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Filed on behalf of Meta Platforms, Inc.

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

META PLATFORMS, INC.,
Petitioner

v.

MULLEN INDUSTRIES, LLC,
Patent Owner

Case No. IPR2025-00703
U.S. Patent No. 11,033,821

DECLARATION OF GREGORY WELCH, PH.D. IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 11,033,821

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provide a video game comprising a virtual character with a virtual location on a virtual playfield, said virtual character is displayed on said display, said virtual location on said virtual playfield corresponds to said physical location on said physical playfield, and a direction of gameplay of said videogame is operable to be established by recording a manually provided direction in response to a prompt requesting said manually provided direction." 79

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3. 102[b]: *"a locating device operable to determine the physical location of said locating device on a physical playfield, wherein said locating device comprises a movement measuring device operable to be utilized, at least in part, to determine said physical location;"* 109

4. 102[c]: *"a directional device operable to determine the physical direction of said directional device on said physical playfield; and"* 110

5. 102[d]: *"a processor coupled to said display and said locating device, wherein said processor is operable to provide a video game comprising a virtual character with a virtual location and facing a virtual direction on a virtual playfield said virtual location on said virtual playfield corresponds to said physical location on said physical playfield, an origin of gameplay of said videogame is operable to be established by recording a manually provided origin in response to a prompt requesting said manually provided origin, and said virtual direction on said virtual playfield corresponds to said physical direction on said physical playfield."* 110

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3. 1[a]-1: *"a display,"* 132

4. 1[a]-2: *"a locating device operable to determine the physical location of said locating device on a physical playfield; and,"* 133

5. 1[a]-3: *"a processor coupled to said display and said locating device, wherein said processor is operable to provide a video game comprising a virtual character with a virtual location on a virtual playfield, said virtual character is displayed on said display, said virtual location on said virtual playfield corresponds to said physical location on said physical playfield, and a direction of gameplay of said videogame is operable to be established by recording a manually provided direction in response to a prompt requesting said manually provided direction."* 137

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5. 102[d]: *"a processor coupled to said display and said locating device, wherein said processor is operable to provide a video game comprising a virtual character with a virtual location and facing a virtual direction on a virtual playfield said virtual location on said virtual playfield corresponds to said physical location on said physical playfield, an origin of gameplay of said videogame is operable to be established by recording a manually provided origin in response to a prompt requesting said manually provided origin, and said virtual direction on said virtual playfield corresponds to said physical direction on said physical playfield."*..... 166

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I. INTRODUCTION

1. I, Gregory Welch, have been retained by Meta Platforms, Inc. ("Meta") to provide an analysis of the scope and content of U.S. Patent No. 11,033,821 ("the '821 patent") relative to the state of the art at the time of the earliest application to which the '821 patent claims priority. My analysis relates to claims 1, 4, 11, 16, 30, and 102. I have also been retained to provide analysis regarding what a person of ordinary skill in the art ("POSITA") would have understood at the time of the earliest application underlying the '821 patent.

2. This declaration summarizes the opinions I have formed to date. I reserve the right to modify or amend my opinions, if necessary, based on further review and analysis of information that I receive subsequent to the filing of this declaration, including in response to positions taken by Mullen Industries, LLC ("Mullen") or its experts that I have not yet seen, including any secondary considerations evidence that Mullen or its expert may consider and present.

3. It is my opinion that claims 1, 4, 11, 16, 30, and 102 of the '821 patent are unpatentable based on the following grounds.

Ground 1	Claims 1, 4, and 11 are obvious over Cheok (EX1006) in view of Foxlin077 (EX1008)
Ground 2	Claims 16 and 30 are obvious over Cheok in view of Foxlin077 and Rallison (EX1014)
Ground 3	Claim 102 is obvious over Cheok in view of Nakamura (EX1007)

Ground 4	Claims 1, 4, and 11 are obvious over Nakamura in view of Benini (EX1009)
Ground 5	Claim 102 is obvious over Nakamura

II. EXPERIENCE, QUALIFICATIONS, AND STATUS AS AN INDEPENDENT EXPERT

4. My curriculum vitae ("CV") is Exhibit 1004. I am a Pegasus Professor and the AdventHealth Endowed Chair in Simulation at the University of Central Florida ("UCF") with appointments in the College of Nursing, the Department of Computer Science, and the Institute for Simulation & Training. I am also the Co-Director of the IST Synthetic Reality Lab. Prior to my appointment at UCF, I was an adjunct professor at the University of North Carolina at Chapel Hill ("UNC"), where I worked on the Voyager Spacecraft Project at NASA's Jet Propulsion Laboratory on airborne electronic countermeasures at Northrop-Grumman's Defense Systems Division.

5. In 1986, I was awarded a Bachelor of Science degree in Electrical Engineering Technology with *Highest Distinction* from Purdue University.

6. I was awarded a master's degree, and then, a Ph.D. in Computer Science from UNC in 1995 and 1997, respectively.

7. My research career has focused on human-computer interaction, human motion tracking, and virtual and augmented reality, with applications such as

healthcare and defense. Notably, my research includes my highly cited 1995 introductory article on the Kalman Filter, which is an algorithm that provides an efficient way to estimate the state of a dynamic system from noisy observations (that is, data or measurements that are influenced by errors and inaccuracies). I maintain an internationally recognized website dedicated to the Kalman Filter.

8. I have published over 170 articles in peer-reviewed journals, conferences, and symposia. A sampling of these papers include "Revisiting Trends in Augmented Reality Research: A Review of the 2nd Decade of ISMAR (2008–2017)," "The Office Of The Future: A Unified Approach to Image-Based Modeling and Spatially Immersive Displays," "High-Performance Wide-Area Optical Tracking: The HiBall Tracking System," and "Motion Tracking: No Silver Bullet, But a Respectable Arsenal." Notably, my introductory paper on the Kalman Filter authored alongside Gary Bishop has been cited over 12,000 times. My work in Augmented Reality and tracking were cited in my promotion to IEEE Fellow, and a pair of seminal papers of mine on Spatial Augmented Reality in 1998 earned me and my co-authors the Long-Lasting Impact Award at the IEEE Virtual Reality Conference in 2016.

9. I have served as a peer reviewer and editor for more than 15 journals and science organizations. I have also written a dozen book chapters and sections,

including those on, for instance, virtual, mixed, and augmented reality in computer science.

10. I am named as an inventor on 28 issued patents and have several others in various stages of prosecution. Two relevant examples are US Patent. No. 11,467,399, "Augmentation of Relative Pose In Co-located Devices," which pertains to the concept of cooperative tracking of two or more individuals in proximity of each other, and US Patent. No. 9,808,549, "System for Detecting Sterile Field Events and Related Methods," which pertains to the concept of establishing and maintaining bounded volumes around sterile medical procedures, and the detection of unsafe interactions within.

