

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

CYWEE GROUP LTD.,

Plaintiff

v.

SAMSUNG ELECTRONICS CO., LTD.
AND SAMSUNG ELECTRONICS
AMERICA, INC.,

Defendants.

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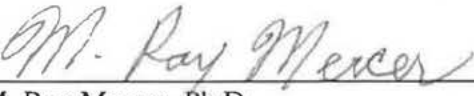
NO. 2:17-CV-00140-WCB-RSP

EXPERT REPORT OF DR. M. RAY MERCER REGARDING NONINFRINGEMENT

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M. Ray Mercer, Ph.D.

December 3, 2018

Date

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I. INTRODUCTION

1. My name is Dr. M. Ray Mercer. I have been retained by Paul Hastings LLP, counsel to Defendants Samsung Electronics Co., Ltd. (“SEC”) and Samsung Electronics America, Inc. (“SEA”) (collectively, “Samsung” and/or “Defendants”), as an independent expert witness in this litigation initiated by Plaintiff CyWee Group Ltd. (“Plaintiff” or “CyWee”).

2. This report provides my opinions regarding the infringement allegations against Defendants that CyWee has raised concerning the asserted patent claims of U.S. Patent Nos. 8,441,438 (“438 Patent”) and 8,552,978 (“978 Patent”).

3. I reserve the right, within the Court’s guidelines, to supplement or amend my opinions, as well as the basis for my opinions, if additional data or information that affects my opinions becomes available, including any evidence that CyWee or its experts may present.

4. I expect to testify at trial regarding the matters expressed in this report and any supplemental reports or declarations that I may prepare for this litigation. I also expect to testify at trial with respect to any matters addressed by any expert testifying on behalf of CyWee, if asked.

II. BACKGROUND AND QUALIFICATIONS

5. I have summarized in this section my educational background, career details, and other relevant qualifications. Additional details appear in my curriculum vitae, attached as Exhibit A to this declaration.

6. I have more than forty-seven years of dual industrial and academic experience in Electrical Engineering and Computer Engineering. I received a B.S. in Electrical Engineering from Texas Tech University in 1968, a Master of Science in Electrical Engineering from Stanford University in 1971, and a Doctor of Philosophy in Electrical Engineering from The

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University of Texas at Austin in 1980. Further, I have authored dozens of published technical papers and delivered many lectures addressing various aspects of Electrical and Computer Engineering.

7. From 1968 to 1973, I was a Research/Development Engineer at General Telephone and Electronics Sylvania in Mountain View, California. I received my M.S. in Electrical Engineering from Stanford University in 1971. At Stanford, I worked on techniques that were unique in that they involved adaptive linear optimizations for monitoring non-stationary signals. This work involved the application of filtering and estimation techniques using data gathered from sensors. For example, I worked on a project involving in vitro detection of signals generated by a fetal heartbeat in the presence of multiple noise sources from the pregnant mother. During this period, much of my work related to communications, computer control of data collection, and analysis systems used by organizations in the United States government. Leading-edge sensing techniques were a key aspect of much of this work.

8. From 1973 to 1977, I was a Member of Technical Staff at Hewlett-Packard’s Santa Clara Division and subsequently at Hewlett-Packard Laboratories in Palo Alto, California. During that time, I continued to develop application programs. I also designed interface hardware to interact with computer software and accomplish various tasks. One major project I was responsible for was the real-time control of environmental test systems for satellites and satellite components. Applications for these analysis and control tools required filtering of noise components to isolate data collected by sensors from noise inherent in the system using a previously unknown set of filtering techniques designed and implemented by my team and utilized Fourier Transforms for tasks best performed in the frequency domain. For example, these tools allowed automated analysis of communication systems. Key concepts in this work are

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related to this case because they involved digital data communications, motion control, motion analysis, and data collection based upon sensors including accelerometers. During this period, I also used variations of these tools to monitor and analyze motions of rigid and semi-rigid objects—particularly with respect to vibration mode analysis. The same tools also found application in the automated diagnosis of communication systems such as telephone systems.

9. At HP Laboratories, among other projects, I developed hardware and software to provide real-time control of manufacturing systems for solid state devices. This work related directly to the issues in this case because the tools I developed involved sensor systems and control systems for displacement, rotation, temperature control, etc. I also did some of the earliest research on the dominant sources for the degradation of liquid crystal displays.

10. From 1977 to 1980, I was a Lecturer in the Division of Mathematics, Statistics, and Computer Science at the University of Texas at San Antonio. As the director of a laboratory teaching students to program and build hardware interfaces and control systems using small computers, my students and I purchased, built, and operated some of the earliest personal computers. Additionally, I taught courses in the design of digital systems. During this period, I also completed my Ph.D. in Electrical Engineering at the University of Texas at Austin in 1980. I also did my first consulting work at this time involving the control, sensing, and evaluation of human motion control capabilities under adverse environmental conditions.

11. From 1980 to 1983, I was a Member of Technical Staff at Bell Laboratories in Murray Hill, New Jersey. My work involved the programming of computers and the design of hardware components for communication systems. I was part of a three-person team that designed, tested, and directed the manufacture of an integrated circuit that was a key component in a digital telephone modem. I also actively worked with designers of large scale digital

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telephone switching systems. This work relates generally to the topics in this case because modems obviously sense and produce sound. The manufacture testing of this product involved extensive investigation of the external sensing aspects of this product and associated conclusions about aspects of the device that were only indirectly determinable.

12. In 1983, I was appointed Assistant Professor of Electrical and Computer Engineering at the University of Texas at Austin. In 1987, I was promoted to Associate Professor. In 1991, I was promoted to Professor. During this period, I taught Computer Engineering courses at the undergraduate and graduate levels, directed the research of graduate students, and consulted with numerous organizations. One consulting project I did at this time involved the study of early printed circuit board surface mount techniques where component placement was automated using pick-and-robotic systems. As part of this work I interfaced with more than a dozen of the largest printed circuit manufacturers in the United States at that time. Aspects of this work relate to issues in this case since the manufacturing systems made extensive use of sensors and controllers.

13. In 1995, I was appointed Professor of Electrical and Computer Engineering, Leader of the Computer Engineering Group, and Holder of the Computer Engineering Chair in Electrical Engineering at Texas A&M University in College Station, Texas. My teaching, my research, my technical publications, and my supervision of graduate students during that period included the areas of the modeling, design, and fabrication of digital hardware and software systems. As with my previous work (at The University of Texas at Austin), during this period, I taught courses at the undergraduate and graduate levels, directed the research of graduate students, and consulted with numerous organizations on a variety of topics. I was also responsible for monitoring controlled experiments to optimize and quantify the use of tester time

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to detect defects in electrical products, and I was part of a team that used analytical techniques to predict the expected growth of quiescent currents in MOS transistors as a function of the reduction in integrated circuit feature sizes.

14. In September 2005, I retired from my teaching position, and the Regents of the Texas A&M University System appointed me as Professor Emeritus of Electrical and Computer Engineering at Texas A&M University.

15. In 1984, I formed Mercer and Associates, an independent consulting firm that I have owned and directed to this day. Since 1979, I have provided private consultation and advice in Electrical and Computer Engineering to numerous entities, including IBM Corp., Rockwell International, Motorola Semiconductor, AT&T, Inc., and SigmaTel.

