could be a
19 picture, image, text, 3D object, some graphical widget.
20 Q In this declaration for the '687 in
21 Section 9 -- you can look at the table of contents,
22 perhaps.

1 A Okay.
2 Q This would be easier. There are four Sections
3 A, B, C, D, where you lay out certain elements not being
4 present in Bassompierre.
5 Do you see that?
6 A Yes.
7 Q So the section we were just talking about,
8 which is VIII E, to which discussion in Section IX does
9 that discussion in VIII E apply?
10 A I would say IX C, resulting deviation.
11 Q All right. Looking at that section then --
12 A Yes.
13 Q -- can you tell me how the discussion or
14 explanation you just gave related to the absence of
15 display -- absence of the recitation of display
16 reference frame applies here in this Section IX C?
17 A Well, the first thing to note is that we're
18 defining a resulting deviation to be roll, pitch, and
19 yaw angles, 3 degrees of freedom. And Bassompierre does
20 not essentially deal with 3 degrees of freedom. They
21 deal with 2 degrees of freedom, which is the roll and
22 the pitch.

1 And even then, those are just used to compute
2 angular velocities which are used, then, to determine
3 where the mouse pointer should go on the screen.
4 So Bassompierre really doesn't deal with these
5 angles, these three -- these 3D orientation angles in
6 terms of using it as part of creating content for the
7 display; right? It's just using these two angle
8 velocities to create the content of the display. That's
9 what this is basically saying.
10 Q And does that have anything to do with the
11 fact that, as you say, Bassompierre is a pointer and on
12 display and not a system where the two are fixed?
13 A Oh, yeah. Well, I mean, Bassompierre is
14 definitely -- they're not fixed. Bassompierre is
15 designed to be like a remote control, right? And so --
16 and in fact, like I said, Bassompierre, all they care
17 about is this roll (indicating), pitch. And as you hold
18 it and rotate it, and the cursor will move, you rotate
19 it this way and this way, the cursor moves down; right?
20 And so all they really ever care about are
21 those -- the roll and pitch, those two angles.
22 And then it gets translated in based on the

1 angle of velocity to how you move the cursor.
2 Q I understand that. But I'm not following is
3 how that earlier discussion you had about Claim 1 and
4 its progression with Claim 7 and 8 relates to the
5 argument you're making here in Section IX C.
6 A Okay.
7 I guess the main relationship between those
8 two things is that in VIII E, it's basically saying that
9 the claims essentially include all of the information
10 necessary to take a piece of content and place it on the
11 screen. And it relates to Bassompierre not disclosing
12 the resulting deviation in that, because it doesn't
13 disclose that, it's not necessarily telling you, from
14 a -- from a architectural point of view, you need a
15 separate step in order to do what Bassompierre does,
16 which is the converting of the -- of the angles to the
17 angular velocities.
18 So in the '687 patent, there's not necessarily
19 a need, especially for Claim 1, to talk about how the
20 angles that you're using gets you to some content on a
21 screen as opposed to Bassompierre, which does require
22 you to have some information that tells you that you

1 need to convert these -- these angles into angular
2 velocities that can be used to put something on the
3 screen, namely a cursor.
4 So '687 patent says that the steps -- the
5 steps to create -- to move the content are kind of
6 embedded in the claims and Bassompierre, there are
7 several. Bassompierre are separate as part of its
8 procedure in how you would move the cursor up and down,
9 and left and right.
10 Q Looking at Claim 1 of the '687 patent, it
11 says, looking at -- around line 50 of column 31, it says
12 "Wherein the processor circuitry is further configured
13 to provide content based on the resulting deviation in
14 the spatial reference frame."
15 Do you see that?
16 A Yes.
17 Q And are you saying that Bassompierre does not
18 show that element?
19 A Yes.
20 Q Why?
21 A Well, Bassompierre doesn't have -- I don't
22 believe they have a spatial reference frame. Maybe they