11. My teaching experience includes undergraduate and graduate level classes. Example topics include Virtual Reality and Augmented Reality and computer modeling and animation.

12. I am a Fellow of the National Academy of Inventors (NAI) and a Fellow of the Institute and Electrical and Electronics Engineers (IEEE). I was inducted into the IEEE Virtual Reality Academy in 2022.

13. I have received a number of awards, including the Virtual Simulation Innovation Award in 2025 (UCF CON STIM Center), IEEE Virtual Reality Technical Achievement Award in 2018, and the Long Lasting Impact Paper Award from the IEEE VR Conference as mentioned above. I have also been designated a

Pioneer of the Association for Computing Machinery's Special Interest Group on Graphics and Interactive Techniques ("ACM SIGGRAPH"), which is a recognition of long-time contributions in the computer graphics space. I currently serve as a technical expert for the IEEE for its virtual, augmented, and mixed reality Public Visibility Initiative.

14. I have been a keynote speaker at 20 scientific conferences, workshops, and colloquiums throughout the world. I have similarly been invited to give talks at, participate in, or serve on dozens of scientific committees for conferences, workshops, and panels worldwide.

15. A detailed list of my professional activities, memberships, and speaking engagements is included in my CV (EX1004).

16. I am being compensated at the rate of $600 per hour for my work on this declaration. My fee is not contingent on the outcome of any matter or on any of the technical positions I explain in this declaration.

17. I have no financial interest in Meta. I have been informed that Mullen claims ownership of the '821 patent. I have no financial interest in Mullen.

III. MATERIALS REVIEWED AND CONSIDERED

18. My opinions in this declaration are based on working in the field of computer science and engineering, particularly in virtual, augmented, and mixed reality, including my teaching, research, and consulting. I have an established

understanding of the relevant field at the relevant time frame and I have an understanding of the skill set, capabilities, and knowledge of a POSITA as of September 2, 2003.

19. My opinions are also based on investigation and study of the patent at issue, its file history, and the prior art. In the course of forming my opinions, I have reviewed the exhibits submitted with the Petition, which are specifically identified in Appendix A.

20. I may rely upon these materials and/or additional materials to rebut arguments raised by Mullen. Further, I may also consider additional documents and information in formatting any necessary opinions including documents that may not yet have been provided to me.

IV. UNDERSTANDING OF RELEVANT LEGAL PRINCIPLES

21. I understand that statutory and judicially created standards must be considered to determine the validity of a patent claim. I am not an attorney and, consequently, will offer no opinion on the law itself. My understanding of the pertinent law is described in this section and is the result of explanations provided by counsel. I have applied this understanding in my analysis.

22. I understand that a patent claim is unpatentable if it is anticipated by, or obvious in view of, the prior art. I further understand that the time frame of reference

for determining whether a claim is unpatentable is from the perspective of a POSITA at the time of invention.

A. Anticipation

23. I have been informed that for a patent claim to be anticipated by the prior art, each and every limitation of the claim must be found, expressly or inherently, in a single prior art reference as recited in the claim. I have been informed that a claim limitation not expressly found in a prior art reference is inherent if the prior art necessarily functions in accordance with, or includes, the claim limitation. Mere probability that a limitation is included is not sufficient to establish inherency.

B. Obviousness

24. In analyzing obviousness in light of the prior art I have been informed that it is important to understand the scope of the claims, the level of skill in the relevant art, the scope and content of the prior art, the differences between the prior art and the claims, and any objective indicia of non-obviousness (also called secondary considerations).

25. I have been informed that a patent claim is unpatentable for obviousness if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a POSITA to which said subject matter pertains. I have been

informed that obviousness may be based on one reference or a combination of references. I have been informed that the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results.

26. I have been informed that when a patented invention is a combination of known elements, the Patent Trial and Appeal Board ("Board") must determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue by considering the teachings of prior art references, the effects of demands known to people working in a field or present in the marketplace, and the background knowledge possessed by a POSITA.

27. I have been informed that the Supreme Court has recognized several rationales for combining references or modifying a reference to show obviousness of the claimed subject matter. I understand that several of these rationales are: (1) combining prior art elements according to known methods to yield predictable results; (2) simple substitution of one known element for another to obtain predictable results; (3) use of a known technique to improve a similar device (method or product) in the same way; (4) applying a known technique to a known device (method or product) ready for improvement to yield predictable results; (5) choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success; (6) and 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 have been informed that in order to prove that a claimed invention is not patentable for obviousness, a petitioner must (1) identify the differences between the claim and particular disclosures in the prior art references, singly or in combination, (2) specifically explain how the prior art references could have been combined in order to arrive at the subject matter of the claimed invention, and (3) specifically explain why a POSITA would have had reasons to so combine the prior art references.

C. Priority

29. I have been informed that to claim priority to a prior application, each application in the chain that leads to an earlier application must comply with the written description requirement. I have been informed that in order to satisfy the written description requirement, the specification of the provisional application must contain a written description of the invention and the manner and process of making and using it, in such full, clear, concise, and exact terms, that it would enable a person of ordinary skill in the art to practice the invention claimed in the non-provisional application. I have been informed that the provisional application must describe the invention claimed in the non-provisional application such that a person of skill in

the art can clearly conclude that the inventor had invented the claimed invention by the provisional application filing date.

V. TECHNOLOGY OVERVIEW

30. In this section I provide overviews of technologies and prior art pertinent to the '821 patent and to the state of the art as of 2003. *See* Sec. VI.B.1 (addressing priority of the '821 patent). In later sections I address in detail how the prior art discloses and renders obvious the recitations of the challenged claims.

31. The prior art references described below and discussions of what was known to a person of ordinary skill in the art provide a general description of the state of the art at the time of the invention, provide additional motivation to modify the primary references evaluated in the grounds of invalidity with the knowledge of a person of ordinary skill in the art or other references cited herein, and provide support for why a person of ordinary skill in the art would have had a reasonable expectation of success in combining the teachings of the references. The additional prior art references identified in this section are exemplary in nature and are included to provide factual support for my opinions.

A. Virtual and Augmented Reality Paradigms

32. The development and use of interactive computer-generated simulations of virtual environments and entities have been around for many decades — long before September of 2003. Such simulations have long been used for

applications such as training, education, science, and entertainment. What began as targeted, virtual simulations have grown into more comprehensive virtual "experiences," with the common goal of cognitive and sometimes sensory immersion driving these developments through the early 2000s.