16. I first served as an expert witness at the request of the Office of the State Attorney General of Texas in 1984. Since then, I have been hired by numerous law firms to provide them and their clients with expert consultation and expert testimony, often in the areas of patent infringement litigation related to electrical and computer engineering. Among other topics, I have opined with respect to communications systems including telephony, cell phone networks and devices, and particular characteristics of private and public network communications networks, including the Internet. I have testified regarding standalone and Internet-based online gaming systems. I have testified regarding home entertainment systems that use wireless communications. I have testified with respect to online educational institutions and technical aspects of their media distribution systems. I have testified with respect to media and entertainment systems for mobile vehicles as well as special aspects of display equipment similar to the equipment at issue in the current case. I have testified in a case involving delta-sigma modulation for high performance analog-to-digital and digital-to-analog converters—such as

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those commonly utilized in personal computers. Many of the technical issues and topics in this work relate directly to the key technical issues in this current case.

17. Throughout my career, I have been actively involved in numerous professional organizations, including the Institute of Electrical and Electronics Engineers (“IEEE”) and was recognized as an IEEE Fellow in 1994. I was the Program Chairman for the 1989 International Test Conference, which is an IEEE sponsored annual conference with (at that time) more than one thousand attendees and over one hundred presented papers. I won the Best Paper Award at the 1982 International Test Conference.

18. I also won a Best Paper Award at the 1991 Design Automation Conference, an annual conference with (at that time) more than ten thousand attendees and five hundred submitted papers, many of which related to the design of integrated circuit-based systems.

19. I also won a Best Paper Award at the 1999 VLSI Test Symposium. This paper was focused on manufacturing techniques to optimize the quality of manufactured digital systems. I am the inventor of two United States patents that relate to the design of integrated circuits and digital systems. I was selected as a National Science Foundation Presidential Young Investigator in 1986. This award included \$500,000 for support of my research.

III. SUMMARY OF MY OPINIONS

20. I have been asked to compare the asserted claims of the patents-in-suit against the Accused Devices. In particular, I have been asked to evaluate the arguments that CyWee’s Experts, Dr. LaViola and Dr. Brown, made in their infringement reports (the “LaViola Report” and “Brown Report,” respectively).

21. As described below, it is my opinion that Samsung does not infringe any asserted claim of the patents-in-suit.

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IV. MATERIALS CONSIDERED

22. In rendering my opinions, I considered the items listed in Exhibit B and the items discussed or listed herein. I have also relied on my professional and educational experiences in the field.

23. I have also attached as Exhibit C the asserted claims and a table of the asserted claims as well as any constructions as agreed to by the parties or provided by the Court. Each element of each claim is numbered, and I will refer to these elements by those numbers in this report.

V. RETENTION AND COMPENSATION

24. I am being compensated at my normal consulting rate of \$650 per hour. I am being separately reimbursed for any out-of-pocket expenses. My compensation does not depend in any way on the outcome of this case, my particular testimony, or the opinions that I express.

VI. LEGAL STANDARDS

25. I am not an attorney. However, the general guidelines and rules for determining whether a party may be liable for infringement have been explained to me, and my understanding is as follows.

26. I have been advised that a party may be liable for direct infringement if that party, without authority, makes, uses, offers to sell, or sells a patented invention within the United States or imports into the United States a patented invention during the term of the patent.

27. I have been advised that a determination of direct infringement entails two steps. In the first step, the asserted claims are interpreted. I understand that patent claims are interpreted in light of the claims, specification, and prosecution history, including amendments made to narrow the scope of the claims, and accompanying remarks. I understand that claims are to be

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viewed from the perspective of one of ordinary skill in the art at the time of the alleged invention. The second step of the direct infringement analysis is a comparison of the claims, as properly construed, to the accused products, systems, or processes.

A. Literal Infringement

28. I have been advised that an accused device, system, or method literally infringes a claim of the patent if and only if the accused device, system, or method contains every element of the claim.

B. Infringement Under the Doctrine of Equivalents

29. I have been advised that if a given claim limitation is not literally present in an accused device, system or method, the accused device, system, or method may nevertheless meet this limitation under the doctrine of equivalents. I have been informed that the test for infringement under the doctrine of equivalents is whether the accused device, system, or method possesses structure or steps that are insubstantially different from the claim limitation. I further understand that whether the difference is insubstantial can be analyzed using the “function-way-result” test, wherein a claim limitation is deemed to be equivalently present in the accused device, system, or method if the accused device, system, or method performs substantially the same function in substantially the same way in order to achieve substantially the same result.

30. I have also been advised that the doctrine of equivalents cannot apply for a claim limitation if doing so would vitiate that claim limitation.

C. Indirect Infringement

31. I have been advised that even if a patentee is unable to show direct infringement by a party, that party may still be liable for indirect infringement by inducing another to directly infringe the patent or by contributing to another’s direct infringement.

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1. Induced Infringement

32. I have been advised that a party may be liable for induced infringement of a claim if that party induces another’s direct infringement of a claim. I understand that in order to establish induced infringement of a claim, the patentee must establish that a single party is responsible for direct infringement of the claim, or that a single party directs or controls others who literally infringe every limitation of the claim.

33. I have been advised that the patentee must also prove that the alleged inducer actively and knowingly encouraged another’s direct infringement of the claim and the alleged inducer knew of the patent—*i.e.*, that the alleged inducer knew that the encouraged action, if taken, would constitute infringement of the claim—or acted with “willful blindness.” I have been advised that to show the alleged inducer acted with willful blindness, the patentee must show that the alleged inducer believed there was a high probability that the acts taken by another would infringe the claim or that alleged inducer took deliberate steps to avoid of learning of that infringement.

34. In other words, it is not sufficient that the other party itself directly infringes the claim or that several actors separately perform all the steps of the claimed method; nor is it sufficient that the alleged inducer was aware of the acts by the other party or parties that allegedly constitute the direct infringement. Rather, in order to establish induced infringement, the patentee must prove that the alleged inducer specifically encouraged the other parties to infringe the patent and that the alleged inducer either knew that the other parties would infringe the patent or believed there was a high probability of that happening but deliberately avoided learning the infringing nature of the other parties’ acts. The mere fact that the alleged inducer knew or should have known that there was a substantial risk that the other parties’ acts would

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infringe the patent is not sufficient to demonstrate induced infringement.

VII. LEVEL OF ORDINARY SKILL IN THE ART

35. I have been asked to provide an opinion as to a person of ordinary skill in the art (“POSA”) at the time of the purported invention of the ’438 and ’978 Patents, which I understand CyWee contends to be January 6, 2010, the filing date of Provisional Application No. 61/292,558. My opinions below would not change if the time of the invention was July 29, 2009, September 25, 2009, November 11, 2010, March 28, 2011, or July 6, 2011.

36. It is my opinion that one of ordinary skill in the art relevant to the technology of the ’438 and ’978 Patents is someone who has a computer science, electrical engineering, mechanical engineering, or other related technical degree at the undergraduate level, and knowledge of sensor systems. Superior experience in one of these areas could compensate for lesser experience in the other.

37. I understand that CyWee has asserted that a POSA typically would have had at least a Bachelor’s Degree in Computer Science, Electrical Engineering, Mechanical Engineering, or Physics, or equivalent work experience, along with knowledge of sensors (such as accelerometers, gyroscopes, and magnetometers), and mobile computing technologies. I understand CyWee has newly asserted that a POSA would also be familiar with Kalman filters, and nonlinear estimators such as extended Kalman filters, and the equations typically used with such filters.

38. I do not agree. However, my opinions below would not substantively change if the level of a person of ordinary skill in the art were based on CyWee’s assertion of a POSA, although I reserve my right to consider and respond to any other opinions or findings as to such a level.