1 do.
2 Q For what it's worth, in Section IX of your
3 declaration, you do not state that Bassompierre does not
4 disclose the spatial reference frame.
5 A Bassompierre has a different reference frame.
6 They have actually three of them. And there's an image
7 related to this.
8 Yeah. It has a device reference frame, the
9 carrier reference frame, and the screen reference frame.
10 And in the '846 patent -- or I'm sorry, '687 patent, it
11 just has spatial reference frame and sometimes a device
12 reference frame -- I'm sorry -- sometimes the display
13 reference frame.
14 Q So Bassompierre does have a spatial reference
15 frame; correct?
16 A Well, it's not called the spatial reference
17 frame. I suppose you could say that the device
18 reference frame is similar to the spatial reference
19 frame. But the spatial reference frame also, you know,
20 can include the display reference frame if they're the
21 same. I don't -- in this particular case, this is
22 always holding a controller and moving a cursor on a

1 screen.
2 Q You're pointing to Figure 2 of Bassompierre?
3 A Yes. So it's never the case where the thing
4 that you're holding is going to have the screen on it.
5 So there's always going to be this transformation that
6 needs to be done for the Bassompierre as opposed to in
7 the '687 where that transformation does not necessarily
8 need to be done if the display is connected with the
9 special reference frame.
10 Q Okay. But does Bassompierre -- I think --
11 withdraw that.
12 I think you said that Bassompierre does have a
13 spatial reference frame. Am I correct?
14 MR. EVANS: Objection, form.
15 THE WITNESS: Well, I said they have a device
16 reference frame.
17 BY MR. LAURENZI:
18 Q And what is the device reference frame?
19 MR. EVANS: Same objection.
20 THE WITNESS: It's the reference frame for the
21 actual device that you're holding. It's similar to
22 the spatial reference frame. We just call it -- I

1 mean, it's called two different things. But it's
2 kind of the same thing.
3 BY MR. LAURENZI:
4 Q Does Bassompierre have a display reference
5 frame?
6 A Well, they have a screen reference frame.
7 Which I suppose you could consider -- well, screen
8 reference frame implies two dimensions. Display
9 reference frame does not imply two dimensions. It
10 implies potentially more dimensions, like three
11 dimensions. So there's a significant difference between
12 Bassompierre and the '687 in terms of that.
13 It's kind of like Bassompierre shows you how
14 to do this, you know, with an external screen for moving
15 a mouse cursor, whereas as in '687 shows you how you can
16 do it if that display is anywhere, or if it's on the
17 device or if it's off the device. So there's more going
18 on in the '687 patent in terms of embodiment than what
19 is being done in Bassompierre.
20 Q Again, looking at the portion of Claim 1 of
21 the '687 patent that I asked you about, it says "Wherein
22 the processor circuitry is configured to provide content

1 based on the resulting deviation in the spatial
2 reference frame."
3 Does Bassompierre meet that claim element or
4 no?
5 Again, this is column 31, line 50 through 52.
6 A What the hell am I looking at? Are we in '687
7 or '846?
8 Q We're in '687, Claim 1.
9 A Yeah. I got it.
10 Q The "wherein" clause at the end of Claim 1.
11 A Gotcha.
12 So you're asking me if Bassompierre teaches
13 this claim?
14 Q No.
15 A This piece?
16 Q That piece, the wherein clause of Claim 1 of
17 the '687 patent.
18 A No, it does not.
19 Q And why not?
20 A Because in Bassompierre, you've got to take it
21 and move it to the screen reference frame, otherwise
22 it's not going to do anything at all. The whole point

1 is getting to the screen reference frame so that you can
2 move the cursor around.
3 This thing, this just talks about the display
4 reference frame, assuming that the display reference
5 frame is the same as the spatial reference frame. So it
6 doesn't say anything explicitly but it's implicit in the
7 claim that when you move something in spatial reference
8 frame, it's going to be a -- the content will be
9 displayed on the screen.
10 But because Bassompierre has a screen
11 reference frame and that screen is always separate from
12 the pointer, okay, it's always separate from the
13 pointer, then you're going to have to do a
14 transformation to get it into the screen space.
15 In the '687 patent, you do not necessarily
16 have to do a transformation to get it into this "screen
17 space," which is really the display reference frame that
18 we're talking about here.
19 Q In Bassompierre, does movement of the device
20 in a spatial reference frame result in the cursor
21 deviating in its position on the screen?
22 A No, it doesn't.

