

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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SONY INTERACTIVE ENTERTAINMENT LLC  
Petitioner

v.

MOTIVA PATENTS, LLC  
Patent Owner

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Case No. IPR2019-01134  
U.S. Patent No. 8,159,354

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**DECLARATION OF DR. GREGORY F. WELCH**

I, Gregory F. Welch, hereby declare the following:

## **I. INTRODUCTION**

1. I, Gregory F. Welch, have been retained by counsel for Petitioner as a technical expert in the above-captioned case. Specifically, I have been asked to render certain opinions with respect to U.S. Patent No. 8,159,354 (“the ’354 Patent”) in the above referenced proceeding. I understand that the Challenged Claims are claims 32, 33, 49, 50, 56-58, 63, 72 and 73. My opinions are limited to those Challenged Claims.

2. My compensation in this matter is not based on the substance of my opinions or the outcome of this matter nor do I have any financial interest in the outcome of this proceeding. I am being compensated at an hourly rate of \$500 for my analysis and testimony in this case.

### **A. Materials Reviewed**

3. In reaching my opinions in this matter, I have reviewed the following materials:

- Exhibit 1001 – U.S. Patent No 8,159,354 to Ferguson et al. (“the ’354 Patent”);
- Exhibit 1002 – File History of U.S. Patent No 8,159,354 (“the ’354 File History”);
- Exhibit 1005 – U.S. Patent No. 6,162,123 to Woolston (“Woolston”);
- Exhibit 1006 – U.S. Patent Application No. 2001/0034257 to Weston et al. (“Weston”);
- Exhibit 1007 – U.S. Patent No. 6,456,977 to Wang (“Wang”);
- Exhibit 1008 – U.S. Patent No. 5,181,181 to Glynn (“Glynn”);

- Exhibit 1009 – U.S. Patent Application Publication No. 2004/0012557A1 to Daniel (“Daniel”);
- Exhibit 1010 – F. J. Ferrin. Survey of helmet tracking technologies. Proceedings of SPIE, 1456:86–94, April 1991 (“Ferrin”);
- Exhibit 1011 – Greg Welch and Eric Foxlin (2002). Motion Tracking: No Silver Bullet, but a Respectable Arsenal, IEEE Computer Graphics and Applications, special issue on Tracking, November/December 2002, 22(6): 24–38 (“Welch”);
- Exhibit 1012 – I. E. Sutherland. A head-mounted three dimensional display. In Proceedings of the 1968 Fall Joint Computer Conference, AFIPS Conference Proceedings, volume 33, part 1, pages 757–764. Thompson Books, Washington, D.C., 1968 (“Sutherland”);
- Exhibit 1013 – Christopher G. Atkeson and John M. Hollerbach. Kinematic Features of Unrestrained Vertical Arm Movements. The Journal of Neuroscience, Vol. 5, No. 9, pages 2318-2330, September 1985. Society for Neuroscience (“Atkeson”);
- Exhibit 1014 – U.S. Patent No. 3,898,445 to Macleod et al. (“Macleod”);
- Exhibit 1015 – B. R. Sorensen, M. Donath, G.-B. Yang, and R. C. Starr. The minnesota scanner: a prototype sensor for three-dimensional tracking of moving body segments. IEEE Transactions on Robotics and Automation, 5(4):499–509, 1989 (“Sorensen”);
- Exhibit 1016 – C. Verplaetse. Inertial proprioceptive devices: self-motion-sensing toys and tools. IBM Syst. J., 35(3- 4):639–650, 1996 (“Verplaetse”);
- Exhibit 1017 – A. Wilson and S. Shafer. Xwand: Ui for intelligent spaces. In CHI ’03: Proceedings of the SIGCHI conference on Human factors in computing systems, pages 545–552, New York, NY, USA, 2003. ACM (“Wilson”);
- Exhibit 1018 – Jun Rekimoto. GestureWrist and GesturePad: Unobtrusive Wearable Interaction Devices. In ISWC ’01 Proceedings of the 5th IEEE International Symposium on Wearable Computers, pages 21-27, Washington, DC, USA, 2001. IEEE (“Rekimoto”);
- Exhibit 1019 – Grigore C. Burdea and Philippe Coiffet. Virtual Reality Technology 2<sup>nd</sup> Edition. 2003. John Wiley & Sons, Inc. (“Burdea”);
- Exhibit 1020 – Mark J.P. Wolf. Before the Crash Early Video Game History. Wayne State University Press, 2012 (“Wolf”);
- Exhibit 1021 – Richard Marks. EyeToy, Innovation and Beyond, retrieved from <https://blog.us.playstation.com/2010/11/03/eyetoy-innovation-and-beyond/> on May 23, 2019 (“Marks”);

- Exhibit 1022 – M. Wiley. Nintendo WaveBird Review – IGN, retrieved from <https://www.ign.com/articles/2002/06/11/nintendo-wavebird-review> on May 23, 2019 (“Wiley”);
- Exhibit 1023 – Ehud Sharlin, Pablo Figueroa, Mark Green, Benjamin Watson. A Wireless, Inexpensive Optical Tracker for the CAVE™. In Proceedings IEEE Virtual Reality 2000, New Brunswick, NJ, USA, 2000. IEEE (“Sharlin”);
- Exhibit 1024 – U.S. Patent No. 6,475,090 to Roelofs (“Roelofs”); and
- Exhibit 1025 – W. Buxton and B. Myers. A study in two-handed input. In CHI ’86: Proceedings of the SIGCHI conference on Human factors in computing systems, pages 321–326, New York, NY, USA, 1986. ACM Press (“Buxton”).

## **B. Background and Qualifications**

4. I have summarized in this section my educational background, career history, and other relevant qualifications. I have also attached a current version of my Curriculum Vitae as Exhibit 1004.

5. I am a Professor and the AdventHealth Endowed Chair in Healthcare Simulation at the University of Central Florida (UCF) with appointments in the Computer Science Department in the College of Engineering & Computer Science, the Institute for Simulation & Training, and the College of Nursing. I am also an Adjunct Professor of Computer Science at the University of North Carolina at Chapel Hill (UNC).

6. In 1986, I received a B.S. degree in Electrical Engineering Technology from Purdue University (with Highest Distinction). In 1995, I received an M.S. in Computer Science from UNC, and in 1997, I received a Ph.D. in Computer Science from UNC.

7. Previously, I have been a Research Professor at the University of North Carolina at Chapel Hill. I also was a Senior Engineer at Northrop-Grumman's Defense Systems Division where I worked on the AN/ALQ-135 electronic countermeasures system for the U.S. Air Force F-15 Eagle aircraft. And, I was also a member of the technical staff of NASA's Jet Propulsion Laboratory where I worked on the Voyager Spacecraft project.

8. My current research interests include human-computer interaction, virtual and augmented reality, human motion tracking systems, projector-based graphics, computer vision, virtual humans, and related applications for training, assessment, and practice in domains such as healthcare and defense. I have co-authored over 150 peer-reviewed publications in these areas, and I am a co-inventor on multiple patents (issued, pending, and planned).

9. I currently supervise over \$2 million in research funding and am jointly responsible for over \$30 million in grants overall since 1996. Examples of grantors for my research include the National Science Foundation (NSF), the Office of Naval Research (ONR), The National Institutes of Health National Library of Medicine (NIH-NLM), the Defense Advanced Research Projects Agency (DARPA), the Department of Energy (DOE), and private companies—all involving multi-disciplinary and multi-institutional projects.

10. I have co-organized and co-chaired major research events (e.g., the International Symposium on Mixed and Augmented Reality in 2012, the IEEE Virtual Reality conference in 2013, multiple Dagstuhl Seminars, and an Augmented Reality Visioning Workshop in 2018), served on numerous program committees, co-chaired workshops, and served as a peer reviewer for many conferences and journals.

11. In 2018 I received the IEEE Virtual Reality Technical Achievement Award in recognition for my “contributions to human motion tracking and to mixed reality applications in medicine and training.” In 2017 I received a UCF Luminary Award, and in 2016 a UCF Research Incentive award. I have received multiple paper awards, including the 2016 IEEE International Symposium on Mixed and Augmented Reality’s Long Lasting Impact Paper Award. I am a member of the UCF Chapter of the National Academy of Inventors. I serve as an IEEE Technical Expert in the areas of Virtual, Augmented, and Mixed Reality.

12. I am presently serving on the World Economic Forum’s Global Future Council on Virtual Reality and Augmented Reality, the International Virtual Reality Healthcare Association’s Advisory Board, and the National Council of Architectural Registration Boards’ Future Task Force. I am an Associate Editor for the journal *Presence: Teleoperators and Virtual Environments* and an Associate Editor for the journal *Frontiers in Virtual Environments*.

13. I am a Senior Member of the Institute of Electrical and Electronics Engineers (IEEE), a member of the Association for Computing Machinery (ACM), an ACM SIGGRAPH Pioneer, a member of the Southern Nursing Research Society (SNRS), a member of the International Nursing Association for Clinical Simulation & Learning (INACSL), and a member of the Society for Simulation in Healthcare (SSH).

14. While leading research at UNC and UCF, I have co-developed/prototyped many human-movement tracking systems for applications such as Virtual/Augmented Reality and motion analysis, including systems that used various combinations of digital cameras and analog optical sensors with image processing/computer vision techniques to recognize and track features and objects (both natural and instrumented/active), inertial sensors (accelerometers and gyros), acoustic sensors (continuous and time-of-flight), magnetic sensors (active and passive), and the Global Positioning Systems (GPS). These systems involved a variety of characteristics that are often classified in different ways, such as relative vs. absolute, inside-out vs. outside-in, and active vs. passive. I have developed related systems for other technological applications, such as vehicle tracking (for 3D environment mapping) and automatic camera-projector calibration.

15. A major part of my academic work since the early 1990's, including my Ph.D. work, has involved human motion tracking systems and related methods. (The

IEEE Virtual Reality Technical Achievement Award that I received in 2018 cited “contributions to human motion tracking.”) A prime example is the HiBall Tracking system that I worked on in the 1990’s. The system served to track the six degree-of-freedom (6DOF) position and orientation of a target such as a head, hand, or handheld device in a three-dimensional (3D) space over a large (e.g., lab sized) environment, and was the most accurate, precise, and lowest latency system available during its time. It functioned by sequentially pulsing individual light emitting diodes (LEDs) in the environment, while sensing the direction of the LED light from the HiBall sensor device, to triangulate the position and orientation of the device. I collaborated on the hardware and software aspects of this project, which eventually became a commercial product sold by HiBall Tracker Inc. (3rdTech).

16. Among other related aspects, the HiBall sensor device combined and communicated digitized analog measurement data and control signals over a packet-based network designed to support the “daisy chain” configuration of multiple HiBall units—where the HiBall units are connected in sequence or in a ring. The Kalman-filter based algorithm used to control the input/output and estimate the 6DOF pose of the HiBall sensor was the subject of my Ph.D. thesis, and my subsequent efforts to understand and then teach/facilitate use of the Kalman filter resulted in a widely used web site on the Kalman filter, and an Introduction to the



Kalman filter that, according to Google, has been cited over 8,000 times since I made it available on the Internet in 1995.

17. I have co-developed/worked on systems involving every practical physical medium under a variety of circumstances for a variety of purposes. I have co-developed computer vision-based methods and associated prototype systems, including methods for the optimal control of environment-mounted pan-tilt-zoom cameras to determine the body positions and postures of multiple humans, methods for tracking handheld objects using shape and appearance information about the objects, methods for tracking moving a small handheld camera-cluster using differential imaging techniques, and methods for tracking fixed or moving objects for closed-loop Augmented Reality.

18. In 1995 I developed and published an approach for hybrid inertial-optical of humans or objects, and subsequently developed laboratory prototypes that employed hybrid combinations of inertial sensors and either cameras (sensing natural features) or photodiodes (sensing LEDs). I have co-developed/worked on acoustic human motion capture systems that employed continuous spread spectrum autocorrelation measures and systems that employed pulsed time-of-flight measures, for estimating body posture relative to a fixed environment, body-relative posture for a single human, and human-human relative posture for multiple humans interacting in proximity with each other. I co-developed methods for tracking a

human outdoors using a hybrid combination of body-worn sensors including inertial sensors, outward-looking cameras, passive magnetic sensors, and GPS. I have co-developed fundamental methods for optimizing sensor placement and measurement timing for any types and configurations of sensors.

19. Finally, I have co-authored multiple tracking surveys that describe some of the many technologies used for object/body tracking relevant to the '354 Patent including:

- B. D. Allen, G. Bishop, and G. Welch. Tracking: Beyond 15 minutes of thought: SIGGRAPH 2001 course 11. In Computer Graphics, Annual Conference on Computer Graphics & Interactive Techniques. ACM Press, Addison-Wesley, Los Angeles, CA, USA (August 12-17), SIGGRAPH 2001 course pack edition, 2001.
- G. Welch and E. Foxlin. Motion tracking: No silver bullet, but a respectable arsenal. IEEE Computer Graphics and Applications, 22(6):24–38, 2002.
- G. Welch and L. Davis. Tracking for training in virtual environments: Estimating the pose of people and devices for simulation and assessment. In J. Cohn, D. Nicholson, and D. Schmorow, editors, The PSI Handbook of Virtual Environments for Training and Education: Developments for the Military and Beyond, chapter 30. Praeger Security International, November 30 2008.
- G. Welch. History: The use of the Kalman filter for human motion tracking in virtual reality. Presence: Teleoperators and Virtual Environments, 18(1), 2009.

## **II. LEGAL FRAMEWORK**

20. I am a technical expert and do not offer any legal opinions. However, counsel has informed me that in proceedings before the USPTO claim terms are to be given the meaning they would have to a person having ordinary skill in the art at

the time of the invention, taking into consideration the patent, its file history, and, secondarily, any applicable extrinsic evidence (e.g., dictionary definitions).

21. Counsel has also informed me that a person cannot obtain a patent on an invention if his or her invention would have been obvious to a person of ordinary skill in the art at the time the invention was made. A conclusion of obviousness may be founded upon more than a single item of prior art. In determining whether prior art references render a claim obvious, counsel has informed me that courts consider the following factors: (1) the scope and content of the prior art, (2) the differences between the prior art and the claims at issue, (3) the level of skill in the pertinent art, and (4) secondary considerations of non-obviousness. In addition, the obviousness inquiry should not be done in hindsight. Instead, the obviousness inquiry should be done through the eyes of one of skill in the relevant art at the time the patent was filed.

22. In considering whether certain prior art renders a particular patent claim obvious, counsel has informed me that courts allow a technical expert to consider the scope and content of the prior art, including the fact that one of skill in the art would regularly look to the disclosures in patents, trade publications, journal articles, industry standards, product literature and documentation, texts describing competitive technologies, requests for comment published by standard setting organizations, and materials from industry conferences. I believe that all of the

references that my opinions in this IPR are based upon are well within the range of references a person of ordinary skill in the art would consult to address the type of problems described in the Challenged Claims.

23. In determining whether the subject matter of a patent claim is obvious, neither the particular motivation nor the avowed purpose of the patentee controls. Instead, the important consideration is the objective reach of the claim. In other words, if the claim extends to what is obvious, then the claim is invalid. I further understand the obviousness analysis often necessitates consideration of the interrelated teachings of multiple patents, the effects of demands known to the technological community or present in the marketplace, and the background knowledge possessed by a person having ordinary skill in the art. All of these issues may be considered to determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent.

24. I also understand that in conducting an obviousness analysis, a precise teaching directed to the specific subject matter of the challenged claim need not be sought out because it is appropriate to take account of the inferences and creative steps that a person of ordinary skill in the art would employ. I understand that the prior art considered can be directed to any need or problem known in the field of endeavor at the time of invention and can provide a reason for combining the elements of the prior art in the manner claimed. In other words, the prior art need

not be directed towards solving the same specific problem as the problem addressed by the patent. Further, the individual prior art references themselves need not all be directed towards solving the same problem. I have been informed that common sense is important and should be considered. Common sense teaches that familiar items may have obvious uses beyond their primary purposes.