33. A seminal example of such work is that of Ivan Sutherland and his students at the University of Utah in the 1960s, including Sutherland's "head-mounted three-dimensional display" paper, which is among the most well-known in the field. I reproduce some of the figures from that paper here:

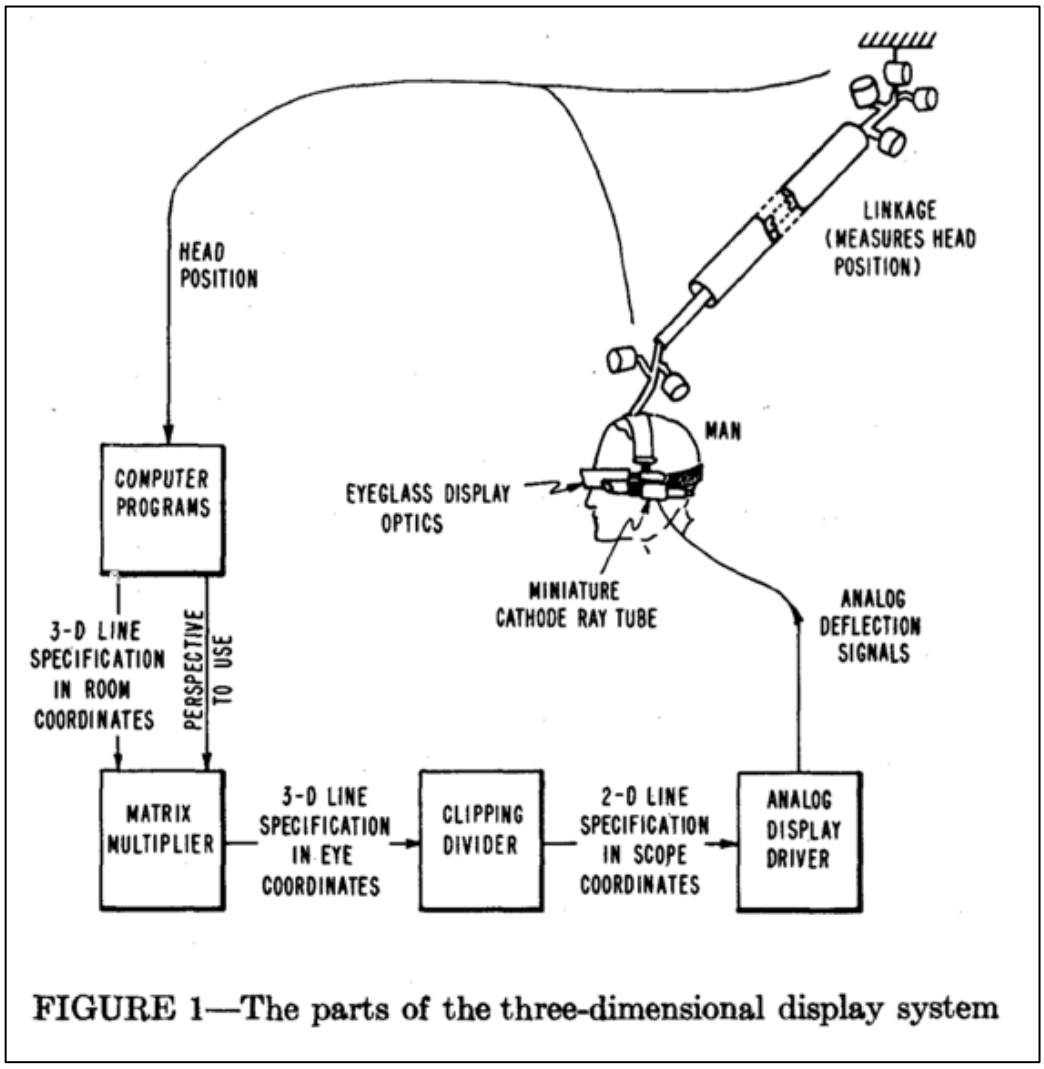


FIGURE 1—The parts of the three-dimensional display system

Sutherland, *A Head-Mounted Three Dimensional Display* (1968) ("Sutherland 1968") EX1015, Fig. 1 (Sutherland's three-dimensional display system); *see also id.* at Figs. 2-4 (photographs of Sutherland's prototype system, showing for example a custom graphics computer, a head tracking system, and a head-mounted display):

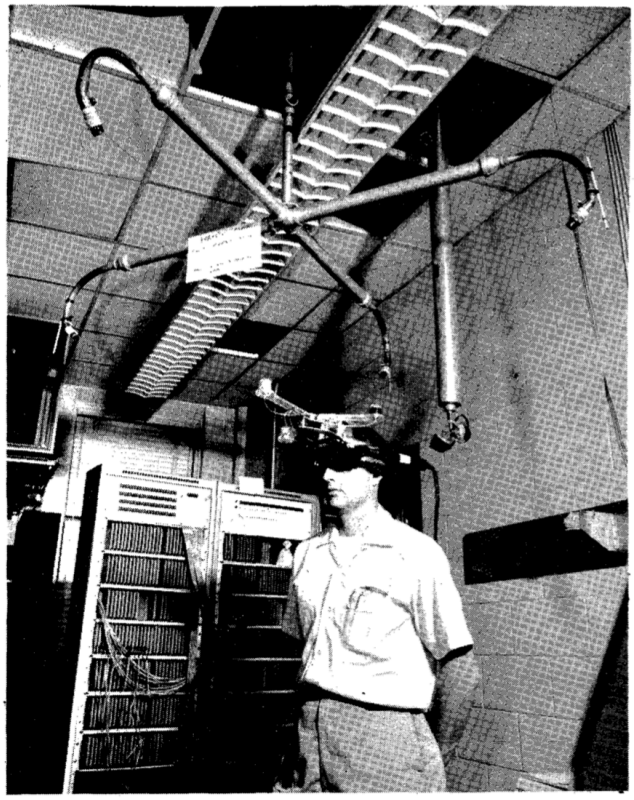


FIGURE 3—The mechanical head position sensor in use



FIGURE 4—The ultrasonic head position sensor in use

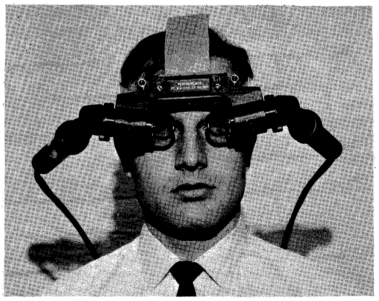


FIGURE 2—The head-mounted display optics with miniature CRT's

34. Sutherland's work above offers one of the earliest examples of wearable electronic devices for displaying computer-generated "virtual" content to users. Such systems continuously estimated or "tracked" the position and orientation ("pose") of a user's head in a coordinate system corresponding to real, physical space, mathematically transforming pose estimates into a coordinate system corresponding to virtual space, rendering the virtual environment, and displaying it in a head-worn device, e.g., with a head-mounted display ("HMD").