1 Q What's the point of the pointer in
2 Bassompierre?
3 A Well, I mean, Bassompierre is not -- you know,
4 is not -- was not made to try to mimic the '687 patent.
5 It's a separate patent and separate thing going on.
6 And that separate thing is, is -- you know, if
7 you look at what Bassompierre does, it does a
8 transformation to the screen display frame to be able to
9 move the cursor frame. And that's what it does.
10 This guy, the '687 patent, kind of implies
11 that that screen can be in a location where there is no
12 difference between the display reference frame and the
13 spatial reference frame. If there's no difference, then
14 it automatically is there without you having to do
15 anything.
16 In this one, in Bassompierre, you have to do
17 this every time, okay, in order to get it on to the
18 screen, you have to do this transformation every time.
19 In '687, you do not have to do it every time
20 because sometimes it is done for you.
21 Q The transformation is done for you?
22 A Because the display reference frame and the

1 spatial reference frame are the same thing.
2 Q What I'd asked you, though, is two questions
3 ago, do you read that with Bassompierre, movement of the
4 pointer device causes some deviation of the position of
5 the cursor on the display?
6 A I mean, it causes the cursor to move in two
7 dimensions.
8 Q You don't think that's enough to meet the
9 wherein clause of Claim 1 because the spatial reference
10 frame and the display reference frame in Bassompierre
11 are not the same?
12 A Okay. In -- yes. In Bassompierre, they are
13 not the same, definitely. Okay?
14 In '687, they could be the same, right? In
15 one embodiment, the display is separate. Another
16 embodiment, the display is embedded on top of the
17 spatial reference frame. That's the difference. This
18 '687 patent's a little broader to what you can do with
19 it.
20 Q What about Claim 1 in the '687 patent?
21 A Same thing. Like I said, if the display
22 reference frame is the same as the spatial reference

1 frame, then Claim 1 will meet the limitation that some
2 content is going to be displayed on the screen. I mean,
3 that -- like I said before, Figure 6 is where this is --
4 this is where this works, right?
5 For Figure 5, it requires Claim 1 and I
6 believe 6 and -- and 6 and 7 and 8.
7 Q Is Claim 6 broader than Claim 1?
8 MR. EVANS: Objection, beyond the scope.
9 THE WITNESS: Claim 6 is just saying that the
10 content is visual, right? When you're talking
11 about a display -- right? -- display could be
12 visual, it could be auditory, it could be tactile.
13 This is just giving you a limitation that says it's
14 visual.
15 BY MR. LAURENZI:
16 Q Is Claim 7 broader than Claim 1?
17 MR. EVANS: Objection, beyond the scope.
18 THE WITNESS: I would -- it really depends on
19 how you read it. I mean, for Claim 7, it says
20 that, you know, it's going to "further translate,
21 resulting deviation in the spatial reference frame
22 into a real-time movement pattern in a display

1 reference frame."
2 So if you read it one way, okay, there's two
3 distinct reference frames here and we're going to
4 move the movement pattern from the deviation into
5 the display reference frame from the spatial
6 reference frame.
7 But if you say that the spatial reference
8 frame was the same as the display reference frame,
9 well, then it wouldn't be his problem, it would be
10 equivalent to Claim 1.
11 I would think that the patent -- the patent
12 owners that did this made Claim 7 in order to
13 broaden its applicability. So it's not just you
14 can do this patent on like a phone or a tablet, but
15 you can do it on a laptop or a notebook computer or
16 something.
17 So in that sense, it's broader.
18 BY MR. LAURENZI:
19 Q Let's look at the '846 patent again.
20 A Okay.
21 Q Let's look at Equations 12, 13, and 14 in
22 column 19.