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VIII. CLAIM CONSTRUCTION

39. I have reviewed Magistrate Judge Payne’s Claim Construction Opinion and Judge Bryson’s Order on Defendants’ Objections to Magistrate Judge Payne’s Claim Construction Opinion. I have applied Judge Payne’s Opinion and Judge Bryson’s Order in my analysis. A chart summarizing the terms construed by the Court is below:

Term	Court's Construction
“three-dimensional (3D) pointing device”/ “3D pointing device” (’438 Patent, Claims 1, 3, 4, 5, 14, 15, 16, 17, 19) (’978 Patent, Claim 1)	Plain and ordinary
“six-axis motion sensor”/“six-axis motion sensor module” (’438 Patent, Claims 1, 5, 14, 15, 16, 17, 19)	Plain and ordinary
“global reference frame associated with Earth” (’978 Patent, Claim 10)	“reference frame with axes defined with respect to the Earth”
“using the orientation output and the rotation output to generate a transformed output associated with a fixed reference frame associated with a display device” (’978 Patent, Claim 10)	“using the orientation output and rotation output to generate a transformed output representing a movement in a fixed reference frame that is parallel to the screen of the display device”

40. I have also reviewed the Parties’ Joint Claim Construction Chart and applied the constructions agreed upon by the Parties in my analysis. A chart summarizing these terms is below:

Term	Agreed Constructions
“calculating predicted axial accelerations A_x' , A_y' , A_z' based on the measured angular velocities ω_x , ω_y , ω_z of the current state of the six-axis motion sensor module without using any derivatives of the measured angular velocities ω_x , ω_y , ω_z ” (’438 Patent, Claims 14, 19)	Plain and ordinary
“detecting and generating a first signal set” (’438 Patent, Claim 1)	Plain and ordinary

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“detecting and generating a second signal set” (’438 Patent, Claim 1)	Plain and ordinary
“resulting deviation comprising resultant angles in said spatial pointer reference frame”/ “resulting deviation comprising said resultant angles in said spatial pointer reference frame of the 3D pointing device” (’438 Patent, Claims 1, 14, 19)	Plain and ordinary
“the measured state includes a measurement of said second signal set and a predicted measurement obtained based on the first signal set without using any derivatives of the first signal set” (’438 Patent, Claim 1)	“the measured state includes a measurement of axial accelerations and predicted axial accelerations calculated using the angular velocities without computing derivatives of said angular velocities (i.e. angular accelerations)”
“spatial pointer reference frame”/ “spatial pointer reference frame of a three-dimensional (3D) pointing device”/“spatial reference frame of the 3D pointing device”/“spatial reference frame associated with the 3D pointing device” (’438 Patent, Claims 1, 4, 14, 15, 19; ’978 Patent Claim 10)	“frame of reference associated with the 3D pointing device, which always has its origin at the same point in the device and in which the axes are always fixed with respect to the device”

41. I have included these terms and their constructions in Exhibit C to my report.

42. I understand that other terms in the patent claims should be interpreted to have their plain and ordinary meaning as would have been understood by one of ordinary skill in the art at the time of the invention.

IX. THE PATENTS-IN-SUIT

A. U.S. Patent No. 8,441,438

1. Summary

43. U.S. Patent No. 8,441,438 is entitled “3D pointing device and method for compensating movement thereof.” The named inventors are Zhou Ye, Chin-Lung Li, and Shun-Nan Liou.

44. The ’438 Patent is directed to a 3D pointing device and a method of calculating

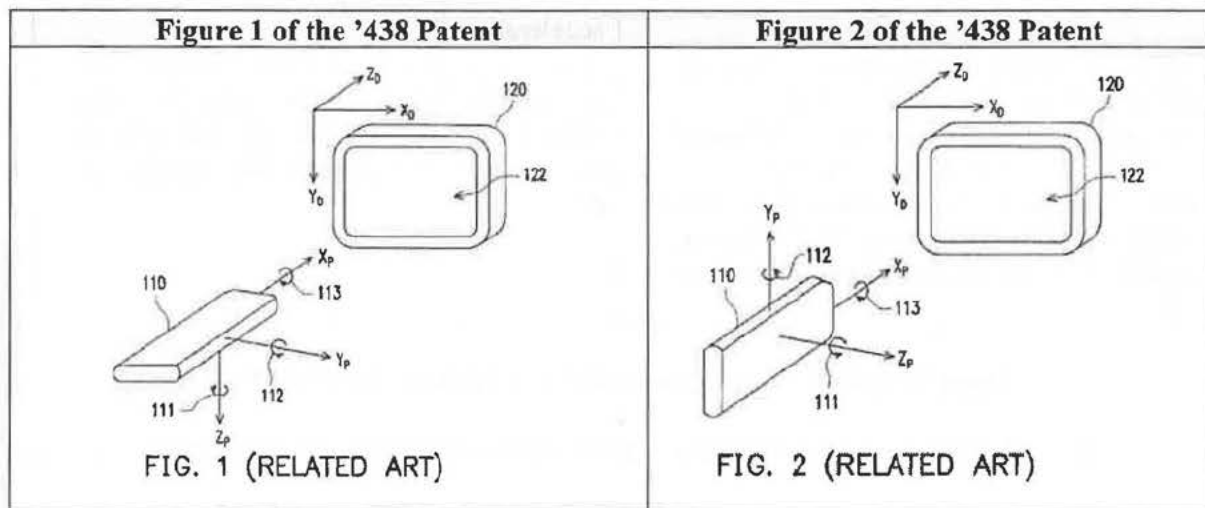
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the orientation of the 3D pointing device in relation to the reference frame of a display device.

'438 Patent at Abstract, 1:53–57, 3:52–4:2.

45. More specifically, the '438 Patent claims an improvement over other 3D pointing devices equipped with orientation sensors, which the '438 Patent admits were known in the prior art. *Id.* at 2:38–3:15.

46. The '438 Patent depicts 3D pointing devices in Figures 1 and 2 (reproduced below).



47. As shown in Figures 1 and 2 of the '438 Patent, when the user moves the 3D pointing device (110), a cursor on the screen (122) moves relative to the device. *Id.* at 1:29–2:40.

48. As shown in Figure 4 of the '438 Patent (reproduced here), the 3D pointing device includes a six-axis motion sensor module, which contains a rotation sensor (342) and accelerometer (344). *Id.* at 7:59–61. The six-axis sensor module is connected to a processing and transmitting module

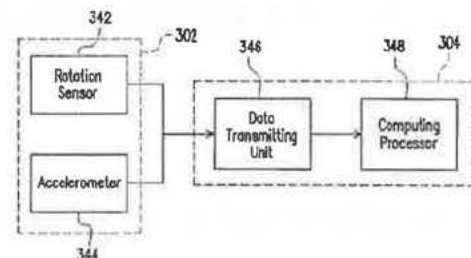


FIG. 4

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containing a data transmitting unit (346) and a computing processor (348). *Id.*

49. The ’438 Patent admits that “comparison” methods using accelerometers and gyroscopes to calculate orientation were known in the prior art. Instead of claiming all sensor fusion algorithms and/or all 3D pointing devices, the ’438 Patent claims an “enhanced comparison method” that allegedly overcomes problems with prior art 3D pointing devices. *Id.* at 2:38–3:15, 3:51–4:2.

50. Specifically, the ’438 Patent states that prior art 3D pointing devices did not accurately calculate movements when the device was subject to unexpected dynamic movements—“in particular, during unexpected drifting movements and/or accelerations along with the direction of gravity.” *Id.* at 2:38–3:15.