25. I also understand that a particular combination of prior art elements being “obvious to try” may indicate that the combination was obvious even if no one attempted the combination. If the combination was obvious to try (regardless of whether it was actually tried) or leads to anticipated success, then it is likely the result of ordinary skill and common sense rather than innovation. I further understand that in many fields it may be that there is little discussion of obvious techniques or combinations, and it often may be the case that market demand, rather than scientific literature or knowledge, will drive the design of an invention. I understand that an invention that is a combination of prior art must do more than yield predictable results to be non-obvious.

26. I understand that for a patent claim to be obvious, the claim must be obvious to a person of ordinary skill in the art at the time of the invention. I understand that the factors to consider in determining the level of ordinary skill in the art include (1) the educational level and experience of people working in the field at the time the invention was made, (2) the types of problems faced in the art and the

solutions found to those problems, and (3) the sophistication of the technology in the field.

27. I understand that at least the following rationales may support a finding of obviousness:

- Combining prior art elements according to known methods to yield predictable results;
- Simple substitution of one known element for another to obtain predictable results;
- Use of a known technique to improve similar devices (methods, or products) in the same way;
- Applying a known technique to a known device (method, or product) ready for improvement to yield predictable results;
- “Obvious to try”—choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success;
- A predictable variation of work in the same or a different field of endeavor, which a person of ordinary skill would be able to implement;
- If, at the time of the alleged invention, there existed a known problem for which there was an obvious solution encompassed by the patent’s claim;
- Known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on technological incentives or other market forces if the variations would have been predictable to one of ordinary skill in the art; and/or
- Some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior-art reference or to combine prior-art reference teachings to arrive at the claimed invention.

28. I understand that “secondary considerations” must be considered if presented. In most instances, the patentee raises these secondary considerations of non-obviousness. In that context, the patentee argues an invention would not have been obvious in view of these considerations, which include: (a) commercial success

of a product due to the merits of the claimed invention; (b) a long-felt, but unsatisfied need for the invention; (c) failure of others to find the solution provided by the claimed invention; (d) deliberate copying of the invention by others; (e) unexpected results achieved by the invention; (f) praise of the invention by others skilled in the art; (g) lack of independent simultaneous invention within a comparatively short space of time; (h) teaching away from the invention in the prior art.

29. I further understand that secondary considerations evidence is only relevant if the offering party establishes a connection, or nexus, between the evidence and the claimed invention. The nexus cannot be based on prior art features. The establishment of a nexus is a question of fact. While I understand that Patent Owner has not offered any secondary considerations at this time, I will supplement my opinions in the event that Patent Owner raises secondary considerations during the course of this proceeding.

### **III. OPINION**

#### **A. Background of the Technology**

30. At least since the 1960s, work on the development of systems for body-worn or handheld motion tracking systems has been carried out by a diverse set of researchers in different communities, funded by government contracts/grants or private enterprises, and shared publicly via a wide range of venues. As a result, motion tracking has been applied to a wide variety of disciplines over the decades,

for a wide variety of purposes, as described in the many motion tracking surveys. See, e.g., Ex. 1010, *Ferrin*; Ex. 1011, *Welch*. Because there were so many known motion tracking methods, applications, and systems prior to the '354 Patent, all of the concepts embodied in the Challenged Claims were already well known in the art.

31. In 1968, Ivan Sutherland published a pioneering paper describing a head-mounted, three-dimensional display system that presented an image that changed as the user moved his or her head. Ex. 1012, Sutherland at p. 757 (“The fundamental idea behind the three-dimensional display is to present the user with a perspective image which changes as he moves.”). As shown in the figure below, the system included a head-mounted display (HMD), a head position sensor, and a computer used to drive the HMD based on head position sensor inputs:

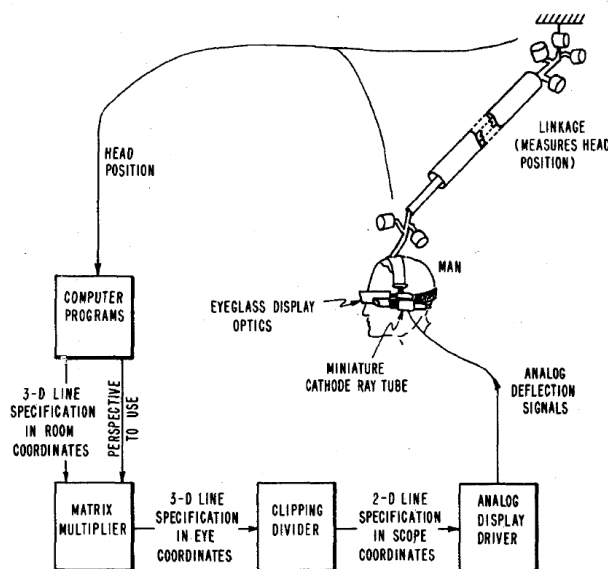


FIGURE 1—The parts of the three-dimensional display system

*Id.* at p. 758.



32. The HMD included cathode ray tubes presenting a virtual image in front of each of the user's eyes:

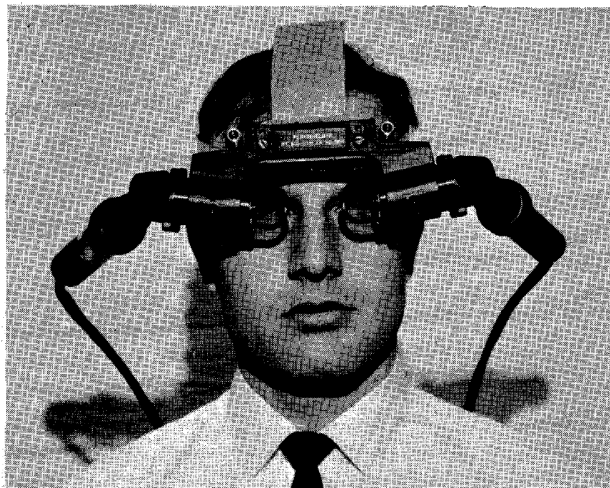


FIGURE 2—The head-mounted display optics with miniature CRT's

*Id.* at p. 759; *see also, id.* at p. 759 (“The special headset which the user of the three-dimensional display wears is shown in Figure 2. The optical system in this headset magnifies the pictures on each of two tiny cathode ray tubes to present a virtual image about eighteen inches in front of each of the user's eyes.”).

33. Sutherland's system used a head position sensor “to measure and report to the computer the position and orientation of the user's head.” *Id.* at 759. There were two implementations of the head position sensor. The first was a mechanical sensor that accurately measured the absolute<sup>1</sup> position and orientation of the user's

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<sup>1</sup> In the context of position/orientation tracking, the term “absolute” generally means that the available measurements indicate the position/orientation of a target with respect to a coordinate frame at a particular instant in time, without the use of position/orientation estimates from a prior instant in time.

head, but per Sutherland, was “rather heavy and uncomfortable to use.” *Id.* at p. 760.

34. The second head position sensor was an ultrasonic sensor including “[t]hree transmitters which transmit ultrasound at 37, 38.6, and 40.2 kHz [] attached to the head-mounted optical system.” *Id.* at pp. 760-761. The continuously transmitted ultrasonic signals were received by four receivers “mounted in a square array in the ceiling.” *Id.* at p. 761. The computer measured phase shifts in the received ultrasonic signals to measure the relative<sup>2</sup> change in position of the user’s head, which was then used to generate the virtual image displayed to the user. *Id.* at pp. 759–761.

35. Early motion tracking systems were also used for measuring human movement for purposes of biomechanical analysis. The Selspot system, for example, was developed in the 1970s and employed multiple user-worn or user-held LEDs that were tracked by room-mounted optical sensors. Ex. 1013, *Atkeson* at 2318 (“We have investigated unrestrained human arm trajectories between point targets using a three-dimensional tracking apparatus, the Selspot system.”); 2320 (“The infrared LED markers were placed on the subject so as to facilitate later reconstruction of the subject’s elbow and shoulder angles . . . . LED 1 was placed at

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<sup>2</sup> In the context of position/orientation tracking, the term “relative” generally means that the available measurements indicate a *change* in position/orientation of a target with respect to a coordinate frame at a *prior* instant in time.

the end of the subject's pointing finger. Two metal strips were prepared with an infrared marker at each end and attached to the subject's upper arm and forearm approximately by one end of the forearm strip. . . . The cameras were approximately located at 90° to each other and 45° to the plane of movement and at a distance of 3 m.”).

36. The CODA mxp30 Motion Capture System from B&L Engineering in 1999 (Charnwood Dynamics Ltd. prior to that) tracked LEDs for object/body posture. Other systems that tracked LEDs for object/body posture at least in the early 2000s included systems by Naturalpoint (2002) and PhaseSpace (1999).

37. Examples of tracking systems using light pulse timing as described in Woolston (Ex. 1005), which I discuss in more detail below, existed at least as early as 1975, including US Patent 3,898,445 issued in 1975, and the Minnesota Scanner system published in 1989. Ex. 1014, *Macleod*; Ex. 1015, *Sorensen*. These two systems employed circularly sweeping light planes emanating from fixed sources in the environment, and photodetectors mounted on the object to be tracked. The systems measured the timing of the light pulses at the detectors, which corresponds to the phase/angle of the detectors relative to the light source, and the measurements were used to triangulate the spatial position and orientation of the object. This is the same approach used by the Valve “Lighthouse” tracking system, which is included with HTC’s Vive virtual reality head-mounted display system available today.

38. Prior to the development of microelectromechanical system (MEMS) technologies in the 1990s, inertial sensors were too big and expensive for use in most motion tracking applications. Ex. 1016, *Verplaetse* at p. 640 (“Until recent years, inertial sensors have only found use in the few fields mentioned above, since their cost and size have traditionally been quite prohibitive . . .”); Ex. 1011, *Welch* at p. 26 (“Not until the advent of MEMs . . . inertial sensors in the 1990s did the development of inertial input devices begin.”).

39. By the mid 1990s, systems tracking the motions of small, hand-held or body-worn objects including MEMS accelerometers and gyroscopes were developed. In 1996, Verplaetse envisioned a “proprioceptive device” able “sense its own motion and position” incorporated into everyday objects such as pens, shoes, baseball bats, balls, etc. Ex. 1016, *Verplaetse* at p. 639. Verplaetse’s paper proposes applying his system to create a “smart” pen that senses its motion, recognizes patterns, and processes information written by the user:

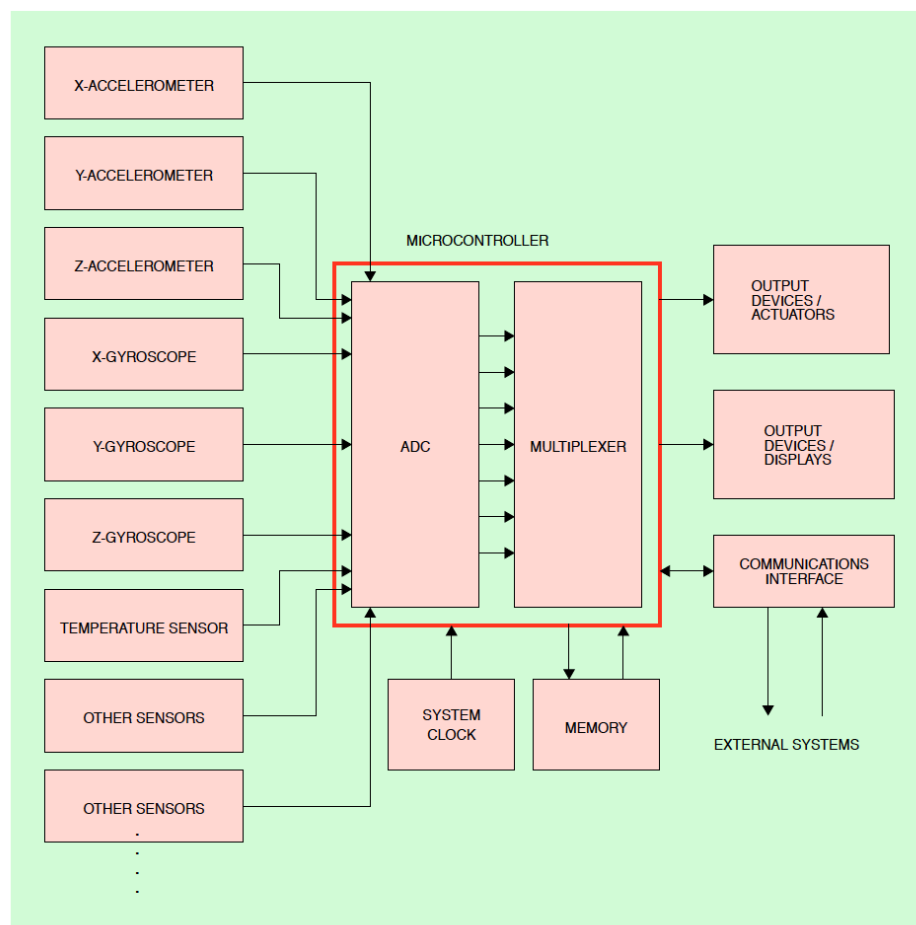
If a pen is given inertial sensors and on-board computation and memory resources, it can sense its motions while it writes and use those motion data to estimate its time-varying position. By employing a pattern recognition method such as a neural network or hidden Markov model[] on its time-varying pen tip position, the pen can know and remember what it has written. Such a “smart” pen could not only save notes and letters but also send electronic mail (e-mail), solve mathematical problems, check for spelling errors, and carry out other standard computer operations.

*Id.* at p. 642.

40. Another application includes “toys and tools that are swung or waved expressively by their users,” such as “[a] baseball bat or tennis racket that senses its motions [to] tell a player how fast he or she is swinging, and . . . give feedback information about the player’s performance.” *Id.* at p. 643.

41. As shown in the figure below, Verplaetse’s system includes inertial sensors measuring translational and rotational motions in six degrees of freedom (DOF):

Figure 2 Schematic of general proprioceptive system



*Id.* at p. 644.

42. While inertial sensors can reliably track relative motions, one well-known limitation is the accumulation of error when using inertial sensors to track absolute position. *Id.* at p. 640 (“However, inertial systems are not well-suited for absolute position tracking. In such systems, positions are found by integrating, over time, the signals of the sensors as well as any signal errors. As a result, position errors accumulate.”); Ex. 1011, *Welch* at p. 27 (“The weakness that prevents inertial trackers from being a silver bullet is drift. If one of the accelerometers has a bias error of just 1 milli-g, the reported position output would diverge from the true position with an acceleration of  $0.0098 \text{ m/s}^2$ . After a mere 30 seconds, the estimates would have drifted by 4.5 meters!”). To combat this problem, hybrid systems combining multiple motion tracking techniques were developed. Ex. 1011, *Welch* at p. 28 (“Inertial sensors have provided the basis for several successful hybrid systems.”); (“You can address most of the shortcomings we’ve mentioned by building a hybrid system that combines acoustic sensors with others that have complementary characteristics—inertial sensors, for example.”).

43. One example of such a hybrid system is the XWand system developed by Microsoft Corporation in 2003. Ex. 1017, Wilson. “The XWand is a novel wireless sensor package that enables styles of natural interaction with intelligent environments.” *Id.* at p. 1. The XWand device is “a handheld device which embeds a variety of sensors which in combination support pointing and gesture recognition

tasks.” *Id.* “For example, a user may point the wand at a device and control it using simple gestures.” *Id.* The handheld XWand device is shown in the image below:



**Figure 1:** The XWand.

*Id.*

44. The XWand utilizes hybrid motion tracking techniques to “support pointing and gesture recognition tasks.” *Id.* at p. 1. The wand’s motion tracking system includes a 2-axis MEMS accelerometer, 1-axis gyroscope, 3-axis magnetometer, and IR LED. *Id.* at p. 2. The IR LED is “seen by cameras equipped with an IR pass filter” and “used to support position tracking of the wand.” *Id.* at p. 2. Specifically, “[t]he position system works by finding the 2-d position of a flashing IR LED on the device from two different video cameras trained on the room.” *Id.* at p. 3. “These 2 2-d observations are then combined to find the 3-d position by triangulation.” *Id.* The outputs of the XWand’s accelerometer and magnetometer are used to determine the 3D orientation of the device. *Id.* at p. 2. (“[W]e can

combine the magnetometer and accelerometer outputs to find the full 3-d orientation of the wand.”).