1 A Equations 12, 13, and 14?
2 Q Take a moment to look at this section.
3 A Okay.
4 Q And my question is: What are these equations?
5 A Okay. These equations convert quaternions
6 into Euler angles assuming that a magnetometer is
7 present.
8 So "In one embodiment, the computing processor
9 may use a data conversion utility to convert the third
10 quaternion of the updated state of the nine-axis motion
11 sensor module into the yaw, pitch, and roll angles
12 thereof."
13 Okay. Including a nine-axis motion sensor
14 module. Nine-axis motion sensor module contains
15 acceleration, a gyroscope for angular velocity, and a
16 magnetometer which is to measure the earth's magnetic
17 field.
18 Q Can these equations be used if no magnetometer
19 is present?
20 A Well, you wouldn't be able to get yaw if you
21 didn't have a magnetometer. That's for sure.
22 I'm not sure. I would have to --

1 I didn't really opine on anything related to
2 these equations in my report so I'd have to look at this
3 in more detail to give you a good answer.
4 Q Can you get yaw using only an accelerometer
5 and gyrometer?
6 A Can you get yaw with just an accelerometer and
7 gyrometer?
8 Q Yes.
9 A Well, you can't get yaw from the
10 accelerometer. You can get it from the
11 gyroscope -- right? -- because you can integrate the --
12 integrate the angle of velocities to give you yaw.
13 Q I think you said you hadn't studied these
14 equations. Do you know if these Equations 12 through
15 14, were known in the art?
16 A It's possible. I'm not 100 percent sure.
17 Q Let's move to Bassompierre, please.
18 A Okay.
19 Q It's Exhibit 1006. And turn to Equation 23.
20 Now, you see Equation 23 provides X hat K?
21 A Uh-huh.
22 Q Does calculating X hat K result in a pitch and

1 roll angle?
2 A Yes.
3 Q And then is that pitch and roll angle used in
4 Bassompierre to determine the movement on the display?
5 A It's used in Equation 24.
6 Q And is Equation 24 used to determine movement
7 on the display?
8 A Yes. Those are the angular velocities that
9 are used to determine the X and Y coordinates of the
10 pointer.
11 MR. LAURENZI: Okay. Let's go off the record.
12 (A brief recess is had from 2:10 p.m. to 2:16
13 p.m.)
14 CERTIFIED STENOGRAPHER: Okay. Back on the
15 record.
16 MR. LAURENZI: I'll pass the witness.
17 CERTIFIED STENOGRAPHER: Counsel, just a
18 minute.
19 (Off the record.)
20 EXAMINATION
21 BY MR. EVANS:
22 Q Dr. LaViola, I want to talk about

1 Exhibit 1006, Bassompierre. And specifically, does
2 Bassompierre ever talk about outputting anything in the
3 device reference frame?
4 MR. LAURENZI: Objection, form.
5 THE WITNESS: I don't believe that it does.
6 BY MR. EVANS:
7 Q Okay. Now, I want to go back to the '687
8 patent.
9 A Um-hum.
10 Q So I believe you were testifying that you
11 think that you read Claim 1 as requiring the resultant
12 deviations to be output in the spatial reference
13 frame, right?
14 A Yes.
15 Q And then you -- and those outputs could be
16 anything. They don't have to be visual content?
17 A Based on what this says, yeah, could be
18 anything.
19 Q Just anything based on role, pitch, and yaw
20 calculations, right?
21 A Um-hum.
22 Q So then when Claim 6 limits it to visual

1 content, that's a narrowing?
2 A Yes.
3 Q And then Claim 7 talks about transforming that
4 content into a different reference frame, the display
5 reference frame?
6 A Correct.
7 Q And then Claim 8 adds the hardware that would
8 allow you to display that visual content. Is that your
9 understanding?
10 MR. LAURENZI: Objection, form, leading.
11 THE WITNESS: Yes, that's correct.
12 BY MR. EVANS:
13 Q Okay. Now, I want to talk about the '846
14 patent, just briefly. In your opinion, does Claim 1
15 cover the embodiment shown in Figure 5?
16 A Claim 1...
17 So it says "Wherein, the process or circuitry
18 is further configured to translate the resultant angles
19 of the result in deviation in the spatial reference
20 frame into a real-time movement pattern in the display
21 reference frame."
22 So, having said that, it appears that Claim 1