51. To overcome the alleged problems with prior art 3D pointing devices, the ’438 Patent teaches a method of calculating the orientation of the 3D pointing device in relation to the reference frame of a display using purported “predicted axial accelerations” that are calculated without taking the derivatives of the angular velocities.

52. Specifically, the ’438 Patent recites an algorithm by which:

- A “current state” of the device at current time *t* is calculated using the measured angular velocities obtained from the rotation sensor. *Id.* at 11:5–8. This “current state” is defined in terms of orientations but it does not have an associated magnitude.
- A “measured state” of the device at current time *t* is calculated using measured axial accelerations and purported “predicted axial accelerations.” These “predicted axial accelerations” are obtained without taking the derivatives of the angular velocities, *id.* at 11:9–15, and are also expressed solely in terms of

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orientations (*i.e.*, the “predicted axial accelerations” do not have an associated magnitude).

- An “updated state” of the device at current time *t* is obtained by comparing the “current state” with the “measured state.” *Id.* at 11:9–15. This “updated state” is used to calculate the deviation (*i.e.*, orientation) of the 3D pointing device, and this deviation is mapped to the display reference frame. *Id.* at 11:18–21, 15:26–30.

53. As disclosed in the ’438 Patent File History (summarized below), the ’438 Patent narrowly claims a specific “enhanced comparison method” that is different from other “comparison methods” because it uses predicted axial accelerations that are calculated without taking the derivatives of the measured angular velocities.

54. Although the ’438 Patent does not disclose how exactly the above algorithm operates, I understand that CyWee and its experts have stated that the ’438 Patent discloses an Extended Kalman filter or something similar to an Extended Kalman filter. *See* CyWee’s Opening Claim Construction Brief, Dkt. No. 66 at 9; February 23, 2018 Declaration of Joseph J. LaViola, Jr. (“LaViola Decl.”), Dkt. No. 66-6 ¶¶ 22, 29, 39, 41–42.

2. The ’438 Patent File History

55. The ’438 Patent issued from U.S. Patent Application No. 12/943,934 (“’934 Application”), which was filed on November 11, 2010.

56. The ’934 Application was filed with twenty original claims. In an August 16, 2012 Office Action, the Examiner rejected all twenty pending claims as obvious over a combination of one or more of U.S. Patent No. 7,817,134 (“*Huang*”), U.S. Patent No. 8,138,938 (“*Troy*”), U.S. Patent No. 7,924,264 (“*Ohta*”), and U.S. Patent No. 6,061,611 (“*Whitmore*”).

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’438 Patent File History at 131–143.

57. In rejecting all twenty pending claims, the Examiner stated that *Huang* discloses a three-dimensional pointing device. *Troy* discloses “the concept of including a six-axis inertial measurement unit (IMU)” which “has accelerometers and gyros for measurement of linear acceleration and angular velocity, respectively[.]” *Id.* at 131–32. *Ohta* discloses “the concept of wirelessly transmitting the data obtained by the acceleration sensor . . . in order to compute the orientation of the handheld apparatus[.]” *Id.* at 137. Finally, *Whitmore* discloses “an update program used to obtain an updated state based on a previous state” using quaternion vectors. *Id.* at 138.

58. In an October 15, 2012 Office Action Response, the Patent Applicant argued that *Whitmore* and *Troy* do not teach obtaining a “predicted measurement” because: (i) *Whitmore* relied on “time averaging past measurements to arrive at a correction strategy” and therefore was not based on “separating and distinguishing between rotation sensor data and the accelerometer data usage” and (ii) *Troy* only teaches that “acceleration data must be transformed into a stationary coordinate system” and as such, the acceleration data in *Troy* already existed and “is not being predicted, but being transformed from one coordinate system to another[.]” *Id.* at 120.

59. In an December 14, 2012 Office Action, the Examiner again rejected all twenty pending claims as obvious, this time over a combination of one or more of U.S. Patent Publication No. 2009/0262074 (“*Nasiri*”) and “Improving Static and Dynamic Registration in a See-through HMD” by Ronald Azuma and Gary Bishop (1994) (“*Azuma*”).

60. In particular, the Examiner stated that *Nasiri* teaches both a 3D pointing device and an Inertial Measuring Unit (IMU) which may include three gyroscopes and three accelerometers. *Id.* at 65. In addition, *Azuma* discloses utilizing a comparison to obtain an

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updated state and using an “inertial-based predictor.” *Id.* at 76–77.

61. In a March 3, 2013 Office Action Response, the Patent Applicant argued that a POSA would not have combined *Nasiri* and *Azuma* because: (i) *Nasiri* teaches moving an object in “the coordinate system in which a specific 3D object is defined” while (ii) *Azuma* teaches formulas under “world space.” *Id.* at 53.

62. The Patent Applicant also added new Claim 21, which included the limitation of:

obtaining a measured state of the six-axis motion sensor module by obtaining measured axial accelerations A_x, A_y, A_z gained from the motion sensor signals of the six-axis motion sensor module at the current time T and calculating predicted axial accelerations A_x', A_y', A_z' based on the measured angular velocities $\omega_x, \omega_y, \omega_z$ of the current state of the six-axis motion sensor module without using any derivatives of the measured angular velocities $\omega_x, \omega_y, \omega_z$; said current state of the six-axis motion sensor module is a second quaternion with respect to said current time T ; comparing the second quaternion in relation to the measured angular velocities $\omega_x, \omega_y, \omega_z$ of the current state at current time T with the measured axial accelerations A_x, A_y, A_z and the predicted axial accelerations A_x', A_y', A_z' also at current time T ;

Id. at 50–51 (highlighted).

63. The Patent Applicant argued that *Azuma* failed to teach calculating predicted axial accelerations based on the measured angular velocities without using the derivatives of the measured angular velocities because *Azuma* teaches removing unwanted angular acceleration components by subtracting out the derivative of the angular velocity. *Id.* at 54.

64. In a subsequent March 28, 2013 telephonic interview, the Examiner and Patent Applicant agreed that the independent claims would be placed in condition for allowance if the limitation “without using any derivatives of the measured angular velocities $\omega_x, \omega_y, \omega_z$ ” was inserted into each of the independent claims. *Id.* at 25.

65. This Examiner amendment was entered into each of the independent claims and the claims were subsequently allowed under this narrow limitation. *Id.* at 26–27.

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3. The Asserted Claims

66. I understand that CyWee has asserted Claims 1, 3, 4, 5, 14, 15, 16, 17, and 19 of the '438 Patent against Samsung.

67. The asserted claims of the '438 Patent are set forth below.

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

a housing associated with said movements and rotations of the 3D pointing device in a spatial pointer reference frame;

a printed circuit board (PCB) enclosed by the housing;

a six-axis motion sensor module attached to the PCB, comprising a rotation sensor for detecting and generating a first signal set comprising angular velocities ω_x , ω_y , ω_z associated with said movements and rotations of the 3D pointing device in the spatial pointer reference frame, an accelerometer for detecting and generating a second signal set comprising axial accelerations A_x , A_y , A_z associated with said movements and rotations of the 3D pointing device in the spatial pointer reference frame; and

a processing and transmitting module, comprising a data transmitting unit electrically connected to the six-axis motion sensor module for transmitting said first and second signal sets thereof and a computing processor for receiving and calculating said first and second signal sets from the data transmitting unit, communicating with the six-axis motion sensor module to calculate a resulting deviation comprising resultant angles in said spatial pointer reference frame by utilizing a comparison to compare the first signal set with the second signal set whereby said resultant angles in the spatial pointer reference frame of the resulting deviation of the six-axis motion sensor module of the 3D pointing device are obtained under said dynamic environments, wherein the comparison utilized by the processing and transmitting module further comprises an update program to obtain an updated state based on a previous state associated with said first signal set and a measured state associated with said second signal set; wherein the measured state includes a measurement of said second signal set and a predicted measurement obtained based on the first signal set without using any derivatives of the first signal set.