35. The notion of Virtual Reality on a handheld device originated at least as early as 1993. For example, in that year George Fitzmaurice et al. published two relevant articles: "Virtual Reality for Palmtop Computers" ("Fitzmaurice") EX1016, 197 and "Situated Information Spaces and Spatially Aware Palmtop Computers" ("FitzmauriceB") EX1017, 39.

36. The first article, "Virtual Reality for Palmtop Computers," appeared in the July edition of the ACM Transactions on Information Systems. In that article, Fitzmaurice et al. described how they were "exploring how virtual reality theories can be applied toward palmtop computers." EX1016, 197. They introduced a prototype, called the "Chameleon," which comprised a hand-held "palmtop" computer with a 4-inch monitor and six degree-of-freedom (6 DOF) tracking to "detect user gestures and input selections for issuing commands." *Id.*, 197. They also discussed how their "palmtop VR" fit in the general context of Virtual Reality, such as the work that originated with Ivan Sutherland et al. above. For example, they wrote that:

> "[T]here are a set of head-mounted display (HMD) systems [Sutherland 1968] which position a small monitor directly in front of one or both eyes, similar to a pair of goggles. As the user moves his or her head, the displays are updated to reflect the new viewpoint." *Id.*, 198.

They also wrote that:

> "Two seemingly disparate approaches have been pursued in the VR community: outside-in systems—simulating 3D environments within the 2D computer screen (e.g., rooms, information visualizer, and cone trees [Card et al. 1991]—and inside-out systems—virtual-reality environments in which users are completely immersed into an artificial 3D space by wearing a head-mounted display and, potentially, a DataGlove." *Id.*, 199.

I have included Figure 8c from (*Id.*, 211) below, which shows a user moving the palmtop virtual reality device until a cursor displayed in the window (the display) appeared to be positioned over the real box on the table in front of him.

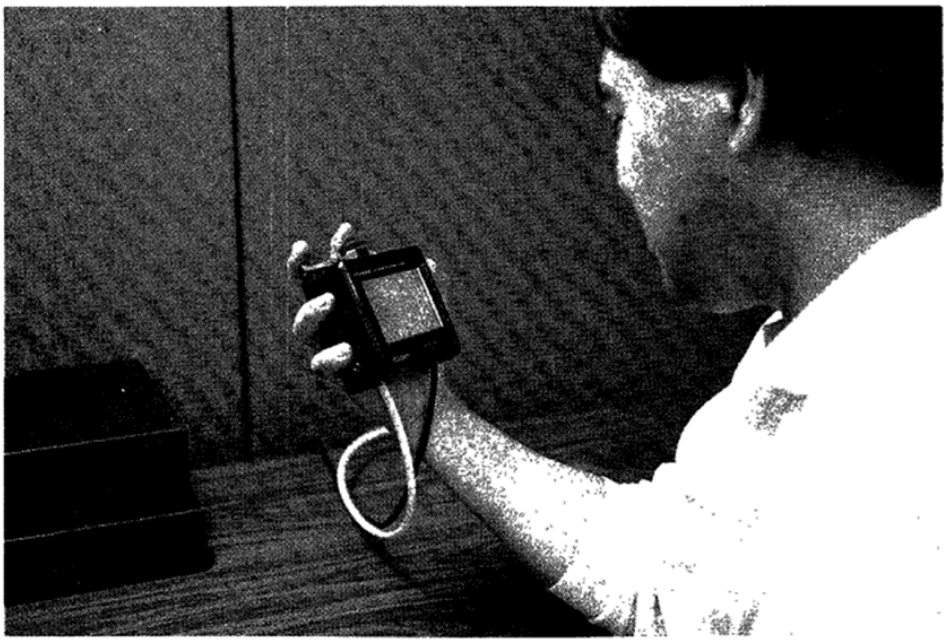
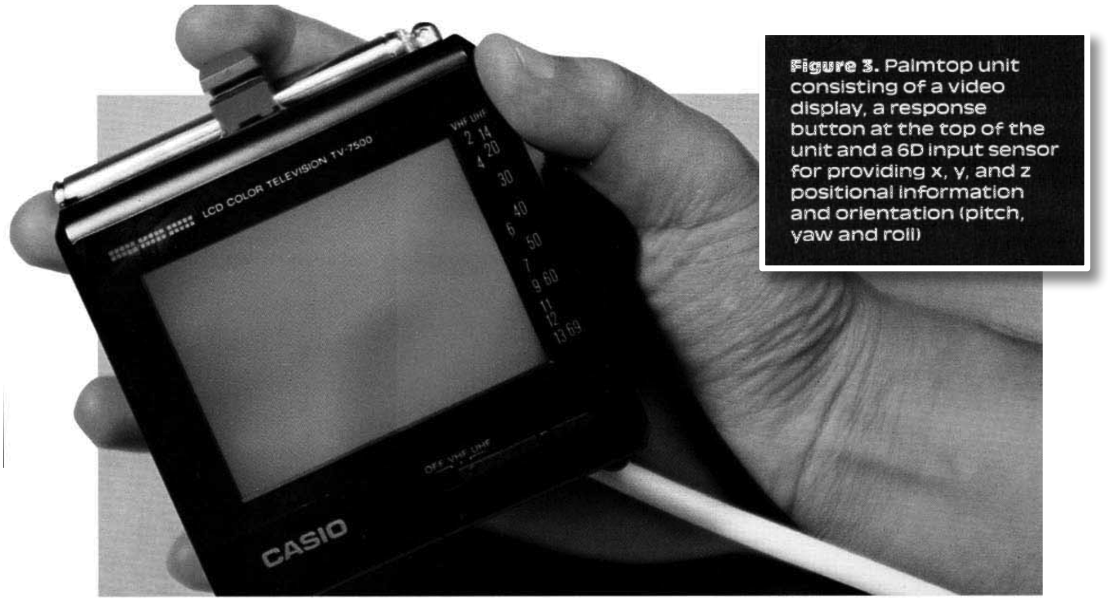


Fig. 8c. Third experiment condition consisting of a small 4-inch monitor, dynamic display using the palmtop virtual-reality system for input.

37. The second article, "Situated Information Spaces and Spatially Aware Palmtop Computers," appeared in *Communications of the ACM* (Association of

Computing Machinery) in July of 1993. EX1017, 39. In that article, Fitzmaurice conveyed the idea that "[a] small, portable, high-fidelity display and spatially aware palmtop computer can act as a window onto the 3D-situated information space-providing a bridge between the computer-synthesized data and physical objects." *Id.*, 39. I have included Figure 3 from that article below, with the caption superimposed by me in the upper right.