45. The user may also enter speech commands or provide inputs via a pushbutton on the wand. *Id.* at p. 4 (“Presently, the referent may be determined from the wand pointing target or speech recognition events, while the command may be specified by a wand gesture, a button press event, or a speech recognition event.”).

46. The XWand device also includes a wireless transceiver “used to send and receive signal information to a matching base station.” *Id.* at p. 2. The wand wirelessly receives feedback data from a host computer. For example, a visible green LED on the exterior housing of the wand “is lit by commands from the host when the wand is pointing at any object known to the system” thereby providing visual feedback to the user. *Id.* at p. 6. “[A]udio feedback is provided with the selected target changes” and “assures the user that the object pointed to has been selected.” *Id.*

47. In 2001, Jun Rekimoto of Sony CSL developed similar wearable input devices allowing “users to interact with wearable or nearby computers by using gesture-based commands.” Ex. 1018, *Rekimoto* at Abstract. The GestureWrist device is worn on the user’s wrist and includes a 2-axis accelerometer for measuring the inclination of the user’s forearm and a capacitance sensor for measuring wrist shape changes. *Id.* at 22 (“GestureWrist, is a wristwatch-type input device that



recognizes human hand gestures by capacitively measuring changes in wrist shape.”), 23 (“Figure 2 shows the current GestureWrist prototype. This device consists of two input sensors (capacitance and acceleration sensors), and one tactile feedback actuator.”), 24 (“In addition to the hand-shape measurement, an acceleration sensor . . . is mounted on the wristwatch dial. This sensor is a solid-state 2-axis sensor and measures the inclination of the forearm.”).

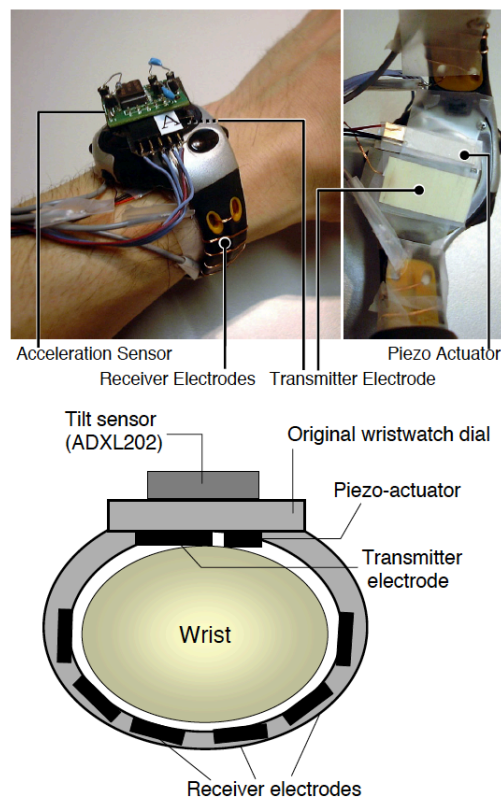


Figure 2: GestureWrist: Wristband-type input device.

*Id.* at 23. The inputs of these two sensors are combined to detect gesture commands input by the user. *Id.* at 24 (“By combining these two inputs, we designed simple gesture commands.”).

48. The GestureWrist device also includes a piezoelectric actuator used to provide tactile feedback to the user when a gesture is recognized. *Id.* at 24 (“When a gesture is recognized, the GestureWrist gives feedback to the user by tactile sensation. On the inside of the wristwatch dial, a ceramic piezoelectric-actuator is attached to produce the feedback.”).

49. Tracking the user’s motion and providing feedback based on the detected motion has also been a key feature of virtual reality systems for many years. Virtual reality systems “typically measure the motion of the user’s head, limbs or hands, for the purpose of view control, locomotion, and object manipulation.” Ex. 1019, *Burdea* at p. 17. Such systems provide feedback from the simulation in response to the user’s input. *Id.* at p. 57 (“Now we look at the special hardware designed to provide feedback from the simulation in response to this input.”). For instance, it is well known that combining several types of sensorial feedback (e.g., visual, aural, and haptic) improves the simulation’s realism. *Id.* (“Combining several types of sensorial feedback in the simulation increases the user’s immersion into the VR. Furthermore, combining several sensorial modalities improves the simulation realism and therefore the usefulness of VR applications.”).

50. Video game systems, including, for example, the Sony PlayStation, Super Nintendo, Sega Genesis, Atari, etc., have traditionally included a game console running the game software and at least one game controller used to provide

inputs to the game. Game controllers have traditionally included input devices such as buttons, keys, joysticks, etc. that are actuated by the user. For example, the Magnavox Odyssey 2 included a peripheral keyboard with buttons and handheld joysticks as shown in the image below:



Ex. 1020, *Wolf* at p. 33.

51. However, video game systems also utilizing motion tracking techniques to enable players to provide game inputs were developed in the 1990s and early 2000s. For example, the Sony EyeToy was released in October 2003 and is a camera that enables users to interact with PlayStation 2 games via motion. Ex. 1021, *Marks* at p. 2 (“The EyeToy USB camera was the first of its kind to translate your body movements into game controls, map your face onto in-game characters and more. It was created to allow you to physically interact with games, such as Antigrav, EyeToy Play and Kinetic, using your body.”).

52. Likewise, the Woolston patent, which was filed in 1997, describes a virtual sword fighting game system that tracks the motions of a hand-held sword device and provides vibrational and visual feedback to the user based on the motions of the hand-held sword device. *See*, ¶¶57-80. Like the XWand system, Woolston’s game system utilizes hybrid motion tracking techniques including LED position tracking and inertial sensing. *See*, ¶¶62-64.

53. Initially, game controllers were coupled to video game consoles through the use of various wired technologies; however, controllers using wireless communication technologies were being sold at least as early as 2002 with the introduction of the Nintendo Wavebird, which utilized RF communications to remove the need for a clear line of sight between the controller and the game console. Ex. 1022, Wiley at p. 5 (“Wireless was big at this year’s E3. Plenty of peripheral

makers had cordless controllers on the floor - everything from straight pads to steering wheels to joysticks. While this was exciting to see – it’s about time the technology has advanced to a point at which wireless controllers are actually practical -- the real business was over at the Nintendo booth, where the company reeled in attendees with fully functional WaveBird controllers.”), 6 (“One of the biggest improvements in wireless control is the implementation of RF (radio frequency) technology. The alternative, IR (infrared), requires line of sight to operate, which is extremely impractical considering that few of us play games in empty rooms while keeping our controllers pointing directly toward the console.”).

**B. Level of a Person Having Ordinary Skill in the Art**

54. I was asked to provide my opinion as to the level of skill of a person having ordinary skill in the art of the ’354 Patent at the time of the claimed invention, which counsel has told me to assume is July 29, 2004. In determining the characteristics of a hypothetical person of ordinary skill in the art of the ’354 Patent, I considered several factors, including the type of problems encountered in the art, the solutions to those problems, the rapidity with which innovations are made in the field, the sophistication of the technology, and the education level of active workers in the field. I also placed myself back in the time frame of the claimed invention and considered the students who I had taught and with whom I had worked at that time.

55. In my opinion, a person of ordinary skill in the art would have been someone having the equivalent of at least an undergraduate degree in computer science, computer engineering, electrical engineering, or a similar technical field; a basic understanding of the principles of operation of the technologies commonly used for motion sensing; a basic understanding of the principles of operation of the technologies used for communication between electronic peripherals; and one or more years of experience in analysis, design, or development of systems employing some of the sensing and communication principles; with additional education substituting for experience and vice versa.

56. Based on my education, training, and professional experience in the field of the claimed invention, I am familiar with the level and abilities of a person of ordinary skill in the art at the time of the claimed invention. Additionally, I was at least a person of ordinary skill in the art as of the priority date of the '354 Patent.

**C. Summary of the Prior Art**

*1. Woolston*

57. Woolston describes an “interactive electronic game” system allowing a player to “input velocity and position information into an electronic game and receive physical feedback through the apparatus from the electronic game.” Ex. 1005, *Woolston* at 1:4-9.

58. Woolston's system includes a player interface apparatus that is "a hand held apparatus that may use sensors to determine the position of the apparatus and the gyrostatic effect to provide tactile feedback to the user." *Id.* at 2:38-41. The player interface apparatus is "preferably about the size of a three and/or four D-size cell battery flashlight and is adapted to be held by either one and/or two hands." *Id.* at 2:44-48. In the primary embodiment, the housing of the player interface apparatus is in the shape of sword hilt 200. *Id.* at 2:48-50 ("The sword type device may be ornamentally decorated to resemble the hilt and/or handle part of a traditional and/or futuristic sword."); 5:66-67 ("[T]he sword game of the present invention has a sword housing 200 . . . ."). However, the housing may also be in the shape of "a gun, bazooka, knife, hammer, axe and the like." *Id.* at 3:35-39. For purposes of clarity, I will refer to the hand-held player interface/sword apparatus 200 as "apparatus 200".

59. A game controller 240 "track[s] the position and attitude of sword apparatus 200" and uses this information to project and track a virtual sword blade in a virtual reality game space displayed on display 205. *Id.* at 15:65-16:2, 8:65-9:2 ("FIG. 3 shows the present invention in a deployment perspective showing a television and/or display 205 in a virtual reality and/or the game reality space can be projected 205 from game controller 240 in conjunction with sword housing 200."), Figs. 3, 10. Game controller 240 is "embodied in personal computer software and/or

a personal computer hardware apparatus and/or dedicated hardware.” *Id.* at 9:11-13.

60. For purposes of clarity, it is important to note that a “game controller” traditionally refers to a peripheral input device used to provide game inputs to a computer system running the game software. As is apparent from the description above, Woolston departs from the common vernacular and refers to what typically would be called the game console or game machine as the “game controller 240.” Thus, in Woolston’s system the “game controller” is the game console running the game software, and the apparatus 200 is the peripheral input device used by the player to interact with the game.

61. Display 205 may be a television or computer display as shown in Figure 3 below or display 205 may be “may be replaced with virtual reality glasses and/or helmet arrangement. . . . us[ing] two displays stereoscopically disposed in front of a player’s eyes to give a three dimensional representation of the virtual playing field.” *Id.* at 9:25-30.



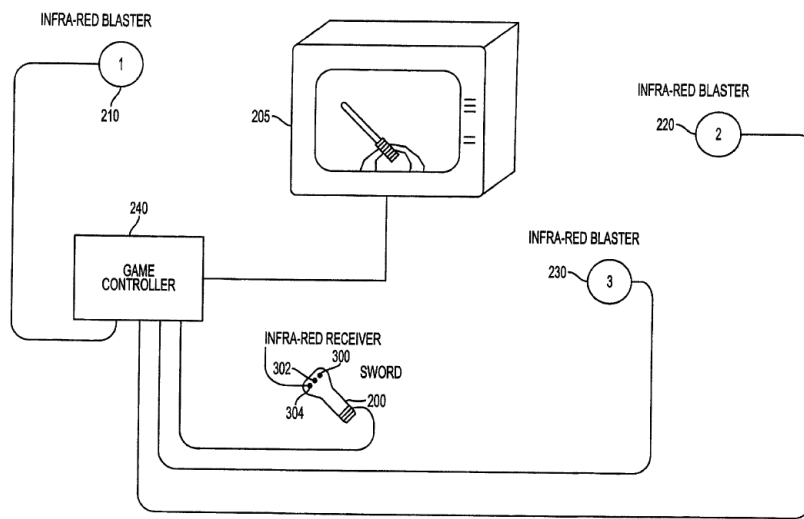


FIG. 3

*Id.* at Fig. 3.

62. Woolston teaches hybrid motion tracking techniques to track the movement of the apparatus 200. Specifically, position tracking is accomplished using “infrared blasters, e.g., high output infrared transmitters . . . to output a pulse and/or timed emission of infrared light which may then be received at the remote sensors, which in the preferred embodiment are infrared receivers, whereupon the timing and/or phase differential of the received signals may be used to triangulate and determine the spatial position of the sword apparatus [200].” *Id.* at 3:60-4:1. In Figure 3 above, the IR transmitters 210, 220, 230 are coupled to the game controller 240 and the apparatus 200 includes IR receivers 300, 302, 304. *Id.* at Fig. 3. However, this arrangement may be reversed and 300, 302, 304 on apparatus 200 may be the IR transmitters and 210, 220, 230 may be IR receivers coupled to the game controller 240. *Id.* at 9:39-46 (“Infrared blasters, shown at 210, 220 and 230

may be reversed, that is they may be infrared receivers and the infrared blaster may be located at 300, 302 and 304. In such a configuration a single and/or multiple infrared burst(s) may be output from 300, 302 and 304 and the timing of receiving or reception could be determined at 210, 220 and 230 in order to triangulate the real position of the sword 200.”). This method is akin to the pulsing light position tracking methods I discussed above in the Background of the Technology. *See*, ¶37.

63. This arrangement of IR transmitters and receivers is used to determine the position of the apparatus 200 in real coordinates. *Id.* at 9:13-17 (“Infrared blaster and/or receivers 210, 220 and 230 may work in conjunction with infrared receivers and/or blasters 300, 302 and 304 to determine the position of the sword in real coordinates.”). Woolston also discusses including IR transmitters at the top and bottom of the apparatus 200 to determine attitude. *Id.* at 4:2-5 (“An infrared output at both the top and the bottom of the sword apparatus may be used to determine the attitude of the sword apparatus and is within the scope of the present invention.”).

64. Inertial sensing is accomplished via “[p]ositional device element 600 [] used to determine the position of the sword and the attitude of the sword in the X, Y and Z axes.” *Id.* at 7:13-15. The positional device element 600 is included in apparatus 200 and may be a gyroscope. *Id.* at 10:15-20 (“Blocks 416, 418 and 420 may represent the circuitry necessary for positional sensors 602, 604 and 606 to determine the pitch, yaw and/or attitude of the sword 200 when a mini-gyroscope is

used to determine the position of the sword 200. Sensors 602, 604 and 606 may be incorporated into functional block 600.”), Fig. 1.

65. The apparatus 200 also includes a propulsion gyrostat 500, which is composed of high torque motors used to simulate sword blows and provide tactile feedback to the user holding apparatus 200. *Id.* at Abstract (“An electro-mechanical device for providing an input to a computer program and said computer program providing a tactile output through said electromechanical device to a user. More specifically, the present invention provides an electro-mechanical virtual sword game apparatus that . . . contains a propulsion gyrostat that under the control of a computer process may be topple to provide a torque on the housing of the sword apparatus that may be used to simulate the impact of sword blows.”), 6:3-7 (“The torque forces from the present invention may be able to approximate the feel of a real sword battle, therefore, the material for the housing, 200, should be of sufficient strength to safely handle the torque imparted by the torque propulsion system 500.”).

66. Speaker 203 “provide[s] an audio output for game sounds.” *Id.* at 6:41-42. Control circuits 400 drive both the propulsion gyrostat 500 and speaker 203. *Id.* at 6:43-44 (“Speaker 203 may be connected by line 204 to control circuits 400. Control circuits 400 may contain a digital to analog converter to generate game sounds.”), 6:64-66 (“Block 400 may represent the control circuits necessary for the analog drive voltages for the propulsion gyrostat means 500.”).