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3. The 3D pointing device of claim 1, wherein the PCB enclosed by the housing comprises at least one substrate having a first longitudinal side configured to be substantially parallel to a longitudinal surface of the housing.

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

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

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

obtaining a previous state of the six-axis motion sensor module; wherein the previous state includes an initial-value set associated with previous angular velocities gained from the motion sensor signals of the six-axis motion sensor module at a previous time $T-1$;

obtaining a current state of the six-axis motion sensor module by obtaining measured angular velocities ω_x , ω_y , ω_z gained from the motion sensor signals of the six-axis motion sensor module at a current time T ;

obtaining a measured state of the six-axis motion sensor module by obtaining measured axial accelerations A_x , A_y , A_z gained from the motion sensor signals of the six-axis motion sensor module at the current time T and calculating predicted axial accelerations A_x' , A_y' , A_z' based on the measured angular velocities ω_x , ω_y , ω_z of the current state of the six-axis motion sensor module without using any derivatives of the measured angular velocities ω_x , ω_y , ω_z ; said current state of the six-axis motion sensor module is a second quaternion with respect to said current time T ; comparing the second quaternion in relation to the measured angular velocities

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ω_x , ω_y , ω_z of the current state at current time T with the measured axial accelerations A_x , A_y , A_z and the predicted axial accelerations A_x' , A_y' , A_z' also at current time T;

obtaining an updated state of the six-axis motion sensor module by comparing the current state with the measured state of the six-axis motion sensor module; and

calculating and converting the updated state of the six axis motion sensor module to said resulting deviation comprising said resultant angles in said spatial pointer reference frame of the 3D pointing device.

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

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

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

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

obtaining a previous state of the six-axis motion sensor module; wherein the previous state includes an initial-value set associated with previous angular velocities gained from the motion sensor signals of the six-axis motion sensor module at a previous time T-1;

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obtaining a current state of the six-axis motion sensor module by obtaining measured angular velocities ω_x , ω_y , ω_z gained from the motion sensor signals of the six-axis motion sensor module at a current time T;

obtaining a measured state of the six-axis motion sensor module by obtaining measured axial accelerations A_x , A_y , A_z gained from the motion sensor signals of the six-axis motion sensor module at the current time T and calculating predicted axial accelerations A_x' , A_y' , A_z' based on the measured angular velocities ω_x , ω_y , ω_z of the current state of the six-axis motion sensor module without using any derivatives of the measured angular velocities ω_x , ω_y , ω_z ; said current state of the six-axis motion sensor module is a second quaternion with respect to said current time T; comparing the second quaternion in relation to the measured angular velocities ω_x , ω_y , ω_z of the current state at current time T with the measured axial accelerations A_x , A_y , A_z and the predicted axial accelerations A_x' , A_y' , A_z' also at current time T;

obtaining an updated state of the six-axis motion sensor module by comparing the current state with the measured state of the six-axis motion sensor module; and

calculating and converting the updated state of the six axis motion sensor module to said resulting deviation comprising said resultant angles in said spatial pointer reference frame of the 3D pointing device.

B. U.S. Patent No. 8,552,978

1. Summary

68. The '978 Patent is a continuation-in-part of U.S. Patent Publication No. 13/072,794, which is a continuation of the '438 Patent. The '978 Patent is entitled "3D pointing device and method for compensating rotations of the 3D pointing device thereof." The named inventors are Zhou Ye, Chin-Lung Li, and Shun-Nan Liou.

69. Like the '438 Patent, the '978 Patent discloses a method of calculating the orientation of the 3D Pointing device in relation to a display's reference frame. '978 Patent at Abstract.

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70. The '978 Patent is also directed to an improvement over prior art 3D pointing devices to provide an “enhanced comparison method” to reduce the “errors and/or noises associated with such signals or fusion of signals from the motion sensors.” *Id.* at 3:53–4:11.

71. As shown in Figure 4 of the '978 Patent (reproduced here), the '978 Patent discloses a nine-axis sensor module (versus the six-axis motion sensor module disclosed in the '438 Patent) containing a: (i) rotation sensor (342); (ii) accelerometer (344); and (iii) magnetometer (345). *Id.* at 9:65–10:1.

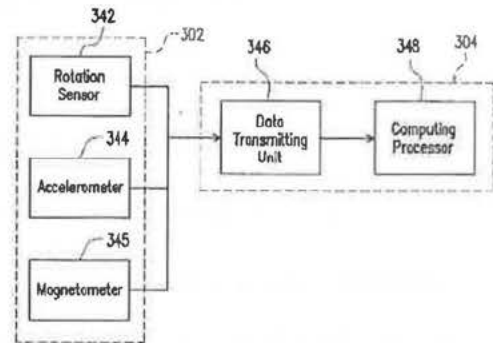


FIG. 4

72. To overcome the alleged problems with prior art 3D pointing devices, the '978 Patent teaches a method of obtaining deviation angles using measured and predicted magnetisms. *Id.* at 22:34–23:34.

73. Specifically, the '978 Patent recites an algorithm by which:

- The rotation sensor generates a rotation output. *Id.* at 33:29–50. The accelerometer generates a first signal set of axial accelerations. *Id.* The magnetometer generates a second signal set of magnetisms. *Id.*
- The orientation output is generated based on: (i) the rotation output, the first signal set, and the second signal set; or (ii) the first and second signal sets. *Id.* The patent discloses that this orientation output may be in the form of a rotation matrix, quaternion, rotation vector, or the three orientation angles: yaw, pitch and roll. *Id.* at 33:53–64.
- The orientation output and rotation output are used to generate a transformed

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output associated with the fixed reference frame of a display device. The '978 Patent discloses that these movements may constitute a “movement pattern in the display plane and the display device may be controlled to move a virtual object or a cursor along the movement pattern.” *Id.* at 31:50–55.

- The deviation of the device is calculated using measured and predicted magnetisms to generate an updated state. *Id.* at 22:34–32:34.

74. Like the '438 Patent, the '978 Patent does not disclose how exactly the above algorithm operates. I understand however that CyWee and its experts have stated that the '978 Patent also discloses an Extended Kalman Filter or something similar to an Extended Kalman Filter. *See* CyWee’s Opening Claim Construction Brief, Dkt. No. 66 at 22; March 7, 2018 Deposition Transcript of Joseph J. LaViola, Jr. (“LaViola Dep. Tr.”) at 160:21–162:24.

2. The '978 Patent File History

75. The '978 Patent issued from U.S. Patent Application No. 13/176,771 (“’771 Application”), which was filed on July 6, 2011.

76. The '771 Application was filed with twenty-two original claims.

77. In a January 28, 2013 Office Action, the Examiner rejected all twenty-two pending claims for double-patenting over Application No. 12/943,934 (which eventually became the '438 Patent). '978 Patent File History at 68. The Examiner instructed the Patent Applicant to “maintain a clear line of demarcation between the applications.” *Id.*

78. The Examiner further rejected all twenty-two original claims as obvious over *Nasiri*. Specifically, the Examiner found that *Nasiri* discloses a 3D pointing device comprising an orientation sensor that generates an orientation output associated with a global reference frame. *Id.* at 70–73.