1 could cover Figure 5.
2 Q What is moving in the spatial reference frame
3 in Claim 1?
4 A The thing that's moving in the spatial
5 reference frame is the electronic device.
6 Q And what is the electronic device composed of?
7 MR. LAURENZI: Objection to form.
8 BY MR. EVANS:
9 Q According to Claim 1. I'm specifically
10 looking at the first two claim elements. What do
11 they -- what's required of the electronic device?
12 A It says the display device associated with a
13 display reference frame and a motion sensor module which
14 contains an accelerometer and gyrometer, otherwise...
15 Q If you go down to the third element that
16 starts "the computing processor," do you see where it
17 says "Calculate a resulting deviation comprising
18 resultant angles associated with the movements and
19 rotations of the electronic device in the spatial
20 reference frame"?
21 A Yes.
22 Q What does that imply?

1 MR. LAURENZI: Objection, form.
2 THE WITNESS: Well, in this particular claim,
3 because we have a display reference frame here, and
4 display device, that would imply that the rotations
5 of the electronic device are in the spatial
6 reference frame. And if they're in the spatial
7 reference frame, then that would imply that the
8 display device is also in the spatial reference
9 frame.
10 BY MR. EVANS:
11 Q So would that cover a split display
12 configuration like Figure 5?
13 A No.
14 Q Is there anything today that you talked about
15 that you feel like needed further explanation or do you
16 feel like you wanted to add any additional commentary
17 to?
18 A I guess the only other thing that I would say
19 is -- and it's in my report but I'll just state it
20 quickly, is Bassompierre does not provide a preference
21 for quaternions or their angles. But if you do the
22 analysis as to what Bassompierre is actually doing in

1 order to get the roll and pitch, if you look at what it
2 takes to do the Euler angle version and what it takes to
3 do the quaternion-based version, the Euler-based version
4 is much simpler and easier to do than the
5 quaternion-based version in this case.
6 So the benefits of the quaternion-based
7 version are minimal. And if I was an ordinary skill in
8 the art -- ordinary skill in the art and I was trying to
9 go with Bassompierre, I would stay with the Euler angle
10 version.
11 MR. EVANS: That's it. Pass the witness.
12 FURTHER EXAMINATION
13 BY MR. LAURENZI:
14 Q Does Bassompierre disclose the use of
15 quaternions?
16 A Yes, it does.
17 Q Does Bassompierre suggest that its state
18 vector can be in quaternion form?
19 A Does it suggest that its state vector --
20 Q Yes.
21 A Yes.
22 Q What's a state vector?

1 A A state vector is a vector that contains the
2 variables that you're interested in trying to model and
3 understand and see how they change through time.
4 Q Does Claim 1 of the '846 patent cover the
5 embodiment of Figure 5?
6 A '846 patent, embodiment of Figure 5...
7 I believe it does.
8 Q You were asked by Mr. Evans "Does Bassompierre
9 ever talk about outputting anything in the device
10 reference frame." You said "I don't believe that it
11 does."
12 A Yes. That's what I said.
13 Q What did you understand the phrase "outputting
14 anything" to mean when you answered that question?
15 A Outputting anything, I guess, through the
16 course of the running the extended Kalman filter, would
17 the outputs from the state vector be in the device
18 reference frame.
19 That basically is what -- that's the only
20 output that there could be. But I believe that that
21 gets translated beforehand into the -- where did it go?
22 Where did it go? -- the carrier reference frame, I

1 think.
2 Q Sorry. What gets translated beforehand?
3 A I think the output of the extended Kalman
4 filter is in the carrier reference frame.
5 Q And then what happens to the output?
6 A Well, and then it gets translated into the
7 screen reference frame.
8 Q And then what's the ultimate result in
9 Bassompierre?
10 A The ultimate result is angular velocities
11 among the X and Y direction that are used to move the
12 cursor on the screen.
13 MR. LAURENZI: Nothing further.
14 FURTHER EXAMINATION
15 BY MR. EVANS:
16 Q I just want to go back to Claim 1 of the '846
17 patent, briefly.
18 A Okay.
19 Q So Claim 1 has an electronic device subject to
20 movements and rotations in dynamic environments
21 comprising a display device, a motion sensor module, and
22 a computing processor, right?