67. “The control circuits 400 and the digital control circuits and/or microprocessor circuit 499 may be placed into a single integrated circuit, group of circuits and/or on the same circuit board.” *Id.* at 7:3-6. The microprocessor 499 “contain the processing elements necessary for control and/or execution of software and/or software elements to effect control of the sword apparatus of the present invention.” *Id.* at 6:58-62. However, “[t]he control functions and/or part or parts of the control function may be moved into the game controller 240.” *Id.* at 6:62-63.

68. Microprocessor 499 also includes a communication interface, such as a USART, enabling the apparatus 200 to receive data signals from the game controller 240. *Id.* at 6:47-50. Woolston also contemplates providing “wireless analog and/or digital control signal to provide an interface between the sword apparatus [200] and the game controller 240.” *Id.* at 6:50-54.

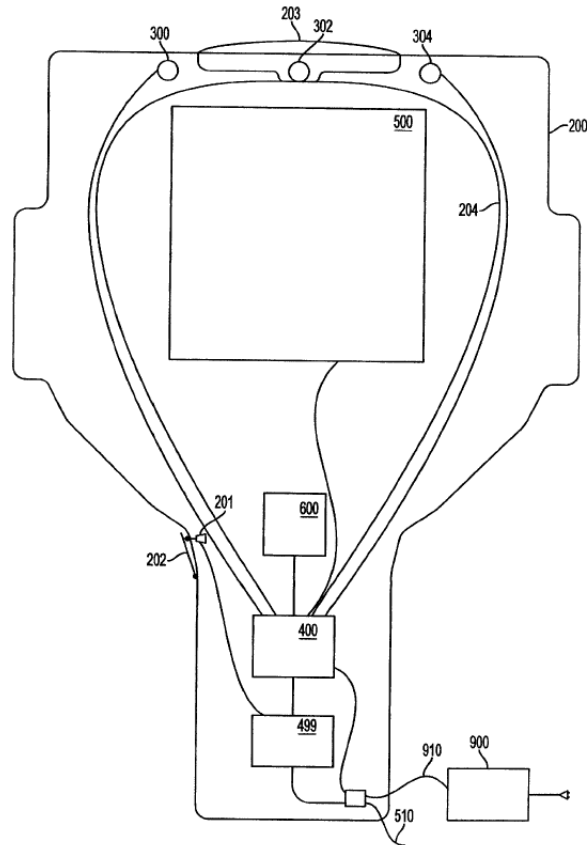


FIG. 1

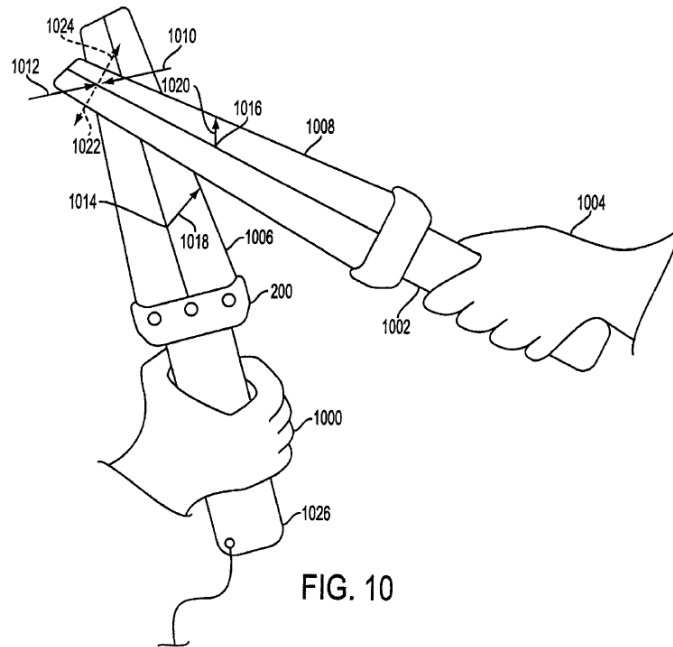
*Id.* at Fig. 1.

69. In operation, the game controller tracks the position and attitude of the apparatus 200 and uses this information to project and track a virtual blade 1006 in the virtual reality game space. *Id.* at 15:65-16:2 (“The game controller 240 may track the position and attitude of sword apparatus 200. The positional and attitude information may be used by the game controller software to project and track the virtual blade 1006.”); 16:4-6 (“The game controller 240 software may also create and track the position of blade 1006 in the game space coordinate system.”). The

game controller 240 also “determine[s] and track[s] the velocity of the blade 1006 by using the differential positioning method . . . .” *Id.* at 16:2-4.

70. The velocity vector (i.e., the “direction and speed of the sword [apparatus 200]”) is determined “by successively determining the position of the player’s sword and then determine from the change in position the velocity of the sword apparatus 200.” *Id.* at 10:51-56. The velocity of the apparatus 200 and virtual sword blade 1006 are determined in the same way. *Id.* at 11:3-6 (“Block 530 labeled ‘get game sword velocity vector’ is a vector, from the game software, providing the velocity and virtual mass of the attacking sword, similar to procedural blocks 524 and 526 described above.”). Thus, the game controller 240 maps the position and attitude of apparatus 200 to game space coordinates to determine the position of the virtual blade 1006 and then tracks the change in position of apparatus 200 to determine the velocity of apparatus 200 and the corresponding velocity of virtual blade 1006.

71. The game controller 240 software determines if a collision occurs between the virtual blade 1006 and another virtual object, such as an opponent’s virtual blade 1008 (shown in Figure 10 below), and determines an intersection point, which is “passed to the procedures described in FIGS. 5, 6 and 7.” *Id.* at 16:8-17.



*Id.* at Fig. 10.

72. Figures 5-8 represent software routines used to determine the output of the propulsion gyrostat 500 to provide tactile feedback to the user holding apparatus 200. Figure 5 depicts “a routine called from the game software to calculate the severity of a sword blow.” *Id.* at 5:44-46, Fig. 5. First, the “calculate blow routine 520” receives the intersection point of the collision discussed above “in the x, y, and z coordinates of the virtual space and when applicable the attacking sword velocity.” *Id.* at 10:28-31. Next, the “get position sword hilt” 522 step “retrieve[s] the actual position of a player’s sword apparatus 200” and “determine[s] the distance from the sword hilt that a sword impact occurred”, which is “used to determine the amount of leverage, e.g., the amount of ‘twisting force’, that the attacking sword blow may

have on the sword apparatus 200.” *Id.* at 10:31-40. Next, the apparatus 200’s idealized mass (step 524) and velocity (step 526) are calculated. *Id.* at 10:40-66.

73. The routine then calls a “get game sword position” 528 function that “yields a value from the game software, . . . which provides the position of the sword hilt from the attacking virtual sword.” *Id.* at 10:66-11:3. And then the “get game sword velocity vector” 530 function subsequently retrieves a velocity vector “from the game software, providing the velocity and virtual mass of the attacking sword, similar to procedural blocks 524 and 526 described above.” *Id.* at 11:3-6. Next the “get game sword blow intensity” 532 function calculates the “force of the attacking blow at the position of the strike” using “the well known equation that force equals mass times acceleration and/or kinetic energy equals one half the mass times velocity squared.” *Id.* at 11:11-15.

74. The “calculated blow/return blow torque vector” 534 function calculates the cross product of “the vector providing the player’s sword direction and force at the impact point and the attacking sword vector providing the direction and force of the impact point idealized at right after impact” in order to determine “the resulting direction and speed of the two swords” (i.e., how much the virtual swords “bounce” off of each other after a virtual impact). *Id.* at 11:22-36.

75. The routine depicted in Figure 6 takes the resulting direction and speed of the two swords calculated by the routine of Figure 5 “to calculate the actual values



of the torque outputs for the pitch and yaw gyrostat toppling motors that provides the simulated impact of the sword at the player's sword apparatus 200.” *Id.* at 11:41-45. To accomplish this the routine determines the current state of the propulsion gyrostat and calibration parameters to “calculate the value of the torque for output to controllers 404 and 406” (step 548). *Id.* at 11:48-12:19. The “output impulse torque 1 and 2” step 550 outputs a “numerical value that may represent a value for eventual output to the toppling motors . . . . to a predetermined memory location in controller 401 that, as will be discussed further below, are accessed by the gyrostat position control routine detailed in FIG. 7.” *Id.* at 12:25-32.

76. The routine shown in Figure 8 is used to calculate a “mysterious force” which is used “to encourage the player to move the sword apparatus toward the center of the predetermined game field,” “lead the player to a future sword impact”, or provide “a swordsman training mode to teach sword fighting techniques.” *Id.* at 4:15-19, 14:20-26. The mysterious force “is essentially a small torque from the propulsion gyrostat whereby the sword device may ‘lead’ the player’s sword blows and/or movement.” *Id.* at 5:3-7.

77. In step 591, the game software provides “a desired virtual x, y, and z point for the virtual sword”, which “is a point and/or coordinate wherein an [sic] game event will occur within the game domain’s future.” *Id.* at 14:26-32. In steps 592 and 593, the position and attitude of the apparatus 200 are determined using the

motion tracking techniques discussed above and used to “determine the virtual location of the virtual sword blade extending from the sword apparatus 200.” *Id.* at 14:32-41.

78. In step 594, the software calculates the “smallest change in position of the virtual sword location” to the desired virtual x, y, and z point for the virtual sword discussed above. *Id.* at 14:41-44. The routine then calculates a torque “to move the virtual sword to intersect the desired X, Y and Z coordinate and/or provide a torque in the direction of the desired X, Y, and Z coordinates” and multiplies this torque with a “mysterious force factor parameter which may be a constant that is multiplied by the torque from block 595 to provide a mysterious force that is either strong, if the mysterious force factor is a large number, or subtle if the mysterious force factor is a small constant.” *Id.* at 14:44-53. The “mysterious force” torque is then output to a memory location where it may be applied by the procedure discussed in reference to Figure 7. *Id.* at 14:67-15:2.

79. The routine shown in Figure 7 is the “gyrostat position control procedure,” which is “the control loop that controls the output to torque control 404 and 406 and governs the position and/or toppling of the propulsion gyroscope 10.” *Id.* at 12:46-50. This procedure is the “master routine” that operates in a continuous loop after initialization of the apparatus 200 and applies the sword blow torque, mysterious force torque, and “the torque output required to cancel the force of a

player rotating the sword apparatus 200 when no torque and/or tactile feedback or output on the sword apparatus 200 is desired.” *Id.* at 12:50-57. Woolston refers to the latter torque as the “tracking torque,” which is “a tracking voltage that topples the propulsion gyrostator to compensate for the change in the sword position” and “may be used to topple the propulsion gyrostator in such a way as to track the position of the sword apparatus 200 so as to minimize the torque felt at the sword apparatus 200 in response to movement of the apparatus, e.g., by the player, when no torque is desired.” *Id.* at 13:10-21.

80. The “get gyro effects” 580 function “calculates the sum of the tracking voltages from block 574, the sword blow torque from FIG. 6 and the mysterious force torque from FIG. 8 to combine these three torque vectors to determine a tracking voltage and/or voltages to create the toppling torque for the propulsion gyrostator 10.” *Id.* at 13:51-57. The sum of the three torque vectors is output as “torque voltages 1 and torque voltages 2 to torque motor controllers 404 and 406” where they are used “to topple the propulsion gyrostator 10 of the present invention to provide the gyrostatic effect of the sword apparatus 200.” *Id.* at 13:57-61.

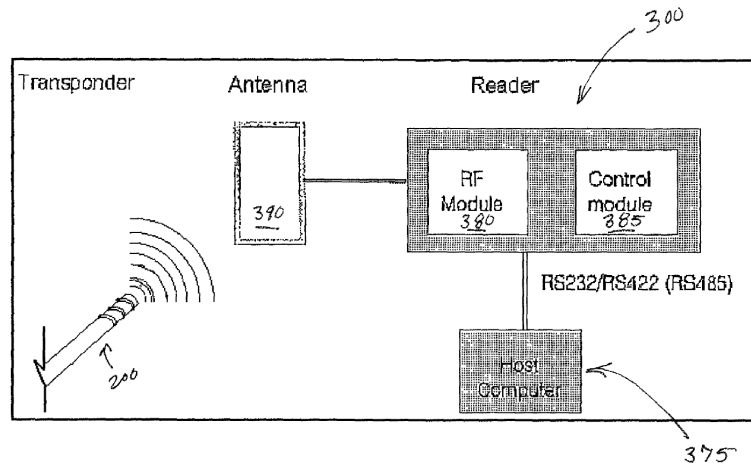
## 2. Weston

81. Weston describes an interactive game system where handheld wand devices enable users “to electronically send and receive information to and from other wand toys, a master system and/or to actuate various play effects within a play

environment.” Ex. 1006, *Weston* at Abstract. “The play environment may be either real or imaginary (i.e. computer/TV generated), and either local or remote, as desired.” *Id.* For example, a virtual play environment may be provided by “television/video/radio programs, computer software program, game console, web site, etc.” *Id.* at [0064].

82. The hand-held wand device includes “position sensors . . . to allow the ‘magic wand’ 200 to be operated by waiving [sic], shaking, stroking and/or tapping it in a particular manner.” *Id.* at [0050]. The user may be required to move the wand in a particular manner as required by the game. *Id.* at [0043] (“Use of the wand 200 may be as simple as touching it to a particular surface or magical item within the play structure 100 or it may be as complex as shaking or twisting the wand a predetermined number of times in a particular manner and/or pointing it accurately at a certain target desired to be ‘magically’ transformed or otherwise affected.”).

83. As shown in the figure below, the wand device 200 wirelessly communicates with a master/host computer 375 coupled to a transceiver 300:



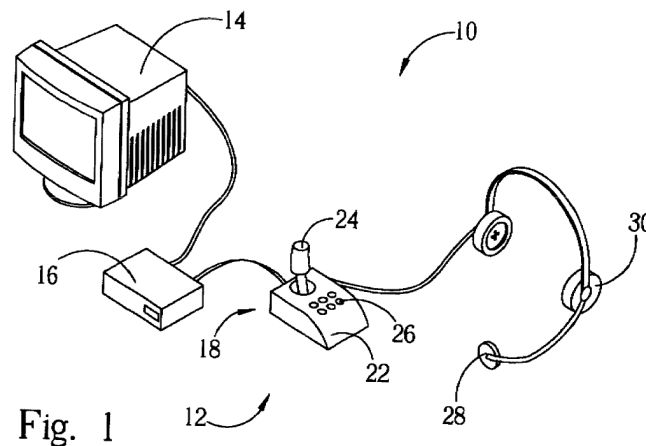
*Id.* at Fig. 3; [0049] (“If desired, the wand 200 may also be configured for long range communications with one or more of the transceivers 300 . . . . Such long-range [sic] wand operation may be readily achieved using an auxiliary battery powered RF transponder, such as available from Axxess, Inc., Dallas, Tex.”).

84. The transceiver 300 “is capable of supporting medium-to-long range (10-40 feet) two-way communications between SRRF objects and a host system, such as a PC running SRRF-compatible software.” *Id.* at [0074]. Wand 200 includes a small SRRF (Send Receive Radio Frequency) module supporting two-way communications with the transceiver 300 and other wands. *Id.* at [0072] (“[A] small SRRF module is preferably incorporated into one or more portable toys or objects that may be as small as a beeper. The SRRF module supports two-way communications with a small home transceiver, as well as with other SRRF objects. For example, a Magic wand 200 can communicate with another Magic wand 200.”).

85. The master/host computer tracks the users' activities and "adjust[s] the play experience for the user based on 'knowing' where the user/player has been, what objectives that player has accomplished and how many points or levels have been reached." *Id.* at [0068].

3. Wang

86. Wang describes a voice control module for a video game system. The game system includes a display device 14, an input device 22, a voice control module 12, and a game controller 16, which may be a PC or PC game box running the game<sup>3</sup>:



Ex. 1007, *Wang* at Fig. 1, 2:34-41 ("The computer game system 10 comprises a game controller 16, a voice control module 12 for controlling the input voice signals for controlling the input voice signals for controlling the game controller 16, a display device 14 used for displaying a screen of images, and a computer joystick

<sup>3</sup> Like Woolston, Wang also refers to refers to what typically would be called the game console or game machine as the "game controller."