38. FitzmauriceB discussed how "palmtop computers designed with a high-fidelity monitor can become spatially aware of their location and orientation and serve as bridges or portholes between computer-synthesized information spaces and physical objects." *Id.*, 42. In other words, the device could act as a dynamic window into a virtual world, where movement of the handheld device in the *real* world causes corresponding movement in the *virtual* world, as seen through the "window" (the

display). FitzmauriceB described how such a handheld device could be used to see and interact with things in the virtual world:

> "In order to allow users to select objects within the **virtual world**, a cross-hair cursor is fixed in the center of the screen. Users line up target objects over the cross-hair and click (or in some situations double-click) on the response button. This causes an imaginary ray centered at the cross-hair to emanate from the palmtop unit toward objects in the **virtual world**." *Id.*, 43 (emphasis added).

39. In his concluding thoughts, Fitzmaurice summarizes his idea for situated information spaces and spatially aware palmtop computers:

> "Electronic information will be available everywhere. In order to avoid being flooded and overwhelmed with the quantity of information, we need to adopt the notion of situated information spaces. The electronic information associated with physical objects should be collected, associated, and collocated with those objects. The physical objects anchor the information, provide a logical means of partitioning and organizing the associated information space into "hot spots," and serve as retrieval cues for users."

Id., 48. The concept of computation that is dependent on the location became known as *location-based computing*, and retrieval of spatially relevant information became known as *location-based services*.

B. Location-Based Virtual and Augmented Reality Gaming

40. In 1994, following the work of Fitzmaurice et al. that I described above, Bill Schilit and Marvin Theimer published an article titled "Disseminating active map information to mobile hosts," where they discussed the idea of mobile distributed computing over wider physical areas:

> "In recent years an extended form of computing has emerged, called **mobile distributed computing**, in which users interact with many different mobile and stationary computers over the course of the day. Computation no longer occurs at a single location in a single environment, but rather spans a multitude of situations covering the office, meeting room, home, airport, hotel, plane, etc." EX1018, 1 (emphasis added).

They explained the necessity for knowing the *location* of the mobile device in such mobile distributed computing:

> "As users move about, the sets of mobile and stationary objects they interact with may change, producing a highly dynamic execution environment in which **location** is important. **Location information is necessary for users and applications that want to query and interact with nearby devices and services**. Such information also allows stationary clients to track moving objects. In general, **location information enables software to adapt according to its location of use, the collection of nearby people and**

> **objects, as well as the changes to those objects over time**. We use the term context-aware computing to describe software exhibiting these general capabilities." EX1018, 1-2 (emphasis added).

41. Over next decade, location-based applications, including location-based games, grew increasingly popular and sophisticated. By 2001, researchers in Sweden had developed a location-based game called "Pirates!" — which comprised "a fantasy archipelago setting, where each player takes on the role as the captain of a ship." EX1019, 1. The players each had a handheld device that could be located in the real world. "In Pirates!, a player's location in the game arena dictates the game events, such as the possibility to explore an island, or engage in combat with another player." EX1020, 2. As the player moved around the real world, they were simultaneously moved in the virtual world, such that "walking between different places in the game arena, becomes equivalent to sailing between islands on ocean. As a player enters the proximity of an island, or another ship in the game arena, he or she has the choice to make landfall and explore the island or engage in battle, respectively." EX1020, 1. Below I have reproduced Figure 2 and Figure 3 from EX1019, including the figure captions.



Figure 1: Screen shot when sailing the open sea in Pirates!



Figure 2: The initial view when exploring an island.



Figure 3: A two-player combat scene.

EX1019, 3.

42. At least by 1998, researchers were developing location-based games involving first-person Augmented Reality (AR) systems, where a user could move around outdoors and see the real physical world around them with spatially integrated virtual objects and beings all around them. At that time, AR systems typically used what are called "video see-through" head-mounted displays (HMDs). The HMDs would be worn on the head such that one or more displays on the inside were positioned in front of the user's eyes as shown in the two images below.



Left: Figure 3 from EX1021, 78. Right: Figure 12 from EX1006, 114.

43. Outward facing cameras mounted on the front of the HMDs would capture live video of the real world, which was sent to a computer (typically worn in a backpack at that time), and then displayed on the display inside the HMD, such that the user could see it. In some ways, the setup is not unlike viewing the screen on a digital camera if you held it in front of your face, however the computer could also add (overlay) virtual imagery onto the video feed from the real world, thus *augmenting* your view of the real world, as shown in the images below, which show HMD views from the same systems as shown above.



Left: Figure 7 from EX1021, 81. Right: Figure 7 from EX1006, 112.

44. The left-side images shown in above (Figure 3 and Figure 7 from EX1021) are from the 2002 paper "First person indoor/outdoor augmented reality application: ARQuake." EX1021, 75. The ARQuake system was a first-person indoor/outdoor AR application developed by Bruce Thomas et al. to replicate the popular game Quake (idSoftware) outdoors. The system used a body-worn AR system that used GPS, a digital compass, and fiducial vision-based tracking to track the person as they moved around a large outdoor space and even into certain indoor spaces, collaborated with other users to explore the real-virtual space, shot virtual monsters, and collected virtual objects.

45. The right-side images shown above (Figure 12 and Figure 7 from EX1006) are from a 2003 paper by Adrian Cheok et al. and titled "Human Pacman: a sensing-based mobile entertainment system with ubiquitous computing and tangible interaction." Adrian Cheok et al. developed multiple VR and AR

experiences and games, including Touch-Space, a "novel computer entertainment system which recaptur[ed] human touch and physical interaction with the real-world environment as essential elements of the game play, whilst also maintaining the exciting fantasy features of traditional computer entertainment," (EX1033, 430), and Human Pacman, which "strives to bring the computer gaming experience to a new level of emotional and sensory gratification by embedding the natural physical world ubiquitously and seamlessly with a fantasy virtual playground." EX1006, 106. The latter is a real working version of the virtual PACMAN game contemplated in the '821 patent, e.g., see the '821 patent at 3:30–4:4.

C. User Devices in VR and AR Location-Based Games

46. While mobile personal computer devices ("mobile devices") are sometimes organized into categories corresponding to form factor or intended use, e.g., handheld, wearable, or head-mounted, they are all computers, and all have various forms of input and output. Forms of direct manual input can include keyboards, mice, joysticks, buttons, and dials. While one could certainly use a keyboard to enter their position and orientation, systems for estimating ("tracking") the position and/or orientation ("pose") can provide continuous automatic input to a personal system in the form of the estimated pose of the device. Real-time tracking information can be used by the system for location-based computing to, for example, look up, calculate, and/or display objects depending on the pose.

47. The most common form of output is that of a visual display. In some systems, a display might be integrated into a handheld component, e.g., with smart phones and handheld computers, as in the work of Fitzmaurice et al. that I described above (EX1016), whereas in other systems, the display might be integrated into a head-worn component, e.g., a HMD such as that used by Sutherland et al. described above.