1 A Correct.
2 Q And "the computer processor, having processor
3 circuitry configured to calculate a resulting deviation
4 comprising resultant angles associated with the
5 movements and rotations of the electronic device in the
6 spatial reference frame."
7 Do you see that?
8 A Yes.
9 Q What does that imply about what is moving in
10 the spatial reference frame? Or what is moving in the
11 spatial reference frame?
12 A Well, if you look at the whole thing
13 collectively, if an electronic device consists of a
14 display device, a motion sensor, and a computing
15 processor, and the resultant angles associated with the
16 movements and the rotations of the electronic -- that
17 device in the spatial reference frame would indicate
18 that the display device with its display reference
19 frame, a motion sensor module, and a computing processor
20 all en route in this spatial reference frame.
21 And if that's true, then it would be difficult
22 to have Figure 5 be sort of embodied in this claim,

1 unless there was some very bizarre contraption that
2 moved the display around.
3 Q But they all have to be moving
4 together, right?
5 MR. LAURENZI: Objection, form, leading.
6 THE WITNESS: Well, yeah, they're moving
7 together.
8 BY MR. EVANS:
9 Q So if the display is moving in the spatial
10 reference frame, is that more like Figure 6 or Figure 5?
11 MR. LAURENZI: Objection, form.
12 THE WITNESS: Well, it's more like Figure 6.
13 MR. EVANS: No further questions.
14 FURTHER EXAMINATION
15 BY MR. LAURENZI:
16 Q Does Claim 1 of the 847 [sic] patent cover
17 embodiment of Figure 5?
18 A I guess Figure 5, as it is drawn, the answer
19 would be no.
20 Q Let me ask you about the qualification when
21 you say "as it is drawn."
22 A Yeah.

1 Q Does Claim 1 of the 847 patent cover Figure 5
2 as it is drawn and described in the specification?
3 MR. EVANS: Objection, form.
4 THE WITNESS: I mean, in order for that to
5 happen, so this is display (indicating), and this
6 is the pointing device.
7 BY MR. LAURENZI:
8 Q What are you pointing to?
9 A This here (indicating).
10 Q What is that?
11 A 560. So pointing to 560, pointing to 582. So
12 in order to have them be moving together, there would
13 have to be some contraption associated with the device
14 with 580 or perhaps with 560 that would literally
15 physically move the display, like a servo or something,
16 so that when you move -- in certain directions, when you
17 move this, this would move along with it.
18 So as it is drawn, because there is nothing
19 showing that there's a connection, physical connection
20 between -- or anything that would indicate that these
21 would be moving together, then I don't believe Claim 1
22 covers it.

1 Q Does Claim 1 of the 847 patent cover the
2 embodiment shown in Figure 5 and as described in the
3 specification?
4 MR. EVANS: Objection, form. The '846 patent.
5 MR. LAURENZI: Let me ask the question again.
6 Thank you.
7 BY MR. LAURENZI:
8 Q Does Claim 1 of the '846 patent cover the
9 embodiment of Figure 5 of the '846 patent?
10 I've asked that at least three times and
11 you've told me no. I just want it to be clear on the
12 record what your best and final answer is.
13 I'm sorry. I withdraw that.
14 I think I've asked you three times and you've
15 said that it does. So I need to get clarity on what the
16 answer is.
17 Again, does Claim 1 of the '846 patent cover
18 the embodiment of Figure 5 of the '846 patent?
19 A I think, based on the claim language -- so on
20 the one hand, we have this computing processor, right?
21 Q What are you talking about?
22 A Number -- column 31, number 23 -- 22.