18 used for producing cursor signals as well as inputs signals from the keyboard for controlling the game controller 16. The game controller 16 may be a PC or PC game box.”).

87. The voice control module receives voice input from the user via a microphone 28 and compares the voice signal to predefined commands stored in a control command file 38. *Id.* at 3:32-39. If the voice signal corresponds to a stored command, the command is transmitted to the game controller where it is executed. *Id.*

88. Examples of commands include “execute commands,” such as “start” and “quit” as well as “switch commands,” such as “change weapon” and “change vehicle.” *Id.* at 4:19-23 (“The control command file 38 comprises two execute commands and two switch commands. “Start” and “quit” are execute commands and “change weapon” and “change vehicle” are switch commands 64, 66.”).

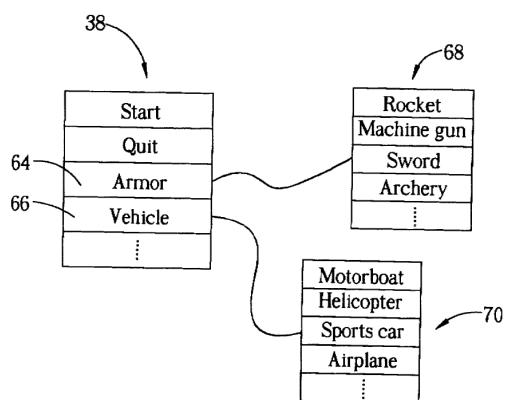


Fig. 5

*Id.* at Fig. 5.

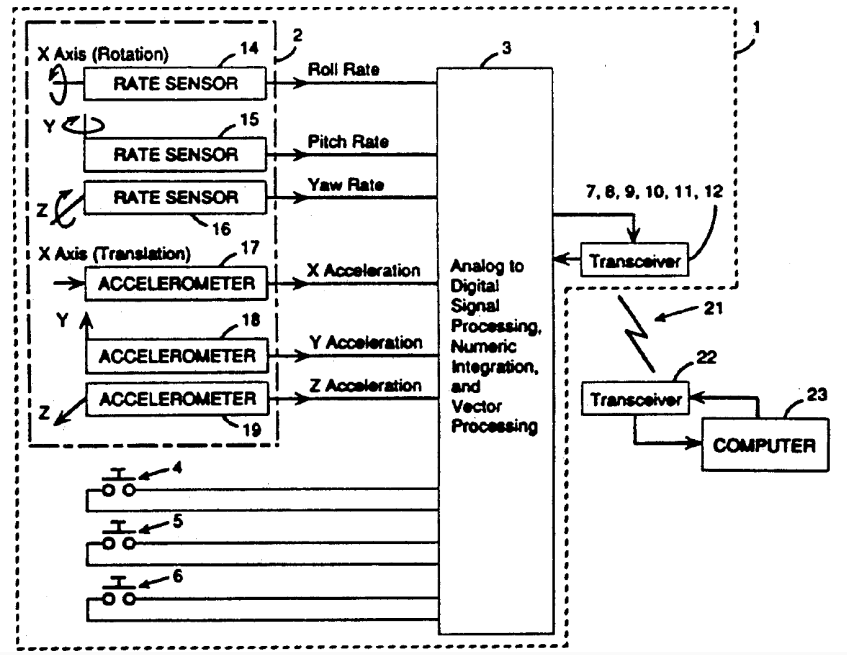
4. Glynn

89. Glynn describes a motion tracking system including a hand-held, peripheral input device including “three accelerometers for sensing linear translation along three axes of a Cartesian coordinate system and three angular rate sensors for sensing angular rotation about the three axes.” Ex. 1008, *Glynn* at Abstract. “Signals produced by the sensors are processed to permit the acceleration, velocity and relative position and attitude of the device to be conveyed to a computer.” *Id.* The computer uses this movement information to, for example, control “movement of a cursor, represented on a computer display in terms of three-dimensional spatial coordinates.” *Id.* at 2:57-61.

90. The input device also includes pushbuttons 4, 5, 6 used “for additional interaction of the operator with the host computer system.” *Id.* at 5:26-28. “For example, actuation of a push-button may command the system to reset the zero reference point from which the relative position and attitude of the mouse 1 is measured.” *Id.* at 5: 47-50.

91. The movement and pushbutton signals are transmitted to the host computer via wireless transceivers 7-12. *Id.* at 6:40-43 (“Information regarding the sensor signals is then provided to mouse transceivers 7-12 for communication to the computer transceiver 22.”).

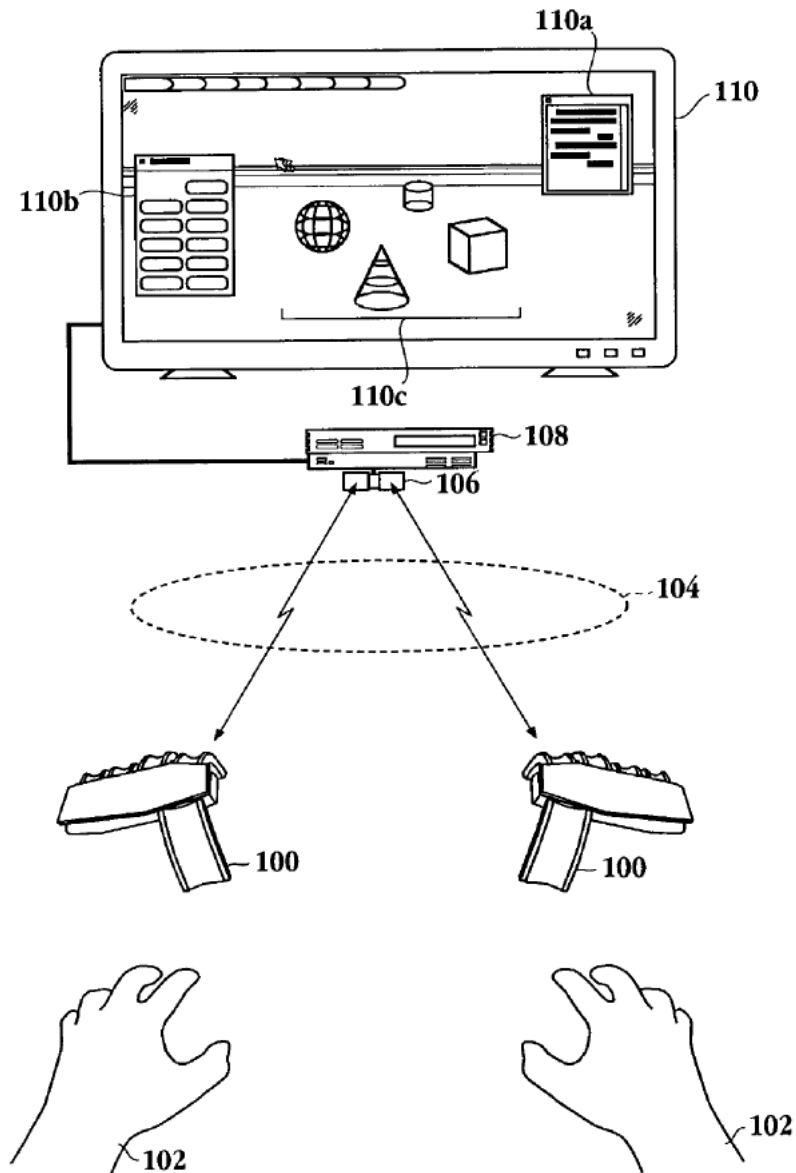




*Id.* at Fig. 3.

## 5. Daniel

92. Daniel describes a hand-held input device for a computer system . Ex. 1009, *Daniel* at [0005]. In one embodiment, the user holds an input device 100 in each hand, and each input device 100 communicates wirelessly with a remote computing device 108:



*Id.* at Fig. 2; [0033] (“It will be apparent to one skilled in the art that the embedded electronics may generate short range radio signals. These signals can be processed in accordance with public or proprietary processing circuitry and/or software. For exemplary purposes, communication of the radio signals can be done using standards such as BLUETOOTH, or other suitable wireless technology (e.g., such as IEEE

802.11).”); [0034] (“External input devices 100 are configured to fit within the palm of each of a user's hands 102. As shown, each of input devices 100 is enabled to communicate with computing device 108 through receiver 106.”)

93. The computing device 108 “can be a computer, or a game console,” such as “a PLAYSTATION™ game console.” *Id.* at [0033]. The input devices 100 “generate commands 104 in response to a user’s hand movements.” *Id.* at [0035]. In particular, the user’s hand/finger movements are “transferred to computing device 108 to initiate a command, respond to a query, maneuver objects in an interactive video game, etc.” *Id.* The input devices are also “enabled to provide tactile feedback to a user in response to hand movements of the user.” *Id.* at [0012].

**D. Combination of Woolston and Weston**

*1. “a transmitter for transmitting signals”*

94. Claims 32, 49, and 50 recite the limitation, “a first hand-held communication device comprising: a transmitter for transmitting signals.” As I discussed above, Woolston’s apparatus 200 includes IR transmitters 300, 302, 304 that “output a pulse and/or timed emission of infrared light which may then be received at the remote sensors, which in the preferred embodiment are infrared receivers.” Ex. 1005, *Woolston* at 3:60-66. In my opinion, this disclosure alone satisfies the requirement for “a transmitter transmitting signals.”

95. However, I have also been asked to opine as to whether it would have been obvious to a person of ordinary skill to include a wireless RF transmitter, such as taught by Weston, in Woolston's apparatus 200 for enabling wireless communications with the game controller 240. For the reasons explained below, this would have been an obvious modification to Woolston's apparatus 200.

96. First, Woolston describes enabling the apparatus 200's microprocessor circuit 499 to use "wireless analog and/or digital control signal to provide an interface between the sword apparatus and the game controller 240." *Id.* at 6:50-54. Thus, Woolston discloses communicating control signals between apparatus 200 and game controller 240 via a wireless interface, but Woolston does not provide the specific details of this interface, such as whether it is bi-directional, for example.

97. Weston's hand-held wand device includes "an elongated hollow pipe or tube having a proximal end or handle portion and a distal end or transmitting portion." Ex. 1006, *Weston* at [0010], Figs. 2A, 2C, 3. The wand enables "long-range transmissions such as via an infrared LED transmitter device or RF transmitter device" in order "to electronically send and receive information to and from . . . a master system" *Id.* at [0010]; Abstract; *see also, id.* at [0049] ("Such long-range wand operation may be readily achieved using an auxiliary **battery powered RF transponder**, such as available from Axxess, Inc., Dallas, Tex. If line of sight or directional actuation is desired, a battery-operated **infrared LED transmitter** and

receiver of the type employed in television remote control may be used, as those skilled in the art will readily appreciate.”) (emphasis added); *see also*, ¶¶83-84.

98. It would have been obvious to a person of ordinary skill in the art to – like Weston – include a transmitter in Woolston’s apparatus 200 to enable it to wirelessly transmit signals to the game controller 240. For example, a person of ordinary skill would understand that the attitude/location signals output by the apparatus 200’s inertial sensing system (discussed above at ¶64) would need to be transmitted to the game controller 240 prior to its use by the game controller software. Ex. 1005, *Woolston* at 3:49-54 (“The gyroscopic inertial positioning system may keep the computer game apprised of the spatial attitude and/or location of the sword apparatus in such a way that the game may provide the proper moments of torque on the motors to provide feedback to the player.”); 15:65-16:2 (“The game controller 240 may track the position and attitude of sword apparatus 200. The positional and attitude information may be used by the game controller software to project and track the virtual blade 1006”).

99. Considering Woolston’s express suggestion to utilize a “wireless . . . control signal to provide an interface between the sword apparatus [200] and the game controller 240” a person of ordinary skill would have been motivated to include a wireless transmitter, such as taught by Weston, to transmit signals, such as the attitude signals discussed above, to the game controller 240. As I discussed

above in the Background of the Technology, handheld communication devices including wireless transceivers used to send and receive signals to/from a remote computing device were already well-known at the time of the '354 Patent. *See*, ¶46. Thus, utilizing a wireless transmitter transmitting signals would have been a reliable and predictable way for the apparatus 200 to communicate with the game controller.

100. Additionally, modifying Woolston's apparatus 200 to communicate with the game controller 240 via a wireless transmitter instead of a wired interface would have permitted the user more freedom of movement when moving apparatus 200 to interact with the game. The benefits of not hindering the user's movements with wires was well-known tenant in the field of motion tracking systems well prior to the '354 Patent. *See, e.g.*, Ex. 1023, *Sharlin* at Abstract ("CAVE™ displays offer many advantages over other virtual reality (VR) displays, including a large, unencumbering viewing space. Unfortunately, the typical tracking subsystems used with CAVE™ displays tether the user and lessen this advantage. We have designed a simple, low-cost feet tracker that is wireless, leaving the user free to move."); *see also*, Ex. 1013, *Atkeson* at 2318 ("We have investigated unrestrained human arm trajectories between point targets using a three-dimensional tracking apparatus, the Selspot system. Our studies indicate the importance of examining natural unrestricted movements as our results agree only in part with previous studies of arm movement."). Even the '354 Patent references prior art motion tracking systems

utilizing “wireless communication means to remotely transmit and process the information and allow for greater mobility and range of movement.” Ex. 1001, ’354 Patent at 1:33-37.

101. Moreover, one benefit of Weston’s wireless arrangement is providing the ability for the user to move freely about a game environment to provide “a complex, interactive play and entertainment system that creates a seamless magical interactive play experience that transcends conventional physical and temporal boundaries.” Ex. 1006, *Weston* at [0064]; *see also id.* at [0067]-[0068].

102. A person of ordinary skill would have understood that modifying Woolston’s apparatus 200 to wirelessly transmit signals using a transmitter as taught by Weston would have been an advantageous way to avoid the need for a wire connecting the sword to the game controller thereby allowing the user more freedom of movement.

103. A person of ordinary skill would have also understood that allowing the user to freely move the apparatus 200 during gameplay – without the hindrance caused by a wire connecting the apparatus 200 to the game controller 240 – would have predictably enhanced the user’s gameplay experience and led to increased satisfaction. As such, a person of ordinary skill would have been motivated to include Weston’s transmitter for transmitting signals in Woolston’s apparatus 200

to remove the need for a wire connecting the apparatus 200 to game controller 240 and improve similar hand-held communication devices in the same way.

104. Given Woolston discloses that apparatus 200 may be powered via batteries instead of relying on power received from the game controller via a wired interface, a person of ordinary skill would have understood that relying on a purely wireless connection between the sword and game controller would not have impacted the apparatus 200's power supply or otherwise rendered it inoperable. Ex. 1005, *Woolston* at 6:38-39 ("it is within the scope of the present invention to draw power from batteries"). Moreover, a person of ordinary skill would understand making Woolston's apparatus wireless would not in any way impact the interactive game system's principle of operation. Therefore, there would have been a reasonable expectation of success when modifying apparatus 200 to include a wireless transmitter for transmitting signals.

2. "a receiver for receiving signals"

105. Claims 32, 49, and 50 recite the limitation, "a first hand-held communication device comprising: . . . a receiver for receiving signals." As discussed above, Weston describes a hand-held wand device able "to electronically send and receive information to and from . . . a master system" using a "battery powered RF transponder" or "a battery-operated infrared LED transmitter and receiver." Ex. 1006, *Weston* at Abstract, [0049], [0046] ("This transponder basically



comprises a passive (non-battery-operated) RF transmitter/receiver chip 340 and an antenna 345 provided within an hermetically sealed vial 350.”); *see also*, ¶¶83-84.