48. HMDs are typically classified according to their capabilities and intended use. In particular, people often use the terms "Virtual Reality HMD" (VR HMD) or "immersive HMD" to refer to HMDs that only display computer-generated content to the user, i.e., the user cannot see the real world around them. Correspondingly, people often use the term "Augmented Reality HMD" (AR HMD) or perhaps "AR goggles" to refer to HMDs that are designed to show the user computer-generated imagery superimposed on a view of the real world. In other words, VR HMDs can be thought of as completely *replacing* the user's view of the real world, whereas AR HMDs can be thought of as *augmenting* the user's view of the real world.

49. Within the realm of AR HMDs, there are two common approaches to augmenting the user's view of the real world: the "video see-through" approach and the "optical see-through" approach. A popular article by Ron Azuma from 1997 ("A

Survey of Augmented Reality" (EX1022, 1) includes two often cited and replicated figures to illustrate the two approaches, which I have reproduced below.

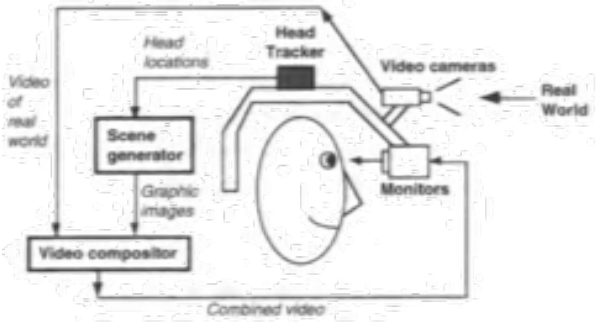


Figure 13. *Video see-through HMD conceptual diagram.*

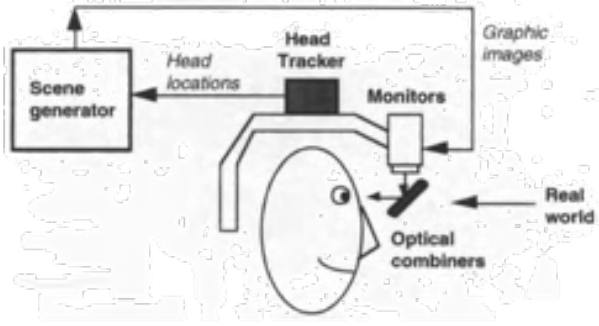


Figure 11. *Optical see-through HMD conceptual diagram.*

Figures 13 (left) and 11 (right) from EX1022, 11.

50. The *video* see-through approach, which I discussed some above in the context of location-based AR games, is depicted on the left above (Figure 13 from EX1022, 11). In video see-through systems, a forward view of the real world is continuously captured by one or more forward-facing cameras mounted on the HMD, the imagery is sent to a video compositor (a computer) where it is combined with computer-generated/virtual imagery, and the resulting combined video is sent to displays ("monitors" in the figure) that are not transparent. The result is that as a user moves around, they see the real world augmented by virtual imagery.

51. The *optical* see-through approach is depicted on the right (Figure 11 from EX1022, 11). In optical see-through systems, an optical combiner element, e.g., a half-silvered piece of glass, combines an actual view of the real world (i.e. the photons from the objects pass through the combiner) with computer-

generated/virtual imagery sent to the same optical element (e.g., reflected from a display mounted above the optical element — "monitors" in the figure), and the resulting optically combined imagery is seen by the user. As with the video see-through approach, the result is that as a user moves around, they see the real world augmented by virtual imagery.

52. While the video see-through and optical see-through approaches generally achieve the same result — the user sees the real world augmented by computer-generated (virtual) imagery — the end result is somewhat different due to the different approaches, and there are tradeoffs. For example, in the case of the video see-through approach, the system can directly replace or cover up anything from the real world, because it can completely replace pixels in the video. However the resolution of such systems is limited by the resolutions of the cameras and the displays, and such systems will always have some added delay in the imagery. In the case of the optical see-through approach, because the system is optically combining video from the display with photons from the real world, i.e. it is adding the light from the display and the real world, it cannot always replace or cover up things from the real world. For example, overlaying any virtual imagery over a bright object in the real world, e.g., a light, can result in the real imagery "swamping" the computer imagery. This is particularly common outdoors, where the system has to compete with light from the sun. Conversely, displaying dark virtual objects does

not typically work well, because darkness in computer graphics system typically corresponds to color values of 0, which in an AR display will appear transparent. So as AR virtual imagery becomes dark (e.g., when rendering dark colored virtual objects) it becomes transparent. However, with an optical see-through system the user's view of the real-world is generally as good as their natural eyesight in terms of resolution, and there is no added delay.

53. Communication between mobile devices, and between any mobile device and the nearby communication infrastructure is typically achieved using some form of electromagnetic radiation, e.g., infrared (IR) light or radio frequency waves. Two examples of devices that communicated via IR light are the Palm III device released in 1998 and the Nokia 8210 mobile phone released in 1999. They used the Infrared Data Association (IrDA) protocols to communicate serially with another device over a relatively short distance, e.g., a meter. IrDA was typically used to transfer data between devices including personal computers.

54. Communication via radio frequency (RF) waves is far more common. Voice communication over RF using cellular phones dates back to the late 1970s. EX1023. The 1980s saw the development of the Global System for Mobile Communications (GSM) standard for data communications. Some of the earliest mechanisms were the multimedia messaging capabilities afforded over the cellular communications networks. Those methods include short messaging service (SMS),

the enhanced messaging service (EMS), and the multimedia messaging service (MMS). These mechanisms were widely in use prior to 2003. EX1024, 431.

55. The concept of a general-purpose wireless local area network (LAN) has been around since the 1970s, but commercial wireless LAN devices only started becoming available in 1990. EX1025, 118. NCR introduced WaveLAN in 1991, and Lucent Technologies, who had played a leading role in driving the Institute of Electrical and Electronics Engineers (IEEE) 802.11 wireless standard, introduced WaveLAN-II in 1998. *Id.* at 118. Two examples of handheld mobile devices that used general-purpose RF network communications include the Palm VII device (1999–2000), which had an antenna for accessing wireless network services (EX1026, 119), and the HP Jornada (1998–2002) which included a PC Card Slot (EX1027, 12) that could accommodate a WaveLAN wireless card. For example, the mobile devices used in the location-based game Pirates! that I described above was an HP Jornada 690 with an IEEE 802.11 WaveLAN card. EX1019, 4. Body-worn Virtual Reality and Augmented Reality systems for location-based games also used wireless LAN cards. For example, the body-worn AR system developed by Thomas et al. for their ARQuake system used a WaveLAN card (EX1021, 84), and the mobile system developed by Cheok et al. for their Human Pacman game were Cisco Aironet Wireless LAN PC Cards. EX1006, FIG. 4. These wireless communication cards

allowed the mobile devices used by Thomas et al. and Cheok et al. to communicate over their standard campus 802.11 wireless networks.