1 "A computing processor having processor
2 circuitry configured to calculate a resulting deviation
3 comprising resultant angles associated with the
4 movements and rotations of the electronic device in the
5 spatial reference frame. The electronic device contains
6 a display device, a motion sensor, and a computing
7 processor."
8 So what this says is that the device is moving
9 in the spatial reference frame.
10 So on the one hand, this would indicate that a
11 spatial reference frame contains the display device and
12 the motion sensor and computing processor together like
13 Figure 6. Okay? But if you go down to line 58,
14 "Wherein the processor circuitry is further configured
15 to translate the resultant angles of the deviation in
16 the spatial reference frame into a real-time movement
17 pattern in the display reference frame."
18 So this implies that you're going to be moving
19 whatever was in the spatial reference frame into the
20 real -- into display reference frame.
21 And if you're doing that, then it would
22 indicate that there would be potentially different

1 reference frames.
2 But up here, in the case that it would be
3 potentially the same reference frame, spatial reference
4 frame, so because of this statement down here in 58, I
5 mean, it potentially opens the door for having a display
6 reference frame different from the spatial reference
7 frame, even though it says it's the same reference --
8 the same reference frame up here. So this is -- the
9 claim is inconsistent.
10 So to answer your question, there would have
11 to be -- it's trying to be broader, I think. And in
12 that case, then Figure 5 and Figure 6 would fit into
13 this claim.
14 MR. LAURENZI: All right. Nothing further.
15 FURTHER EXAMINATION
16 BY MR. EVANS:
17 Q I want to look at your report for the '846,
18 paragraph -- starting at paragraph 104, 105, and 106, if
19 you could just review those.
20 A 105 and 106.
21 Q 104, 105, and 106.
22 A 104, 105, and 106.

1 Q Well, actually first, let me ask you one
2 question.
3 A Um-hum.
4 Q Can you have an embedded display in a phone
5 and have both a special reference frame associated with
6 the device and a different display reference frame
7 associated with that embedded display on the device?
8 MR. LAURENZI: Objection, form, leading.
9 THE WITNESS: Yes.
10 BY MR. EVANS:
11 Q Okay. Let's look at paragraphs 104, 105, and
12 106 of your report. Just please read them --
13 A Um-hum.
14 Q -- to yourself.
15 A Okay.
16 Q Do you agree with what you wrote in paragraphs
17 104, 105, and 106?
18 A Yeah. I wrote it, so I would agree with it.
19 Q And would you agree that Claim 1 encompasses
20 an electronic device that has two separate reference
21 frames, a display reference frame and a spatial
22 reference frame?

1 MR. LAURENZI: Objection, form, and leading.
2 THE WITNESS: Yes. That is true.
3 BY MR. EVANS:
4 Q Can those two reference frames be the same
5 reference frame?
6 A Can they?
7 MR. LAURENZI: Objection, form, leading.
8 THE WITNESS: Yes, they can be the same
9 reference frame.
10 BY MR. EVANS:
11 Q Does Claim 1 describe a separate display
12 device?
13 MR. LAURENZI: Objection, leading, and form.
14 THE WITNESS: No. It describes an electronic
15 device that contains a display device, a motion
16 sensor, and a computing processor.
17 BY MR. EVANS:
18 Q So there's no hardware configuration that
19 Claim 1 would cover where the display is separate from
20 the electronic device?
21 MR. LAURENZI: Objection, form, and leading.
22 THE WITNESS: I'm trying to think if there's

1 any display configuration that you're talking about
2 that would have that.
3 Not off the top of my head.
4 BY MR. EVANS:
5 Q So you agree that the display moves with the
6 electronic device because it is part of it?
7 MR. LAURENZI: Objection, form, and leading.
8 THE WITNESS: Yes. It is part of it, based on
9 this claim.
10 MR. EVANS: Pass the witness.
11 THE WITNESS: Based on what I see here.
12 MR. EVANS: Pass the witness.
13 FURTHER EXAMINATION
14 BY MR. LAURENZI:
15 Q Does Claim 1 of the 847 patent cover
16 Figure 5 -- withdraw that.
17 Does Claim 1 of the '846 patent cover the
18 embodiment of Figure 5?
19 A As it is drawn in the figure, no.
20 Q Does Claim 1 of the '846 patent cover the
21 embodiment of Figure 5? And please do not limit
22 yourself to just what's in the drawing, but also