106. Woolston discloses that apparatus 200 “receive[s] data signals from the game controller 240” and expressly suggests utilizing a “wireless . . . control signal to provide an interface between the sword apparatus and the game controller 240.” Ex. 1005, *Woolston* at 6:47-54. Woolston does not expressly state that the data signals received from the game controller 240 are received via the wireless interface. However, Woolston’s express suggestion to enable wireless communications between the apparatus 200 and game controller 240 would have motivated a person of ordinary skill to include a receiver, such as taught by Weston, in Woolston’s apparatus 200 to wirelessly receive the data signals from the game controller.

107. Again, a person of ordinary skill would have understood that enabling Woolston’s apparatus 200 to receive data signals wirelessly via a receiver would have been an advantageous way to avoid the need for a wire connecting the apparatus 200 to the game controller 240 thereby allowing the user more freedom of movement. For the reasons discussed above, this modification would have predictably enhanced the user’s game experience and increased satisfaction. *See*, ¶¶100-103. Therefore, a person of ordinary skill would have been motivated to include Weston’s receiver for receiving signals in Woolston’s apparatus 200 to

remove the need for a wire connecting the apparatus 200 to game controller 240 and improve similar hand-held communication devices in the same way.

108. For the reasons discussed previously, modifying the apparatus 200 to be wireless would not have changed the game system's principle of operation or otherwise rendered it inoperable for its intended purpose. *See*, ¶104. Therefore, there would have been a reasonable expectation of success when modifying Woolston's apparatus 200 to include a wireless receiver for receiving signals.

3. *“for wirelessly receiving the signals transmitted by the transmitter” and “adapted to wirelessly receive the signals transmitted by the transmitter”*

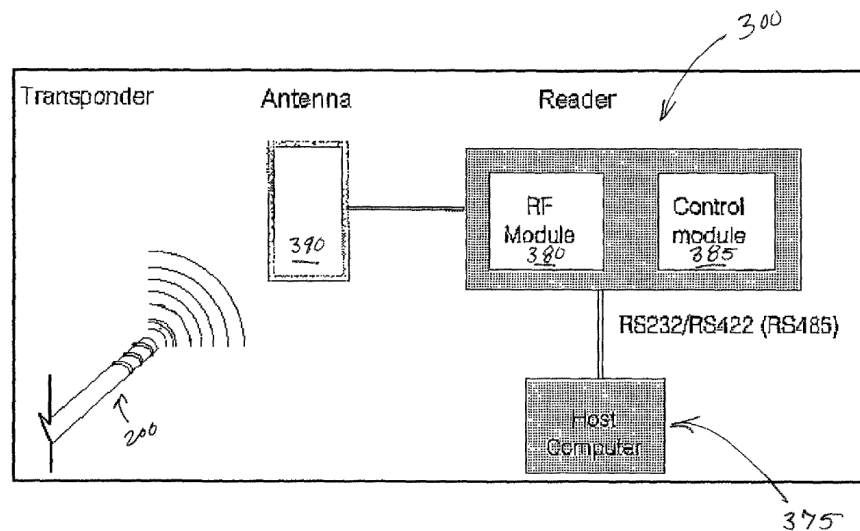
109. Claim 32 recites the limitation, “a processing system . . . for wirelessly receiving the signals transmitted by the transmitter.” Claims 49 and 50 similarly recite, “a processing system . . . adapted to wirelessly receive the signals transmitted by the transmitter.” As I discussed above, Woolston's game controller 240 (i.e., “processing system”) is coupled to IR receivers 210, 220, 230 that receive signals output by IR transmitters 300, 302, 304 “whereupon the timing and/or phase differential of the received signals may be used to triangulate and determine the spatial position of the sword apparatus.” Ex. 1005, *Woolston* at 3:55-4:1, 9:39-46, Fig. 3; *see also*, ¶62. In my opinion, this disclosure alone satisfies the requirement for a processing system “[adapted to] wirelessly [receiving/receive] the signals transmitted by the transmitter.”

110. However, I have also been asked to opine as to whether it would have been obvious to a person of ordinary skill to include a wireless RF transceiver, such as taught by Weston, in Woolston's game controller 240 for enabling bi-directional, wireless communications with the apparatus 200. For the reasons explained below, this would have been an obvious modification to Woolston's game controller 240.

111. Again, Woolston describes enabling the apparatus 200's microprocessor circuit 499 to use "wireless analog and/or digital control signal to provide an interface between the sword apparatus and the game controller 240." Ex. 1005, *Woolston* at 6:50-54. Thus, Woolston discloses communicating control signals between apparatus 200 and game controller 240 via a wireless interface, but Woolston does not provide the specific details of this interface, such as whether it is bi-directional, for example.

112. Weston's interactive game system includes a wand enabling long-range transmissions via a RF transmitter device in order "to electronically send and receive information to and from . . . a master system" *Id.* at [0010]; Abstract; *see also*, ¶¶83-84, ¶97. The master system or master control system 375 as it is also known, includes a transceiver (i.e., transmitter and receiver) 300 that receives wireless signals transmitted by the wand's transmitter. *Id.* at [0049] ("[T]he wand 200 may also be configured for long range communications with one or more of the transceivers 300 (or other receivers)."), [0064] ("[T]he transceivers 300 may or may

not be connected to a master control system or central server 375 (FIG. 3). If a master system is utilized, preferably each wand 200 . . . is configured to electronically send and receive information to and from various receivers or transceivers 300 distributed throughout the play facility 100 using a send receive radio frequency (“SRRF”) communication protocol.”)



**Fig. 3**

*Id.* at Fig. 3.

113. It would have been obvious to a person of ordinary skill in the art to – like Weston – include a transceiver in Woolston’s game controller 240 to enable it to wirelessly receive the signals transmitted by the apparatus 200. As I discussed above, a person of ordinary skill would understand that the attitude/location signals output by the apparatus 200’s inertial sensing system (discussed above at ¶64) would need to be transmitted to the game controller 240 prior to its use by the game

controller software. Ex. 1005, *Woolston* at 3:49-54 (“The gyroscopic inertial positioning system may keep the computer game apprised of the spatial attitude and/or location of the sword apparatus in such a way that the game may provide the proper moments of torque on the motors to provide feedback to the player.”); 15:65-16:2 (“The game controller 240 may track the position and attitude of sword apparatus 200. The positional and attitude information may be used by the game controller software to project and track the virtual blade 1006”).

114. Considering Woolston’s express suggestion to utilize a “wireless . . . control signal to provide an interface between the sword apparatus [200] and the game controller 240” a person of ordinary skill would have been motivated to modify the game controller 240 to include a wireless transceiver, such as taught by Weston, to receive signals, such as the attitude signals discussed above, transmitted by the apparatus 200. Moreover, utilizing a wireless transceiver receiving signals would have been a reliable and predictable way for the apparatus 200 to communicate with the game controller 240.

115. For the reasons discussed above, a person of ordinary skill would have understood that enabling Woolston’s game controller 240 to receive data signals wirelessly via a transceiver would have been an advantageous way to avoid the need for a wire connecting the apparatus 200 to the game controller 240 thereby allowing the user more freedom of movement, which would have predictably enhanced the

user's game experience and increased satisfaction. *See*, ¶¶100-103. As such, a person of ordinary skill would have been motivated to include Weston's transceiver for receiving signals in Woolston's game controller 240 to remove the need for a wire connecting the apparatus 200 to game controller 240 and improve similar interactive game systems in the same way.

116. A person of ordinary skill would further understand that making Woolston's game controller 240 wireless would not in any way impact the interactive game system's principle of operation or render it inoperable for its intended purpose. Therefore, there would have been a reasonable expectation of success when modifying game controller 240 to include a transceiver for wirelessly receiving signals transmitted by the transmitter of apparatus 200.

4. "a second hand-held communication device, in wireless communication with the processing system said second hand-held communication device, comprising a transmitter for transmitting signals"

117. Claim 32 recites the limitation, "a second hand-held communication device, in wireless communication with the processing system said second hand-held communication device, comprising a transmitter for transmitting signals." Claim 50 similarly recites, "a second hand-held communication device, the second hand-held communication device comprising a transmitter for transmitting signals."

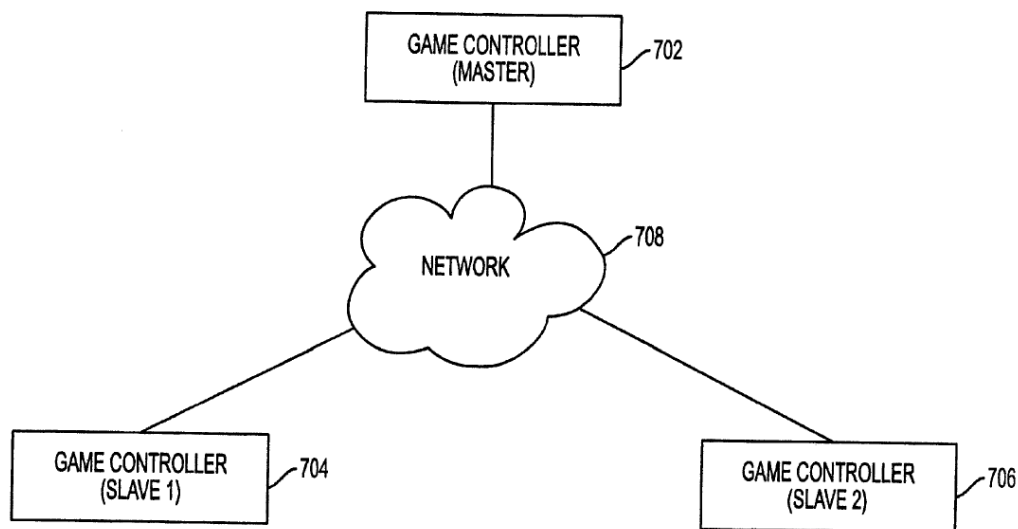
118. Woolston's interactive game system supports a networked, multiplayer mode – including a two-player mode – "allow[ing] virtual sword fights between

multiple players and/or the coordinated efforts of multiple participants.” Ex. 1005, *Woolston* at 5:8-13. Among other things, the position, attitude, velocity of each player’s respective sword device/apparatus 200 is periodically transmitted from a local game station/controller to a master game controller:

FIG. 9A shows the game controllers of the present invention in a network configuration. Game controller 702 may be configured as the master and game controllers 704 and 706 may be in a slave configuration.

A network 708 is shown which may be a TCP/IP network such as the Internet. In the master configuration, the game station programmed as the master sends, receives and coordinates the information transfer from the “slave” configured stations. Information may be transferred between the stations using the communication data packet shown in FIG. 9B. The communication packet provides a terminal identification 750, position information for a sword apparatus 752, attitude information for a sword apparatus 754, velocity information for a sword apparatus 756, resultant force vector information 758 and sword parameter information 760. The slave configured game station may periodically send this information packet to the master configured game controller.

*Id.* at 15:29-46.



*Id.* at Fig. 9A.

Telemetry between the game stations may be used to convey positional, attitudinal and inertial mass, explained further below, of the respective sword devices between game stations.

*Id.* at 5:13-16.

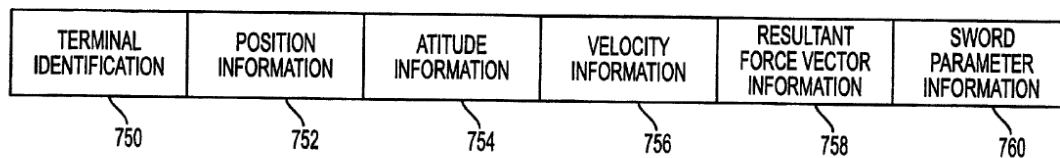


FIG. 9B

*Id.* at Fig. 9B.

119. Thus, in the multi-player mode, each player has a respective apparatus 200 – for example, a first player has the first apparatus 200 and a second player has a second apparatus 200. As I explained above, Woolston’s apparatus 200 is hand-



held and includes a communication interface. *See*, ¶58, ¶68. Therefore, Woolston discloses a second hand-held communication device.

120. As shown above, each game controller transmits its respective apparatus 200's position, attitude, and velocity. As discussed above, Woolston's apparatus 200 includes IR transmitters 300, 302, 304 that "output a pulse and/or timed emission of infrared light which may then be received at the remote sensors . . . whereupon the timing and/or phase differential of the received signals may be used to triangulate and **determine the spatial position of the sword apparatus.**" *Id.* at 3:60-4:1 (emphasis added); *see*, ¶94. A person of ordinary skill in the art would understand that every apparatus 200 in Woolston's game system, including the second apparatus 200, would operate the same way and would therefore include IR transmitters 300, 302, 304 transmitting IR signals used for position tracking.

121. Alternatively, it would have been obvious to a person of ordinary skill in the art to – like Weston – include a transmitter for transmitting signals in Woolston's second apparatus 200 for the same reasons as discussed above with regard to the first apparatus 200. *See*, ¶¶95-104.

122. Woolston does not disclose a local multiplayer embodiment where each apparatus 200 communicates directly with the same game controller 240 (i.e., "the processing system"). Therefore, Woolston does not disclose that the second apparatus 200 is "in wireless communication with the processing system."

However, this limitation would have been obvious in view of the teachings of Weston.

123. In Weston's interactive game system, multiple wand devices (i.e., handheld communication devices) wirelessly communicate with the same master control system. In Weston's system, "multiple play participants, each provided with a suitable 'wand' and/or tracking device, may play and interact together, either within or outside the play environment . . . ." Ex. 1005, *Weston* at [0007]. The play environment may be a local, computer/TV generated environment. *Id.* ("The play environment may either be real or imaginary (i.e. computer/TV generated), and either local or remote, as desired."). Each wand "enabl[es] a trained user to electronically send and receive information to and from other wand toys and/or to and from various transceivers . . . connected to a master control system." *Id.* at [0008]; *see also, id.* at [0067] ("A typical entertainment facility provided with SRRF technology may allow 300-400 or more users to more-or-less simultaneously send and receive electronic transmissions to and from the master control system using a magic wand or other SRRF-compatible tracking device.").

124. Based on the teachings of Weston, it would have been obvious to a person of ordinary skill in the art to modify Woolston's system to enable both the first and second apparatuses 200 to wirelessly communicate directly with the same game controller 240. As I explained above, local multiplayer was a common feature

of most videogame systems prior to the '354 Patent, and users would have expected this feature to be available on Woolston's game system.

125. Additionally, a person of ordinary skill would have understood that the local multiplayer implementation would not suffer from the same network latency problems as the networked multiplayer implementation. Networked games – especially real-time or “twitch” games – were (and still are) especially sensitive to high network latency and variations in latency due to the rapid occurrence of events in the game. *See, e.g., Ex. 1024, Roelofs* at 1:47-60 (“In the context of real-time games, latency becomes an important attribute for the real-time play of ‘twitch’ games. Twitch games are games that require split-second game control by players and cannot tolerate arbitrary communication latencies or delays. Twitch games are by far the most popular category of retail video games-some popular twitch games include ‘Doom’™, ‘Mortal Kombat™, ‘John Madden Football™,’ ‘Sonic the Hedgehog™,’ and ‘Super Mario Brothers™’. Typically, twitch games require less than 100 millisecond communications latency (i.e. delay for a player’s action to take effect on the screen) in order for the games to be playable. In addition, twitch games usually cannot tolerate **varying** delays in communications latency.”) (emphasis added).

126. It was understood that high network latency or variations in latency would severely impact the game’s performance, playability, and consistency

between the players. *Id.*; *see also, id.* at 2:1-8 (“ The different latencies between users can create a number of problems to real time and, at times, non real time games. In particular, players having different latencies can experience different results due to the latencies. For example, a low latency player may take an action with respect to a high latency player, and the high latency player may then take an inconsistent action before experiencing the action of the high latency player.”).

127. Enabling Woolston’s game controller 240 to wirelessly communicate directly with two local apparatuses 200 would have completely alleviated these problems and predictably made the system more responsive and consistent, and less prone to failures. For these reasons, a person of ordinary skill would have been motivated to enable the game controller 240 to wirelessly communicate directly with both the first and second apparatuses 200 in order to improve similar game systems in the same way.