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79. In a April 17, 2013 Office Action Response, the Applicant amended the independent claims (1 and 12) to include new limitations for a: (i) “nine-axis motion sensor module” and (ii) to make clear that the 3D pointing device is configured to obtain a resultant deviation using a plurality of measured and predicted magnetisms. *Id.* at 36–37, 39–40.

80. To provide a clear line of demarcation between the ’438 and ’978 Patents, the Patent Applicant stated that:

Applicant submits that Application No. 12/943,034 includes the claimed subject matter of a six-axis motion sensor module without having and using measured magnetisms and predicted magnetisms.

Id. at 44 (highlighted).

81. The Patent Applicant further argued that *Nasiri* only briefly described magnetometers and that *Nasiri* therefore failed to disclose or teach “obtaining resultant deviation including deviation angles using a plurality of measured magnetisms M_x , M_y , M_z , and a plurality of predicted magnetism M_x' , M_y' and M_z' .” *Id.* at 44, 47–48.

82. The claims were allowed afterwards without further comment. *Id.* at 24.

3. The Asserted Claims

83. I understand that CyWee has asserted Claims 10 and 12 of the ’978 Patent against Samsung.

84. The asserted claims of the ’978 Patent are set forth below.

10. A method for compensating rotations of a 3D pointing device, comprising:

generating an orientation output associated with an orientation of the 3D pointing device associated with three coordinate axes of a global reference frame associated with Earth;

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generating a first signal set comprising axial accelerations associated with movements and rotations of the 3D pointing device in the spatial reference frame;

generating a second signal set associated with Earth's magnetism; generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set;

generating a rotation output associated with a rotation of the 3D pointing device associated with three coordinate axes of a spatial reference frame associated with the 3D pointing device; and

using the orientation output and the rotation output to generate a transformed output associated with a fixed reference frame associated with a display device, wherein the orientation output and the rotation output is generated by a nine-axis motion sensor module; obtaining one or more resultant deviation including a plurality of deviation angles using a plurality of measured magnetisms M_x , M_y , M_z and a plurality of predicted magnetism M_x' , M_y' and M_z' for the second signal set.

12. The method of claim 10, wherein the orientation output is a rotation matrix, a quaternion, a rotation vector, or comprises three orientation angles.

X. TECHNOLOGY OVERVIEW

85. Below is a brief technology background to aid in the understanding of my analysis in this report.

A. Examples of Simple Movement

86. In the patents-in-suit, there are two basic types of motion: (i) linear motion; and (ii) rotational motion.

87. Linear motion is the movement of an object along a straight line.

88. Rotational motion is the movement of an object along a circle. For example, a spinning wheel.

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B. Measuring Movement: Velocity and Acceleration

89. In physics, certain measurements are used to describe an object’s motion. Two key measurements are velocity and acceleration.

90. Velocity can be understood as the rate of change in the position of an object with respect to time. Velocity can be represented as a vector with both a magnitude and a direction. The magnitude represents the speed at which the object is moving. The direction represents the direction of movement. Velocity is often measured in meters per second.

91. Angular velocity can be understood as the rate of change in the angular position of an object relative to a center of rotation with respect to time. Angular velocity can also be represented as a vector with a magnitude and direction. Angular velocity is often measured in radians per second.

92. Linear acceleration can be understood as the rate of change of velocity with respect to time. Like velocity and angular velocity, linear acceleration can be represented as a vector with both a magnitude and direction. The magnitude is a measurement of how quickly the velocity of the object is increasing. The direction reflects the direction in which the gain in velocity is occurring. Linear acceleration is often measured in meters per second squared.

93. Under the laws of physics, an object can experience at least one or more of three types of acceleration: (i) gravitational acceleration due to the gravity of the Earth; (ii) linear acceleration due to an externally applied force; and (iii) centrifugal acceleration due to an externally applied rotational force.

94. Gravitational acceleration measures the acceleration of an object experienced as a result of a gravitational force (the force of attraction between two bodies—each with a corresponding mass). When objects on the Earth are supported by some structure, the force of

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gravity will be counter balanced by an exactly opposite force provided by the supporting structure. An accelerometer in this situation will report the acceleration of gravity as one component of its readings.

95. For example, when two spheres of different weight fall from the same height, both are accelerated by gravity at the same rate and hit the ground at the same time.

96. Similarly, when a person steps onto a bathroom scale, the acceleration of gravity deforms a structure similar to a spring, and the amount of the deformation is read as the person’s weight.

97. Although the magnitude of acceleration due to gravity is almost constant everywhere on the Earth’s surface (9.81 m/s^2), its direction with respect to an object’s frame of reference changes depending on the object’s position and orientation, because gravitational acceleration is always directed towards the center of the Earth.

98. Centrifugal acceleration is experienced when a rotating body (such as a weight held by a string) rotates about a point (such as the center of the circle of motion).

C. Rigid and Non-Rigid Bodies/Simple and Complex Motions

99. Motions can be described with respect to rigid and non-rigid bodies and simple and complex motions.

100. A rigid body is an idealized model of a solid object in which any changes in the shape or size of an object are assumed to be zero. In this way, the distance between any two given points on the object remain constant in time regardless of external forces, *i.e.*, the body does not deform as it moves.

101. In non-rigid bodies, external forces may change the shape and/or size of the body as it moves.

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102. Motions can be simple or compound. For example, humans may produce simple linear acceleration. For example, when a person throws a dart toward a dart board, his arm attempts to linearly accelerate the dart from an initial velocity of zero to the correct velocity so that, after its release, the trajectory of the dart terminates within the bull’s eye of the dart board. Machines can also produce simple linear acceleration. A gun linearly accelerates a bullet from an initial velocity (normally zero) to the very high velocity at which it leaves the gun barrel.

103. Rotational motion induced by a single rigid body motion is simple because the radius of rotation remains constant. Rotational motion induced by multiple rigid bodies and/or non-rigid bodies may produce more complex motions, and the radius of rotation changes with time.

104. In this way, centrifugal accelerations can be either simple or compound (if the motions are not induced by a single rigid object.).

105. As one example, when a baseball is thrown by a mechanical pitching machine, it is in simple rotational motion and has a simple centrifugal acceleration because there is a fixed radius of rotation and a fixed center of rotation. In the case of this motion, both of these values are constant.

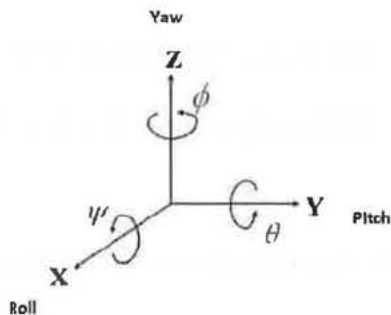
106. In contrast, when the ball is thrown by a human, the centrifugal force experienced by the baseball is compound. This is because the angle of the pitcher’s arm at his elbow changes during the pitch, and therefore, the radius of curvature changes when the pitcher moves. Further, the pitcher’s shoulder and wrist also move so that many complex motions are combined—and each of these anatomical parts induces different radial motions, each with a different radius that may be a constant or variable value.

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D. Representing Orientation

107. In physics, there are a number of different ways of mathematically representing an object's orientation. One common method is known as Euler angles, introduced by the Swiss mathematician, Leonhard Euler, in the 1700s.

108. In Euler angles, the orientation of an object is broken down into three rotations—the roll, pitch, and yaw rotations (as shown below).



109. Another common method of expressing the rotation of an object is by using a *unit* quaternion, which is a quaternion that has been normalized to have a total magnitude of exactly 1. Quaternions were first described by William Rowan Hamilton, an Irish mathematician, in the 1800s.