1 consider what's in the specification.
2 MR. EVANS: Objection, form.
3 THE WITNESS: According to the specification
4 on column 12, 61. "In one embodiment, the
5 computing processor 554 also performs mapping by
6 translating the resultant angles of the resulting
7 deviation of the electronic device in the spatial
8 point of reference frame, preferably about each of
9 three orthogonal coordinate axes of the spatial
10 reference frame, to movement pattern in a display
11 reference frame associated with the notebook
12 computer 580. The movement pattern may be
13 displayed on the screen 582 of the notebook
14 computer 580."
15 The notebook has a display separate from the
16 pointing device, although you can still call it an
17 electronic device.
18 Is there such a thing as a tie?
19 BY MR. LAURENZI:
20 Q Sorry, is that your answer?
21 A No. I just want to know if there was such a
22 thing.

1 Q What do you mean by "tie"? What were you
2 proposing?
3 A Well, after looking at this again, I think I'm
4 going to stick with my report and say the answer is no.
5 Q You would agree that you've answered yes to
6 that question at least three times --
7 A Yes.
8 Q -- during this deposition. You agree with
9 that?
10 A I have answered yes, and now I'm answering no.
11 Q So your final answer is no?
12 A Yes.
13 MR. LAURENZI: Nothing further.
14 MR. EVANS: Nothing further.
15 CERTIFIED STENOGRAPHER: I believe you have a
16 standing order. Can I get your order, please?
17 MR. EVANS: I'll just take regular time.
18 CERTIFIED STENOGRAPHER: Do you need a rough
19 draft?
20 MR. EVANS: No. We want to do a read and
21 sign.
22 (The reading and signing of the deposition is

1 not waived.)
2 (At 3:02 p.m. the deposition was concluded.)
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1 CERTIFICATE OF OATH

2

3 STATE OF FLORIDA)

4 COUNTY OF ORANGE)

5

6 I, the undersigned authority, certify that JOSEPH

7 LAVIOLA, PH.D appeared before me remotely and was duly

8 sworn.

9 WITNESS my hand and official seal this 26th day of

10 May 2026.

11

12

13 DAWN A. HILLIER, RMR, CRR, CLR

14 Notary Public - State of Florida
My Commission No.: HH 300744

15 Expires: 12-15-2026

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1 CERTIFICATE

2

3 STATE OF FLORIDA)

4 COUNTY OF ORANGE)

5 I, DAWN A. HILLIER, RMR, CRR, CLR certify that I
6 was authorized to and did stenographically report the
7 deposition of JOSEPH LAVIOLA, PH.D; that a review of the
8 transcript was requested; and that the transcript is a
9 true and complete record of my stenographic notes.

10

11 I further certify that I am not a relative,
12 employee, attorney, or counsel of any of the parties,
13 nor am I a relative or employee of any of the parties'
14 attorney or counsel connected with the action, nor am I
15 financially interested in the action.

16

17 DATED this 26th day of May 2026.

18

19

20 _____
DAWN A. HILLIER, RMR, CRR, CLR

21

22

No. 633869

Re: Deposition of **Joseph LaViola, Ph.D.**
Date: 5/20/2026
Case: Samsung Electronics Co., LTD. -v- CM HK Limited (PTAB)
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Page	Line	Correction/Change and Reason
15	6	and predicted --> for predictive
15	14	C graph --> SIGGRAPH
19	11	rotated --> rotate
23	13	angle of velocity --> angular velocity
23	13-14	angle of velocity --> angular velocity
30	19	position of --> position and
31	20	on paper --> in the paper
38	1	result in deviation --> resultant deviation
50	5	saw -> solve
57	22	F vex --> F sub x
58	2	F vex --> F sub x
58	3	F vex --> F sub x
62	18	I --> it
87	22	some --> sum
89	17	Connect --> Kinect

6/30/26
(Date)

(Signature)

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ACKNOWLEDGMENT OF DEPONENT

I, Joseph LaViola, Ph.D., do hereby acknowledge that I have read and examined the foregoing testimony, and the same is a true, correct and complete transcription of the testimony given by me and any corrections appear on the attached Errata sheet signed by me.

6/30/26 _____
(Date) (Signature)