128. A person of ordinary skill would have also understood that enabling the game controller 240 to wirelessly communicate with both the first and second sword apparatuses 200 would not have changed the principle of operation of Woolston’s interactive game system. Namely, this modification would have still resulted in an interactive game system enabling players to input velocity and position information into an electronic game and receive physical feedback. *See, Ex. 1005, Woolston* at 1:5-9. Therefore, there would have been a reasonable expectation of success when

enabling the second apparatus 200 to wirelessly communicate directly with the game controller 240 (i.e., “the processing system”).

5. “wherein the processing system is adapted to determine movement information of the second hand-held communication device”

129. Claim 32 recites the limitation, “wherein the processing system is adapted to determine movement information of the second hand-held communication device.” As discussed above, in Woolston’s multiplayer embodiment, the master game controller periodically receives information packets including each apparatus 200’s current position, attitude, and velocity. *See*, ¶118. The master game controller uses this information “to generate a virtual opponent having a virtual sword representation that is mapped into the game space.” Ex. 1005, *Woolston* at 15:47-49.

130. For the reasons discussed above, it would have been obvious to a person of ordinary skill to modify Woolston’s game controller 240 to wirelessly communicate directly with both the first and second apparatuses 200 in order to enable a local, multiplayer embodiment. *See*, ¶¶122-128. A person of ordinary skill in the art would understand that the game controller 240 would need to determine the movement information of the second apparatus 200 in order to generate the virtual opponent/virtual sword. Additionally, a person of ordinary skill would expect the game controller 240 to perform the same routines for both the first and

second handheld apparatuses 200 to ensure that each player has a consistent gameplay experience. For these reasons, a person of ordinary skill would have been motivated to enable the game controller 240 to determine the position, attitude, and velocity of the second apparatus 200 in the same way as this information is determined for the first apparatus 200 (discussed above at ¶¶62-64, ¶¶69-70).

131. This modification would have predictably resulted in the game controller 240 determining the position, attitude, and velocity of both the first and second apparatuses 200 thereby enabling two local players to participate in a virtual sword battle game. Therefore, there would have been no change to Woolston's principle of operation and there would have been a reasonable expectation of success.

6. *“wherein the system is interactive and responds to verbal command input from the user”*

132. Claim 50 recites the limitation, wherein the system is interactive and responds to verbal command input from the user.” Woolston does describe “an electronic interactive sword game,” but does not specifically describe enabling verbal inputs from the user. Ex. 1005, *Woolston* at 2:44. Weston also teaches a similar interactive game system including a hand-held wand device “configured to respond to other signals such as . . . voice commands as will be readily apparent to those skilled in the art.” Ex. 1006, *Weston* at [0050].

133. In my opinion, it would have been obvious to a person of ordinary skill in the art to similarly enable Woolston's interactive game system to respond to voice/verbal commands input from the user as taught by Weston. As I discussed with regard to the Background of the Technology above, interactive motion tracking systems enabling the user to enter voice commands were well-known prior to the '354 Patent. *See*, ¶45. Additionally, allowing the user to input verbal commands to interact with video game systems was also very well known. *See*, ¶¶86-88.

134. The benefits of enabling the user to interact with computer systems via verbal commands were also well established. For example, Wang, which was filed in the late 1990s, acknowledges that voice recognition technology was already being applied in video game systems to improve user-friendliness and reduce frustrations associated with the user inadvertently pressing the wrong button while engrossed in gameplay. Ex. 1007, *Wang* at 1:14-24 (“However, the various setup and functions of the control buttons vary from game to game. This is obviously not user-friendly as it requires the user to remember different functions for each control button depending on which program is being used. Also, while engrossed in game play, a user may inadvertently press the wrong button as he is unable to watch the keypad and the screen at the same time. This disrupts game play and causes user frustration. With the advent of voice recognition technology, it can be applied to solve the above mentioned problem.”).

135. A person of ordinary skill would have understood that in order to play Woolston's virtual sword fighting game, the user would need to rapidly move the apparatus 200 around when battling an opponent. Enabling Woolston's system to respond to verbal commands input from the user as taught by Weston would have provided a convenient way for the user to interact with the game while swinging the sword. Specifically, using verbal commands would allow the user to control the system without taking their finger or hands off the sword or eyes off the display, and would reduce or eliminate any cognitive load associated with remembering and accurately affecting button combinations.

136. Moreover, this modification would have further enhanced the interactivity of Woolston's system and created a more immersive system for the user, as they could remain "in the game" as opposed to invoking or exiting to a menu system of control.

137. For these reasons, a person of ordinary skill would have been motivated to modify Woolston's system to respond to verbal commands input from the user as taught by Weston.

138. This modification would not have in any way changed the principle of operation of Woolston's system or otherwise rendered it inoperable for its intended purpose. Therefore, there would have been a reasonable expectation of success



when modifying Woolston's system to respond to verbal commands input by the user as taught by Weston.

### **C. Combination of Woolston, Weston, and Wang**

139. Claim 33 recites the limitation, "wherein the system is interactive and responds to verbal command input from the user to modulate an activity." I have been informed that Petitioners are interpreting the limitation "to modulate an activity" to at least include "to vary any attribute of an activity." I have applied this interpretation in my analysis below.

140. For the reasons discussed above, it would have been obvious to modify Woolston's interactive game system to respond to verbal commands input from the user as taught by Weston. *See*, ¶¶132-138. Additionally, Wang teaches a video game system that enables the user to vary attributes of a game using verbal commands. Specifically, Wang acknowledges that "while engrossed in game play, a user may inadvertently press the wrong button as he is unable to watch the keypad and the screen at the same time . . . [which] disrupts game play and causes user frustration." Ex. 1007, *Wang* at 1:19-22. This is exactly the sort of cognitive load issue that I describe above (remembering and accurately affecting button combinations). *See*, ¶135. To solve this problem, Wang discloses a voice control module where a user speaks into a microphone and "the input voice signals are compared with pre-existent commands stored in the memory." *Id.* at 1:31-35. If the

input voice signal matches a stored command, “the corresponding command will be executed.” *Id.* at 1:35-37. Examples of commands include “switch command 64 ‘change weapon’ corresponds to the game command file 68 which contains game commands such as ‘rocket’ and ‘machine gun’, and the switch command 66 ‘change vehicle’ corresponds to a game command file 70 which contains game commands such as ‘motorboat’ and ‘helicopter’.” *Id.* at 4:24-30; *see also, id.* at Fig. 5. Thus, Wang’s voice control module responds to verbal commands input from the user to vary attributes of the game (i.e., “activity”), such as changing a selected weapon or vehicle.

141. It would have been obvious to a person of ordinary skill to enable Woolston’s system to vary attributes of the game based on verbal commands input from the user as taught by Wang. A person of ordinary skill would have understood that a user of Woolston’s game system would similarly be engrossed in the virtual battle and would benefit from verbal input of commands to vary attributes of the game, such as changing a selected weapon. Therefore, enabling the user of Woolston’s game system to vary attributes of the game (e.g., change the weapon used) via verbal commands, as taught by Wang, would predictably reduce user frustrations. For these reasons, a person of ordinary skill would have been motivated to modify Woolston’s game system to include a similar voice control module to improve similar video game systems in the same way.

142. This modification would not have in any way changed the principle of operation of Woolston's system or otherwise rendered it inoperable for its intended purpose. Therefore, there would have been a reasonable expectation of success when modifying Woolston's system to vary attributes of the game based on verbal commands input from the user.

**E. Combination of Woolston, Weston, and Glynn**

1. *“the first hand-held communication device comprises a user input device adapted for communication with the processing system through the transmitter”*

143. Claim 56 recites the limitation, “the first hand-held communication device comprises a user input device adapted for communication with the processing system through the transmitter.”

144. Glynn describes a motion tracking system where the user provides inputs to a computer via the movement of a wireless, handheld mouse. Ex. 1008, *Glynn* at Abstract, 2:62-68. Glynn's mouse includes “a plurality of push-buttons 4, 5 and 6 for additional interaction of the operator with the host computer system.” *Id.* at 5:26-28. “The push-buttons may be used, for example, to provide special command signals to the computer . . . [that] are transmitted through the interface ports 7-12 . . . to the computer.” *Id.* at 5:28-32. Interface ports 7-12 are wireless transceivers used to transmit data to “transceiver 22 associated with a computer 23.” *Id.* at 6:32-37, Fig. 3. Thus, Glynn teaches push-buttons 4, 5 and 6 (i.e., user input

devices) adapted for communication with the computer (i.e., processing system) through transceivers 7-12.

145. It would have been obvious to a person of ordinary skill to modify Woolston's apparatus 200 to include pushbuttons used to provide command signals to the game controller 240 through the transmitter, as taught by Glynn. As acknowledged by Glynn, a person of ordinary skill would understand that a user would need to interact with the software running on Woolston's game controller 240 in more ways than just via the movements of apparatus 200. For example, the user would need a way to communicate game menu selections, to pause or end the game, etc. A person of ordinary skill would understand that pushbuttons and voice control (above) would offer complementary mechanisms for communicating with a game controller. For example, whereas voice commands would be useful for game control as described above, a pushbutton would be a simple and effective means to activate the "light saber" described by Woolston. Therefore, a skilled artisan would have been motivated to modify Woolston's apparatus 200 to include pushbuttons adapted to communicate with the game controller 240 through the transmitter.

146. Pushbuttons, such as taught by Glynn, were a common and predictable way of providing inputs to game systems for many years prior to the '354 Patent. *See, e.g.*, ¶50. Therefore, there would have been a reasonable expectation of success when modifying Woolston's apparatus 200 in this way.

2. “wherein: the user input device is adapted for calibrating the first communication device to establish a reference position”

147. Claim 57 recites the limitation, “wherein: the user input device is adapted for calibrating the first communication device to establish a reference position.” Woolston expressly discloses, “It is understood that the game has a suitable calibration mode for configuring the sensor array.” Ex. 1005, *Woolston* at 9:46-47. Woolston also discusses “encourage[ing] the player to re-center the sword 200 and/or to keep the sword 200 in a predetermined playing field of the game.” *Id.* at 9:36-39. However, Woolston does not provide specific details for the calibration or re-centering processes.

148. As I discussed above, Glynn teaches using pushbuttons to provide special command signals to the computer. *See*, ¶144. One such pushbutton command causes “the system to reset the zero reference point from which the relative position and attitude of the mouse 1 is measured.” Ex. 1008, *Glynn* at 5:47-50. Since Glynn’s “zero reference point” includes both a position and attitude, it encompasses a “reference position.” Establishing a “zero-reference point” as described by Glynn is useful because it establishes the starting position and attitude (e.g., which direction is “up” and “to the right”) from which the integration employed by Glynn proceeds. All systems that carry out some form of integration must do so from some starting point.

149. It would have been obvious to a PHOSITA to include a pushbutton on Woolston's sword adapted for calibrating the sword to establish a zero-reference point as taught by Glynn. Woolston describes one inventive feature is to "use sensors, e.g., a receiver and/or a transmitter, *on* the sword apparatus and an array of sensors, e.g., receivers and/or transmitters, *external* and/or internal to the sword apparatus to determine the spatial attitude and/or location of the sword apparatus." Ex. 1005, *Woolston* at 3:55-60 (emphasis added). A person of ordinary skill would understand that if an embodiment employs sensing components (receivers and/or transmitters) that are *external* to the sword, e.g., fixed in the environment, the attitude and/or location of the sword will always be estimated with respect to the environment. Without a calibration to establish a zero-reference point as taught by Glynn, the game could start with the virtual opponent appearing *behind* the user, for example. In contrast, a calibration of a Woolston device to establish a zero-reference point (with respect to the external environment) would allow the system to "re-center the sword" as described by Weston—to always place the virtual opponent in front of the user, no matter which way the user is actually facing when they start the game.

150. Moreover, allowing the user to press a button to re-calibrate the reference position ensures that the user is able to easily recalibrate the system as needed. For these reasons, a person of ordinary skill would have been motivated to modify Woolston's apparatus 200 to include a pushbutton adapted for calibrating

the sword to establish a zero-reference point to enable the user to easily calibrate the position tracking system and ensure proper operation of the game system.

151. A skilled artisan would have appreciated that this modification would not have changed Woolston's principle of operation or rendered it inoperable. As discussed above, Woolston expressly discloses the need to calibrate the position tracking system and re-center the sword. Therefore, there would have been a reasonable expectation of success when implementing Glynn's reference point calibration process in Woolston's interactive game system.

**F. Combination of Woolston, Daniel, and Glynn**

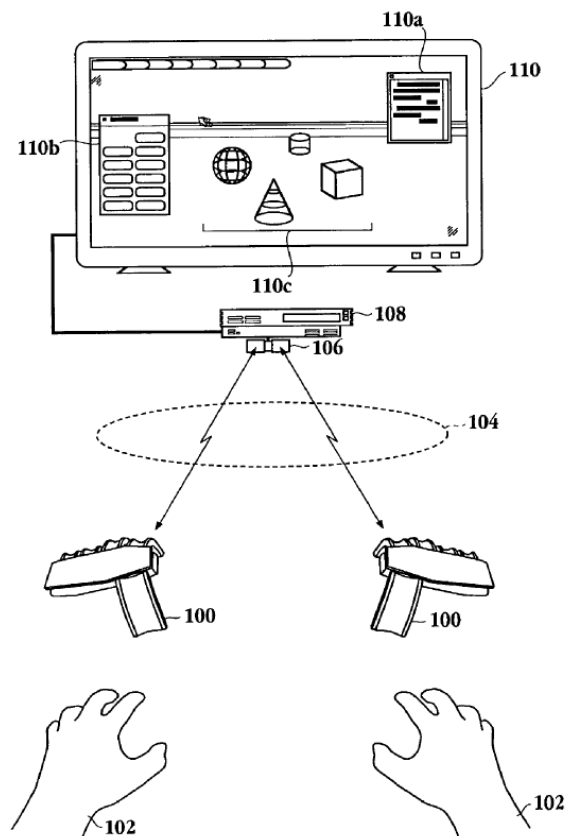
*1. "a transmitter for transmitting signals"*

152. Claims 63 and 72 recite the limitation, "a first hand-held communication device comprising: a transmitter for transmitting signals." As I discussed above, Woolston alone satisfies the requirement for "a transmitter transmitting signals." *See*, ¶94.

153. However, I have also been asked to opine as to whether it would have been obvious to a person of ordinary skill to include a transmitter for transmitting signals, such as taught by Daniel, in Woolston's apparatus 200 for enabling wireless communications with the game controller 240. For the reasons explained below, this would have been an obvious modification to Woolston's apparatus 200.

154. First, Woolston describes enabling the apparatus 200's microprocessor circuit 499 to use "wireless analog and/or digital control signal to provide an interface between the sword apparatus and the game controller 240." Ex. 1005, *Woolston* at 6:50-54. Thus, Woolston discloses communicating control signals between apparatus 200 and game controller 240 via a wireless interface, but Woolston does not provide the specific details of this interface, such as whether it is bi-directional, for example.

155. Daniel describes a hand-held communication device 100 including a transmitter/receiver 118 that transmits signals from sensors 114 to a computing device 108:





Ex. 1009, *Daniel* at Fig. 2.

Line extensions 114a-114e are configured to sense the flex or degree of bend of a finger or thumb. The flex or degree of bend is communicated to transmitter/receiver 118 where the signal is translated into a command that is subsequently transmitted to a computing device in one embodiment. Of course, the signal can be communicated directly to transmitter/receiver 118 without being translated.

*Id.* at [0038].