110. A quaternion is a hyper-complex number in the form of $q = W + Xi + Yj + Zk$ where:

- W is the scalar part of the quaternion;
- i, j , and k are mutually orthogonal unit basis vectors along the three imaginary axes (i, j , and k); and
- X, Y , and Z are the magnitudes of the vectors along the three imaginary axes.

111. The direction of a vector with unitary basis components in R_3 can be represented

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by a “pure” quaternion (the scalar element of the quaternion always equals zero, and the sum of the squares of its four components equals exactly one). An exemplary representation for a quaternion is shown below.

$$\mathbf{q} = (q_0, q_1, q_2, q_3)$$

112. The right hand side of the example expression above could be a 4-tuple, which is composed of four component values, where q_0 (the first component value) specifies the value of its real part and q_1 , q_2 , and q_3 (the following three component values) specify the length of vectors along each imaginary axis (as specified by the vectors i , j , and k respectively).

113. Quaternions, Euler angles, and other methods can be used to describe orientations and calculate rotations.

E. Orientation/Reference Frames

114. The orientation (or “attitude”) of an object is a description of how it is placed in space. If an object is rotating, its orientation changes over time.

115. Conventionally, the orientation of a device is defined with respect to two reference frames.

116. A reference frame provides one origin and a set of axes from which the orientation of an object may be described.

117. In defining orientation, the first reference frame may be described relative to the body of the object (*i.e.*, the “body” reference frame).

118. A second reference frame may be defined with respect to the Earth. The origin of this second reference frame may differ from the origin of the body reference frame. Further, the axes of this second reference frame also differ from those of the body reference frame, and they may not be fixed in space with respect to time, unlike the axes of the body reference frame.

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119. One example of a second reference frame that may be used is the ENU reference frame. In the ENU reference frame, the origin is located on the device (as in the body frame), but one axis always points north. The y-axis of the ENU reference frame (*i.e.*, the “north” direction) is assumed based on the orientation of the device calculated by the first iteration of the algorithm. The other axes of the ENU reference frame must be perpendicular to each other and the y-axis.

120. Quaternion operations can be used to convert a 3D vector representation in one frame of reference to the 3D vector representation in another frame of reference using the following operation:

$${}^B v_q = {}^B q \otimes {}^A v_q \otimes {}^B q^*$$

$$v_q = \begin{bmatrix} 0 & v \end{bmatrix}^T = \begin{bmatrix} 0 & v_x & v_y & v_z \end{bmatrix}^T$$

Where the pure quaternion, ${}^A v_q$, represents the orientation of the object in the first reference frame and the pure quaternion, ${}^B v_q$, represents the second reference frame, ${}^B q$ is the unit (but not necessarily pure) quaternion representing the rotation undergone by the object, and ${}^B q^*$ is the conjugate of that unit quaternion. The operators between the quaternions in the first equation above follow quaternion algebraic rules, which differ from traditional algebraic rules. For example, the commutative property ($x*y = y*x$) in traditional algebra does not hold in the quaternion algebra where ($x*y = -y*x$). This is true because vector multiplication in three dimensions produces both a magnitude and a direction (determined by the right hand rule of thumb). Commuting the order of multiplication does not change the magnitude of the product, but it changes the direction of the product by 180 degrees.

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F. Sensors

121. A gyroscope is a device that can measure the rate of rotation around a particular axis. In other words, a gyroscope measures angular velocities. A triple-axis gyroscope measures the rate of rotation, or the angular velocities, around three axes: x , y , and z .

122. Gyroscopes have existed since at least the 1800s.

123. An accelerometer is a device that measures the accelerations that are acting on a body. Accordingly, an accelerometer measures the vector sum of linear, centrifugal and gravitational accelerations. An accelerometer cannot partition or decompose these three components of acceleration. Instead, it can only report the vector sum of the acceleration experienced due to the above three sources.

124. Accelerometers have existed since at least the 1700s.

125. A magnetometer is a device that detects the Earth’s magnetic field along the three perpendicular axes.

126. Magnetometers have existed since at least the 1800s.

G. Sensor Fusion

127. Gyroscopes, accelerometers, and magnetometers each have their own specific deficiencies.

128. For example, gyroscopes are usually sensitive to outside conditions, like temperature. Gyroscopes are also prone to sensor drift, which results in increasing amounts of errors over time, unless the sensor is recalibrated.

129. Accelerometers are sensitive to electronic noise, such as thermal noise from the internal circuitry of the accelerometers. Usually, that noise can be reduced by calculating an average noise value and subtracting that value from the accelerometer signal.

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130. Magnetometers are sensitive to similar error sources—as well as those errors created by spurious magnetic fields close to the magnetometer. All of these distort the readings of the magnetometer.

131. The process of sensor fusion attempts to combine data from two or more independent sensors with the objective of reducing at least some of the erroneous components from individual sensors in order to produce potentially more accurate results.

132. Kalman filters and Extended Kalman filters are well-known algorithms for performing filtering and sensor fusion.

133. A Kalman filter is a set of mathematical calculations that starts with a set of initial assumptions and measurements that have some element of noise. The Kalman filter attempts to reduce specific types of noise in order to obtain an improved estimated value. An Extended Kalman filter is the non-linear version of a Kalman filter.

134. Kalman filters and Extended Kalman filters have been known since the 1960s and were used for inertial navigation in NASA’s Apollo Moon Project.

XI. SUMMARY OF SAMSUNG ACCUSED DEVICES/FUNCTIONALITY

A. [REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]

XII. NON-INFRINGEMENT

A. The Samsung Accused Devices Do Not Directly Infringe Any of the Asserted Claims

1. [REDACTED]

189. I understand that, in holding that term “3D pointing device” is to be construed to have its plain and ordinary meaning, the Court rejected CyWee’s overly-expansive proposed alternate construction for this term—“a handheld device that includes at least one or more accelerometers and a magnetometer, and optionally a rotation sensor comprising one or more gyroscopes, and uses them to determine deviation angles or the orientation of a device.” Dkt. No. 117 at 7–8.

190. I further understand that, in its responses to *inter partes* review petitions filed by Google regarding the asserted patents, CyWee argued the following regarding the construction of the term “3D pointing device”:

In order to give the meaning to the term “pointing device” as used in the phrase, the device must be able to point to or control something on a display. Ex. 2001, ¶67. A PHOSITA would understand that a “pointing device” is used to “perform control actions and movements . . . for certain purposes including entertainment such as playing a video game, on the display device through the [] pointer on the screen.” *Id.*; Ex. 1001, 1:48–51.

Patent Owner Preliminary Response, IPR No. 2018-01257, dated September 14, 2018.

191. Dr. LaViola opines that the Accused Samsung Devices meet this limitation, but he fails to provide any supporting evidence. *See, e.g.*, LaViola Report, Ex. 3 at 2.

192. Contrary to Dr. LaViola’s opinion, none of the Samsung Accused Products is a

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3D pointing device. Instead, consistent with both the Court’s ruling and CyWee’s arguments in its briefing responsive to Google’s *inter partes* review petition, the plain and ordinary meaning of the term “3D pointing device” describes a device that can point to something on a display. Dr. LaViola does not identify any software installed on the devices as shipped allowing them to do so. Indeed, while Dr. Brown concedes that StarWalk 2 is not pre-installed on the Samsung Accused Devices, *see* Expert Report of Donald Richard Brown III, Ph.D. (dated Oct. 8, 2018) at 24, neither Dr. Brown nor Dr. LaViola state whether or not the Pokémon Go and/or Shooting Showdown applications are pre-installed on those devices. They provide no evidence that those applications are pre-installed, and indeed my understanding is that none of those applications are pre-installed. *See, e.g.,* SAM_CYWEE00000030–34; SAM_CYWEE00002731–39; SAM_CYWEE00004428–40; SAM_CYWEE00004605–13; SAM_CYWEE00000335–43.