56. Aside from user tracking, which I discuss in the next section, there are several common mechanisms for user input for mobile devices. For most mobile devices, a traditional QWERTY keyboard is not practical. Instead, for alphanumeric input, researchers and practitioners have turned to alphanumeric input devices that can be operated in one hand, out of sight, or remapped other user motion to input controls. An example of the former is the Twiddler2, a handheld "chorded" keyboard and mouse used by Cheok et al. with their Human Pacman game. EX1006, 110. Such chorded devices were designed to be operated with one hand, out of sight, by pressing combinations of buttons (chords) to indicate particular input. Thomas et al. determined that they generally did not need alphanumeric input, and so they programmed ARQuake to use a combination of head and body movement along with buttons (e.g., on the two-button haptic gun input device), to affect the necessary input/control.

57. The most common additional element of the user interface for mobile devices is the graphical interface realized with the display and other manual input devices. In some circumstances, this is not that different from the traditional "WIMP" metaphor (Windows, Icons, Mouse, and Pointer), but it is typically implemented with less complexity and larger icons or buttons, etc. because the user

is generally less precise in their control of input devices while moving. As can be seen in Figure 7 from EX1006 (above), the graphical user interface in the HMD for the Human Pacman game of Cheok et al. includes virtual buttons on the display, such as "Request Update." The user would use their thumb on the "mouse" on the Twiddler2 to control a cursor and select items on the display, e.g., a button or an item from a visual menu.

58. Below I include images from EX1021, 77 and EX1006, 110 that show the respective complete body-worn systems, including the manual input devices, tracking devices, and head-mounted displays.



Figure 2 from EX1021 (left) and Figure 4 from EX1006 (right).

D. User Tracking in Location-Based Games

59. For any human-made system that has any relationship to spatial location and/or orientation, the notion of a *coordinate system* comes into play. In the context of location-based computing, a coordinate system is a geometric reference framework used to define the position and orientation of entities in a space, e.g., a two-dimensional (2D) space in a planar grid, or the three-dimensional (3D) space where we live. The entities include points, objects, services, events, and even other (nested) coordinate systems.

60. A coordinate system consists of four primary components:

- A fixed reference point that establishes the position of the coordinate system in an enclosing "parent" coordinate system that is typically located at the spatial coordinates (0,0) in 2D, or the spatial coordinates (0,0,0) in 3D (e.g., root). The root of a coordinate system itself has a position and orientation in the parent coordinate frame, and that position and orientation can be changed.
- A set of mutually orthogonal lines in the space that establish the bases for independent directions (e.g., axes). For example, in 2D space the axes are typically labeled *x* and *y*, and in 3D space they are typically labeled *x*, *y*, and *z*. Points in the space can be defined *along* the axes, and rotations about a point can be defined *around* the axes.

- A representation of the measurement system being used along the axes, e.g., meters or inches, and around the axes, e.g., degrees or radians (e.g., units).
- A way of defining how the order of the axes corresponding to coordinates in the space (e.g., orientation). For example, a 3D coordinate system can be considered right-handed or left-handed, where the *x*, y, and z axes correspond to the fingers of the left or right hand, when held in a particular configuration.

61. Any 3D object in a 3D space has, or can be given, a 3D coordinate system. In general, when one refers to the "position" of the object in 3D, one is referring to the position of the root of the object's 3D coordinate system in the parent's 3D coordinate system. For example, a chair in a room would have a 3D coordinate system. If the chair had four legs, the root might be defined as being at the bottom of the back-left leg, with the *x* axis extending from the root toward the back-right leg, the y axis extending from the root toward the front-left leg, and the *z* axis extending from the root upwards. Similarly, the room itself would have a 3D coordinate system, with the *x*, *y*, and *z* axes defined appropriately in that space. The chair's root would have the x, y, z, coordinates (0,0,0) in its own coordinate system. Similarly, the room's root, which might be defined in one of the corners of the room, would have the x, y, z, coordinates (0,0,0) in its own coordinate system. However,

the chair's root is most likely *not* (0,0,0) in the *room's* coordinate system — it is most likely positioned somewhere in the interior of the room, not in the corner, for example, at room coordinates (1,1,0) to represent one meter into the room along the *x* and *y* axes, and on the floor ($z = 0$). Any object (defined by its own coordinate system) can be translated and rotated in its parent coordinate system by using linear algebra. For example, the chair could be moved an additional meter along the *x* axis of the room, resulting in the chair being at (2,1,0) in the room coordinate system. Similarly, the chair could be rotated around any of the axes of the room coordinate system using linear algebra, for instance, to rotate the chair to the "left," one would use linear algebra to rotate the chair's coordinate system 90° counterclockwise around the *z* axis (up).

62. Further, both real and virtual spaces have independent coordinate systems. While it is possible that the roots of the real and virtual spaces would coincide, it is unlikely. For example, if a VR game played on a tablet, a smart phone, or an HMD was launched while standing at near the southwest corner of Central Park in New York City, e.g., at the corner of Central Park W and W 59th Street, the root of the virtual world of the game, which is (0,0,0) in the coordinate system of the virtual world of the game, would be positioned at a corresponding latitude, longitude, and elevation such as (40.768°, -73.981°, 1601 feet) in the coordinate system of the earth — the earth's *x*, *y*, and *z*. However, if the same game was

launched while standing in the Bronx Zoo, the root of the virtual world of the game would be positioned at something like (40.850°, -73.880°, 280 feet) in the coordinate system of the earth. In either situation, the root of the virtual world in the coordinate system of the *virtual world* would *remain* at (0,0,0), while the root of the virtual world in the coordinate system of the *earth* would *change*.

63. One result of nested coordinate frames such as that I described above, is that any point in either the real or virtual world corresponds exactly to a point in the other world. In addition, translating an object one meter in some direction in one world, e.g., along one of the earth's axes, would typically result in corresponding translation along the aligned axes of the virtual world's coordinate system, in whatever translational units and scale are appropriate. Similarly, rotating an object 90° around some axis in one world, e.g., around the vertical axis, would typically result in corresponding rotation around the aligned axes of the virtual world's coordinate system, in whatever rotational units and scale are appropriate.

64. For a typical location-based game, or a typical VR/AR application, the position and orientation of the display and/or the user's head must be estimated, so that the appropriate imagery can be shown. This is very much like the navigation systems in our smart phones — as we drive around, the unit is continuously determining our position and direction of travel on earth, and rendering the map appropriately, so that we can see where we are on the map. There are many ways to

estimate the position and orientation of a device or a person's head, hands, etc. I have published several articles on this topic, including for example my article "Motion Tracking: No Silver Bullet, but a Respectable Arsenal" with Eric Foxlin EX1028, 24 and the course notes from the ACM SIGGRAPH 2001 course "Tracking: Beyond 15 Minutes of Thought" with Danette Allen and Gary Bishop. In the following I provide a relatively brief overview of some relevant mechanisms.