156. It would have been obvious to a person of ordinary skill in the art to – like Daniel – include a transmitter in Woolston’s apparatus 200 to enable it to wirelessly transmit signals to the game controller 240. For example, a person of ordinary skill would understand that the attitude/location signals output by the apparatus 200’s inertial sensing system (discussed above at ¶64) would need to be transmitted to the game controller 240 prior to its use by the game controller software. Ex. 1005, *Woolston* at 3:49-54 (“The gyroscopic inertial positioning system may keep the computer game apprised of the spatial attitude and/or location of the sword apparatus in such a way that the game may provide the proper moments of torque on the motors to provide feedback to the player.”); 15:65-16:2 (“The game controller 240 may track the position and attitude of sword apparatus 200. The positional and attitude information may be used by the game controller software to project and track the virtual blade 1006”).

157. Considering Woolston’s express suggestion to utilize a “wireless . . . control signal to provide an interface between the sword apparatus [200] and the

game controller 240” a person of ordinary skill would have been motivated to include a wireless transmitter, such as taught by Daniel, to transmit sensor signals, such as the attitude signals discussed above, to the game controller 240. As I discussed above in the Background of the Technology, handheld communication devices including wireless transceivers used to send and receive signals to/from a remote computing device were already well-known at the time of the '354 Patent. *See*, ¶46. Thus, utilizing a wireless transmitter transmitting signals would have been a reliable and predictable way for the apparatus 200 to communicate with the game controller.

158. Additionally, modifying Woolston’s apparatus 200 to communicate with the game controller 240 via a wireless transceiver instead of a wired interface (e.g., USART), would have permitted the user more freedom of movement when moving apparatus 200 to interact with the game. The benefits of not hindering the user’s movements with wires was well-known tenant in the field of motion tracking systems well prior to the '354 Patent. *See*, ¶100. Even the '354 Patent references prior art motion tracking systems utilizing “wireless communication means to remotely transmit and process the information and allow for greater mobility and range of movement.” Ex. 1001, '354 Patent at 1:33-37.

159. A person of ordinary skill would have understood that modifying Woolston’s apparatus 200 to wirelessly transmit signals using a transmitter as taught

by Daniel would have been an advantageous way to avoid the need for a wire connecting the sword to the game controller thereby allowing the user more freedom of movement.

160. A person of ordinary skill would have also understood that allowing the user to freely move the apparatus 200 during gameplay – without the hindrance caused by a wire connecting the apparatus 200 to the game controller 240 – would have predictably enhanced the user’s gameplay experience and led to increased satisfaction. As such, a person of ordinary skill would have been motivated to include Daniel’s transmitter for transmitting signals in Woolston’s apparatus 200 to remove the need for a wire connecting the apparatus 200 to game controller 240 and improve similar hand-held communication devices in the same way.

161. Given Woolston discloses that apparatus 200 may be powered via batteries instead of relying on power received from the game controller via a wired interface, a person of ordinary skill would have understood that relying on a purely wireless connection between the sword and game controller would not have impacted the apparatus 200’s power supply or otherwise rendered it inoperable. Ex. 1005, *Woolston* at 6:38-39 (“it is within the scope of the present invention to draw power from batteries”). Moreover, a person of ordinary skill would understand making Woolston’s apparatus wireless would not in any way impact the interactive game system’s principle of operation. Therefore, there would have been a

reasonable expectation of success when modifying apparatus 200 to include a wireless transmitter for transmitting signals.

2. “a receiver for receiving signals”

162. Claims 63 and 72 recite the limitation, “a first hand-held communication device comprising: . . . a receiver for receiving signals.” Daniel teaches a first input device 100 including a receiver 118 is used “**for receiving signals** from an external device, such as computing device 108 of FIG. 2.” Ex. 1009, *Daniel* at [0036]; [0033] (“For exemplary purposes, communication of the radio signals can be done using standards such as BLUETOOTH, or other suitable wireless technology (e.g., such as IEEE 802.11).”); Figs. 2-3, [0045].

163. Woolston discloses that apparatus 200 “receive[s] data signals from the game controller 240” and expressly suggests utilizing a “wireless . . . control signal to provide an interface between the sword apparatus and the game controller 240.” Ex. 1005, *Woolston* at 6:47-50, 6:58-62. Woolston does not expressly state that the data signals received from the game controller 240 are received via the wireless interface. However, Woolston’s express suggestion to enable wireless communications between the apparatus 200 and game controller 240 would have motivated a person of ordinary skill to include a receiver, such as taught by Daniel, in Woolston’s apparatus 200 to wirelessly receive the data signals from the game controller.

164. Again, a person of ordinary skill would have understood that enabling Woolston's apparatus 200 to receive data signals wirelessly via a receiver would have been an advantageous way to avoid the need for a wire connecting the apparatus 200 to the game controller 240 thereby allowing the user more freedom of movement. For the reasons discussed above, this modification would have predictably enhanced the user's game experience and increased satisfaction. *See*, ¶¶158-160. Therefore, a person of ordinary skill would have been motivated to include Daniel's receiver for receiving signals in Woolston's apparatus 200 to remove the need for a wire connecting the apparatus 200 to game controller 240 and improve similar hand-held communication devices in the same way.

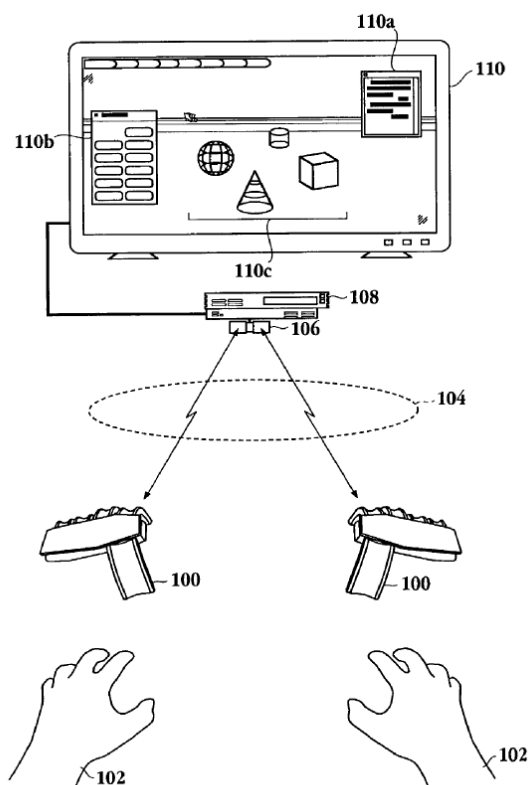
165. For the reasons discussed previously, modifying the apparatus 200 to be wireless would not have changed the game system's principle of operation or otherwise rendered it inoperable for its intended purpose. *See*, ¶104. Therefore, there would have been a reasonable expectation of success when modifying Woolston's apparatus 200 to include a wireless receiver for receiving signals.

3. *“a second hand-held communication device adapted to electrically communicate with the first communication device, and adapted for being attached to, in contact with, or held by the user, the second hand-held communication device comprising a transmitter for transmitting signals”*

166. Claims 63 and 72 recite the limitation, “a second hand-held communication device adapted to electrically communicate with the first

communication device, and adapted for being attached to, in contact with, or held by the user, the second hand-held communication device comprising a transmitter for transmitting signals.”

167. Daniel teaches a video game system where the user holds both a first input device in one hand and a second input device 100 in the other hand:



Ex. 1009, *Daniel* at Fig. 2; [0033] (“External input device 100 is configured to be held within the palm of a user’s hand 102. . . . In one embodiment device 108 can be a computer, or a game console which can be manufactured by any company.”)

168. Each input device 100 is a communication device including transmitter/receiver 118. *Id.* at [0038], Fig. 3. Daniel teaches a single user controlling a game using both a first and second input device:

For instance, for a game where the user is a pilot, a folded sheet of plastic can be used to simulate the cockpit controls (e.g., the instrument panel can be printed on the plastic or other material), and the user can be wearing the input devices on each hand to enable piloting of the airplane or other vehicle or device. A display monitor connected to a computer, or game unit, allows the user to view the interactions. . . . A combination of fingertip pressure, positional tracking, and tactile feedback can be used to interact with the game. . . . The game detects the user gripping the controls by a combination of fingertip pressure and finger flex information and then tracks the motion and/or orientation of the hand to interpret the manipulation of the physical controls.

*Id.* at [0043].

169. It would have been obvious to a person of ordinary skill to modify Woolston's system to allow the user to hold a first apparatus 200 in his/her first hand and a second apparatus 200 in his/her second hand as taught by Daniel. In general, a person of ordinary skill would have appreciated the usefulness of two-handed computer interaction techniques, which have been studied and employed at least since the early 1980s. *See, e.g.,* Ex. 1025, *Buxton*. In addition to a sword configuration, Woolston also teaches configuring the handheld interface device to be a "a gun, bazooka, knife, hammer, axe and the like." Ex. 1005, *Woolston* at 3:35-41. A skilled artisan would have appreciated that giving the user the ability to

interact with the game using multiple weapons would have predictably made the game more versatile and interesting for the user thereby increasing user satisfaction.

170. Moreover, a person of ordinary skill would have appreciated that allowing the user to play other types of games, such as the airplane/vehicle piloting game taught by Daniel, would have further improved Woolston's game system. Therefore, a person of ordinary skill would have been motivated to modify Woolston's game system to enable the user to interact with the game using both a first and second hand-held communication device as taught by Daniel.

171. Regarding the requirement for a second hand-held communication device "adapted to electrically communicate with the first communication device," I have been informed that Motiva contends this limitation should be construed to mean "[a]ble to transmit or receive information electrically, including wirelessly" and that Motiva's infringement allegations imply that this limitation is satisfied when game inputs from one hand-held device are used by the software on the game console to generate haptic response commands sent to the other hand-held device. I have applied this interpretation in my analysis below.

172. In Daniel's system, "each of input devices 100 is enabled to communicate with computing device 108 through receiver 106." Ex. 1009, *Daniel* at [0034]. And, "[e]ach of input devices 100, of FIG. 2, is configured to generate commands 104 in response to a user's hand movements." *Id.* at [0035]. The



commands are received by the receiver 106 of the computing device 108 and used “to initiate a command, respond to a query, maneuver objects in an interactive video game, etc.” *Id.* at [0035]. The computing device 108 also generates tactile feedback responses that are sent to the user input devices 100. *Id.* at [0048]-[0049].

173. Based on the teachings of Daniel, it would have been obvious to a person of ordinary skill to enable Woolston’s game controller 240 to generate tactile feedback responses for the first hand-held device based on the inputs received from the second handheld device. When implementing Daniel’s airplane/piloting game (*id.* at [0043]) on Woolston’s game system, for example, if an input provided by the second hand-held device results in a game event such as a crash or explosion, it would have been obvious to enable the game controller software to generate a tactile feedback response sent to both the first and second handheld devices in order to simulate such a game event thereby enabling the second device to electrically communicate with the first device via the game controller. For these reasons, a person of ordinary skill would have been motivated to modify Woolston’s system in this way in order to improve similar interactive game systems in the same way.

174. For example, with respect to Woolston’s game system, a person of ordinary skill would appreciate that a single user could use two swords at the same time—one in each hand. In a situation where the two swords hit each other (e.g., the user taps them together in a crossing motion, forming an “X” pattern), the two

Swords would “bounce” off each other with an idealized impact.” as indicated by Woolston. Ex. 1005, *Woolston* at 11:32-35. To match the real life transmission of forces from the left sword to the right, and the right sword to the left, a person of ordinary skill would have been motivated to modify the controller of Woolston to calculate the left-right and right-left mechanical forces based on the simulated masses and accelerations, then initiate tactile feedback responses on both swords to electronically simulate the bi-directional mechanical transmission of forces.

175. Since Woolston already discloses providing tactile feedback to the first sword apparatus based on movements of the second sword apparatus, there would have been a reasonable expectation of success when implementing this feature in Woolston’s system.

4. “adapted to wirelessly receive the signals transmitted by the transmitter of the first hand-held communication device”

176. Claims 63 and 72 recite the limitation, “a processing system . . . adapted to wirelessly receive the signals transmitted by the transmitter of the first hand-held communication device.” As I discussed above, Woolston’s game controller 240 (i.e., “processing system”) is coupled to IR receivers 210, 220, 230 that receive signals output by IR transmitters 300, 302, 304 “whereupon the timing and/or phase differential of the received signals may be used to triangulate and determine the spatial position of the sword apparatus.” Ex. 1005, *Woolston* at 3:55-4:1, 9:39-46, Fig. 3; *see also*, ¶62. In my opinion, this disclosure alone satisfies the requirement

for a processing system “adapted to wirelessly receive the signals transmitted by the transmitter of the first hand-held communication device.”

177. However, I have also been asked to opine as to whether it would have been obvious to a person of ordinary skill to include a wireless receiver, such as taught by Daniel, in Woolston’s game controller 240 for enabling wireless communications with the apparatus 200. For the reasons explained below, this would have been an obvious modification to Woolston’s game controller 240.

178. Again, Woolston describes enabling the apparatus 200’s microprocessor circuit 499 to use “wireless analog and/or digital control signal to provide an interface between the sword apparatus and the game controller 240.” Ex. 1005, *Woolston* at 6:50-54. Thus, Woolston discloses communicating control signals between apparatus 200 and game controller 240 via a wireless interface, but Woolston does not provide the specific details of this interface, such as whether it is bi-directional, for example.

179. In Daniel’s system, a computing device 108 receives wireless transmissions from input devices 100 using receiver 106. Ex. 1009, *Daniel* at [0034] (“As shown, each of input devices 100 is enabled to communicate with computing device 108 through receiver 106.”), [0035] (“Each of input devices 100, of FIG. 2, is configured to generate commands 104 in response to a user’s hand movements.

Commands 104 are captured by computing device 108 through receiver 106.”), Fig. 2.

180. It would have been obvious to a person of ordinary skill in the art to – like Daniel – include a receiver in Woolston’s game controller 240 to enable it to wirelessly receive the signals transmitted by the transmitter of apparatus 200. As I discussed above, a person of ordinary skill would understand that the attitude/location signals output by the apparatus 200’s inertial sensing system (discussed above at ¶64) would need to be transmitted to the game controller 240 prior to its use by the game controller software. Ex. 1005, *Woolston* at 3:49-54 (“The gyroscopic inertial positioning system may keep the computer game apprised of the spatial attitude and/or location of the sword apparatus in such a way that the game may provide the proper moments of torque on the motors to provide feedback to the player.”); 15:65-16:2 (“The game controller 240 may track the position and attitude of sword apparatus 200. The positional and attitude information may be used by the game controller software to project and track the virtual blade 1006”).

181. Considering Woolston’s express suggestion to utilize a “wireless . . . control signal to provide an interface between the sword apparatus [200] and the game controller 240” a person of ordinary skill would have been motivated to modify the game controller 240 to include a wireless receiver, such as taught by Daniel, to receive signals, such as the attitude signals discussed above, transmitted by the

apparatus 200. Moreover, utilizing a wireless receiver for receiving signals would have been a reliable and predictable way for the apparatus 200 to communicate with the game controller 240.

182. For the reasons discussed above, a person of ordinary skill would have understood that enabling Woolston's game controller 240 to receive data signals wirelessly via a receiver would have been an advantageous way to avoid the need for a wire connecting the apparatus 200 to the game controller 240 thereby allowing the user more freedom of movement, which would have predictably enhanced the user's game experience and increased satisfaction. *See*, ¶¶158-160. As such, a person of ordinary skill would have been motivated to include Daniel's receiver for receiving signals in Woolston's game controller 240 to remove the need for a wire connecting the apparatus 200 to game controller 240 and improve similar interactive game systems in the same way.

183. A person of ordinary skill would further understand that making Woolston's game controller 240 wireless would not in any way impact the interactive game system's principle of operation or render it inoperable for its intended purpose. Therefore, there would have been a reasonable expectation of success when modifying game controller 240 to include a receiver for wirelessly receiving signals transmitted by the transmitter of apparatus 200.

#### **IV. CONCLUSION**

184. I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Date: 31 MAY 2019

By:   
Gregory F. Welch