193. The only pre-installed application that Dr. LaViola identifies is Google Maps. In my opinion, the Google Maps software does not render the Samsung Accused Devices a 3D pointing device because that application does not provide any functionality that would allow a user to point to something on a display. Thus, in my opinion, the Samsung Accused Devices do not infringe any of the asserted claims of the patents-in-suit.

B. The Samsung Accused Devices Do Not Directly Infringe the Asserted Claims of the ’438 Patent

1. [REDACTED]

194. Claim 1 of the ’438 Patent recites an “update program” that obtains an “updated state” based on a “previous state” and a “measured state” where the measured state “includes a measurement of said second signal set and a predicted measurement obtained based on the first

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signal set without using any derivatives of the first signal set.”

195. I understand that the parties have agreed that this predicted measurement comprises “predicted axial accelerations calculated using the angular velocities without computing derivatives of said angular velocities (i.e. angular accelerations).” *See* Section VIII.

196. Similarly, Claims 14 and 19 of the ’438 Patent recite obtaining a “measured state” in part by “calculating predicted axial accelerations Ax' , Ay' , Az' based on the measured angular velocities ω_x , ω_y , ω_z of the current state of the six-axis motion sensor module without using any derivatives of the measured angular velocities ω_x , ω_y , ω_z .”

197. In contrast to what is claimed in Claims 1, 14 and 19, the Samsung Accused Devices do not “predict” axial acceleration values.

198. [REDACTED]

199. [REDACTED]

200. [REDACTED]

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[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

201. In my opinion, conversion of a measurement (accelerations, in this case) from one frame of reference to another is not a “prediction” in any sense. Specifically, while the term “prediction” means a determination of a *future unknown* value, the conversion from one reference frame to another only involves a transformation of the mathematical expression of the device’s *current known* orientation in one coordinate system to another coordinate system.

202. Second, Dr. LaViola’s interpretation is inconsistent with the Court’s interpretation of an “axial acceleration.” Specifically, I understand that Judge Bryson opined that “it is clear that the references to axial acceleration encompass *all three types of acceleration* that will be detected by an accelerometer, and that *there is no need for the patents to distinguish among those differing types of acceleration.*” Dkt. No. 153 at 8 (emphasis added).

203. Per Judge Bryson’s opinion, the term “axial acceleration” encompasses the composite acceleration value (linear, centrifugal, and/or gravitational) that may be detected by an accelerometer at a particular point in time. A “predicted axial acceleration” can only reasonably be interpreted as a prediction of this composite value, not the gravitational acceleration

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

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component isolated from that composite value.

204. Third, Dr. LaViola strains the meaning of the term “based on.” In particular, CyWee and Dr. LaViola both previously took the position that a quaternion representing orientation is used to generate “predicted axial accelerations.” CyWee’s Opening Claim Construction Brief, Dkt. No. 66 at 99; LaViola Decl. ¶ 21. They also took the position that the aforementioned quaternion representing orientation is calculated using the device’s previous orientation and measured angular velocities. *Id.* [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED] Thus, even under CyWee’s and Dr. LaViola’s positions, the alleged “predicted axial accelerations” are “based on” the device’s current estimated orientation—not the device’s measured angular velocities.

205. [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

206. In particular, it is my opinion that the terms “estimated” and “predicted” are not interchangeable. While the term “prediction” refers to a determination of a future unknown value, as discussed above, an “estimation” refers to determination of a current value. Indeed, the variable t referenced by Dr. LaViola refers to the current time; $t-1$ refers to a previous time.

[REDACTED]

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207. For the reasons above, in my opinion, the Samsung Accused Devices do not infringe Claims 1, 14, and/or 19 of the '438 Patent, and accordingly also do not infringe Claims 3, 4, and/or 5 (which depend from Claim 1) or Claims 15, 16 and/or 17 (which depend from Claim 14).

2. [REDACTED]

208. Claim 1 of the '438 Patent recites “utilizing a comparison to compare the first signal set with the second signal set.” Claim 1 further recites that the “first signal set” comprises “angular velocities ω_x , ω_y , ω_z associated with said movements and rotations of the 3D pointing device in the spatial pointer reference frame.” Claim 1 recites that this first signal set is detected and generated by a rotation sensor. Claim 1 recites that the “second signal set” comprises “axial accelerations A_x , A_y , A_z associated with said movements and rotations of the 3D pointing device in the spatial pointer reference frame.” Claim 1 recites that this second signal set is detected and generated by an accelerometer. Accordingly, Claim 1 recites a comparison between the first and second signal sets (*i.e.*, measured angular velocities and measured accelerations).

209. Similarly, Claims 14 and 19 recite “comparing the second quaternion in relation to the measured angular velocities ω_x , ω_y , ω_z of the current state at current time T with the measured axial accelerations A_x , A_y , A_z and the predicted axial accelerations A_x' , A_y' , A_z' , also at current time T .” Accordingly, Claims 14 and 19 also require comparisons between the measured angular velocities and both the measured and predicted axial accelerations.

210. [REDACTED]

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[REDACTED]

[REDACTED] Specifically, while the term “prediction” means a guess about a *future unknown* value, the conversion from one reference frame to another only involves a transformation of the mathematical expression of the device’s *current known* orientation in one coordinate system to another coordinate system. Further, the ’978 specification never describes a frame of reference transformation as a “prediction.”

245. [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

246. Specifically, as discussed in regards to Dr. LaViola’s opinion regarding the “prediction” of acceleration values, it is my opinion that the terms “estimated” and “predicted” are not interchangeable in the context of the asserted claims. While the term “prediction” refers to a determination of a future unknown value, an “estimation” refers to determination of a current unknown value.

247. [REDACTED]

[REDACTED]

[REDACTED]

248. For the reasons above, in my opinion, the Samsung Accused Devices do not infringe Claim 10 of the ’978 Patent, and accordingly also do not infringe Claim 12 (which depends from Claim 10).

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[REDACTED]

261. [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED] Specifically, term “prediction” means a determination of a *future unknown* value. [REDACTED]

[REDACTED]

[REDACTED]

262. Second, like Dr. LaViola’s analysis, Dr. Brown’s interpretation of the term “axial acceleration conflicts with the Court’s interpretation of that term. *See* Dkt. No. 153 at 8. As discussed in Section XII.B.1, in light of Judge Bryson’s opinion, a “predicted axial acceleration” can only reasonably be interpreted as a prediction of a composite acceleration value (linear, centrifugal, and/or gravitational), not a quaternion the computation of which is to isolate the gravitational acceleration data.

263. For the reasons above, in my opinion, the Qualcomm Accused Devices do not infringe Claims 1, 14, and/or 19 of the ’438 Patent, and accordingly also do not infringe Claims 3, 4, and/or 5 (which depend from Claim 1) or Claims 15, 16 and/or 17 (which depend from Claim 14).

2. [REDACTED]

264. As discussed above in Section XII.B.2, Claim 1 recites a comparison between the first and second signal sets (*i.e.*, measured angular velocities and measured accelerations), and Claims 14 and 19 require comparisons between the measured angular velocities and both the measured and predicted axial accelerations.