65. Using latitude, longitude, and elevation (lat-lon-el) coordinates in the earth (real world) coordinate system as I did above, corresponds to the most commonly used outdoor positioning system in the U.S.: the Global Positioning System (GPS). The GPS system comprises a collection of satellites that orbit the earth in precise patterns while transmitting a radio signal toward earth, a receiver that receives the signals on earth, and a computational unit that estimates the 3D (lat-lon-el) position of the receiver on earth. The computation is based on the time it takes each signal to reach the receiver, which necessitates very precise system clocks. For various reasons, including ill-conditioned geometric positions of the satellites at any one moment, buildings or trees that block or reflect the radio signals, and the intentional injection of controlled error (to deny enemies useful accuracy), the error in the 3D position reported by a GPS receiver can vary significantly over time, e.g., typically 3–10 meters, in the best case 1–3 meters, and in the worst case more than 10 meters. In general, if one knows the 3D position of a fixed object in

the earth's coordinate frame, e.g., a particular grocery store, then a system can use GPS to estimate the position *relative* to that point, e.g., to help one navigate to the grocery store.

66. Position and orientations estimations can also be aided by other sensors, e.g., inertial sensors and/or an electromagnetic compass. However, inertial sensors, e.g., linear accelerometers and angular rate gyros, only measure changes in position or orientation over time, and so the measured values must be integrated (summed over time) to produce estimates of change in position or orientation. For example, linear accelerometers measure the second derivative of the position with respect to time along the primary axis of the sensor, and angular rate gyros measure the first derivative of the orientation with respect to time around the primary axis of the sensor. Devices that make use of an approach like this (e.g., dead-reckoning modules), along with a history of position, speed, and direction estimates, to continually estimate the *change* in position, from a starting point, over time.

67. A significant problem with the integration of the measured accelerations and rates in all such systems is that inevitable measurement noise is integrated along with the true inertial values (which are unknown/unmeasurable), which results in the estimates drifting over time. In the case of linear accelerometers, the measured values must be integrated twice over time (they produce the second derivative of the position over time), which means both the estimates and the

uncertainty in the estimates can drift at a super-linear rate, e.g., quadratically with time. As such, accelerometers and gyros cannot practically be used alone to estimate the position and orientation of a device for any application, including location-based gaming. In fact, every measurement device has problems. For example, electromagnetic compasses can be affected by significant magnetic interference from objects around the device, and even the device itself.

68. These issues with GPS, inertial, and magnetic sensors are some of the reasons why one will always see systems employing multiple modalities, i.e. hybrid systems. For example, today's VR and AR systems typically combine GPS, inertial sensor measurements, electromagnetic compass measurements, and camera imagery to estimate the position and orientation of the device. Sensors that calculate a device's position when GPS signals are unavailable (e.g., dead-reckoning modules) typically do the same, although without camera imagery.

69. Modern devices, including both handheld devices and VR/AR HMDs, benefit tremendously from the commoditization of the smart phone, and the competition that has driven the quality of displays, tracking, and computing upwards, while driving the size, weight, and power requirements downwards. To a large extent, and sometimes literally, today's HMD-based VR/AR systems actually use smart phones internally. At the very least, they use the components and algorithms from smart phones, as they are being continually refined.

E. Navigation and Spatial Awareness

70. As reported by Darken and Cevik in 1999, when navigating a virtual world using a map, the way one navigates depends on the orientation of the map or displayed representation with respect to the user's frame of reference, either an egocentric reference frame (ERF) or a world reference frame (WRF). EX1011, 1. The authors report that the two most common relationships are *north-up* and *forward-up*. *Id*., 1. This is also true for most navigation devices or smart phones. The north-up approach fixes the orientation of the map such that the direction corresponding to north is always towards the top of the display. Even if a user rotates to the right, for example, the orientation of the map remains fixed such that north is up (with respect to the display), east is to the right, etc. The forward-up approach continuously adjusts the orientation of the map such that it is always congruent with the forward direction of the user. So if the user is facing north, the map is oriented so that north is up. However, if the user rotates to the right, the map also rotates, so that now east is up (with respect to the display), south is to the right, etc. As the user rotates, the map continuously re-orients to match the direction they are facing. Both modes typically include a "you are here" (YAH) indicator, e.g., a small dot or symbol that indicates your position in the map. In either case, the YAH marker can be chosen to convey the orientation of the devices, e.g., a cone. *Id.*, 3.

71. Some users prefer one, and some the other. Users might even switch between the two, depending on the task or circumstances. For example, Darken and Cevik report that targeted search tasks, e.g., looking for a particular item, rely on the user's immediate perspective (egocentric reference frame), and are thus more efficient with forward-up maps. EX1011, 5. On the other hand, tasks that are intended to develop an understanding of the overall environment in the world reference frame benefit from north-up maps. The authors also indicate that one's ability to mentally rotate objects can play a significant role in navigation efficiency: users with strong mental rotation skills perform better across both map types, whereas users with lower spatial abilities perform better with forward-up maps as they reduce the need for mental rotation during navigation. *Id.*, 5.

72. Darken and Cevik discuss first-person games such as DOOM™. They report that "[w]hile searching tasks are most prevalent in games such as DOOM™* and its derivatives, there is also a strong demand for configuration knowledge†. Players who learn optimal paths and alternate paths through these environments have an advantage over those who are unfamiliar with the space." *Id.*, 1. This makes sense, as those who learn the space better, and the surprises it holds, will likely fare better in the game. They also report that "[w]hen in map mode, DOOM™ players can move themselves in the environment by manipulating the YAH marker on the map (see figure 1)." *Id.*, 2.

73. As I indicated above in the previous section, the root of the coordinate system of a virtual world can be moved around in the coordinate system of the real world. In my example above, the user could start the game while standing near the southwest corner of Central Park or standing in the Bronx Zoo; in either case the game would start from the same place in the virtual world, but different places in the real world. This same principle applies to orientation: if a game always starts with north facing upward on the display, one could start the game facing north in the real world, in which case the north of the real and virtual worlds would be colinear (the same), or one could start the game facing some other direction, e.g., east, in which case eastward movement in the real world would cause northern movement in the virtual world.

74. If one was playing a location-based game in an infinitely large space, the relative orientations of the real and virtual world coordinate systems would not matter — the user could walk as far as desired in any direction in the virtual world and never face the issue of running out of space, or running into something, in the real world. However, in the real world, we do not have infinite space. Any location-based game that seeks to correlate real world movement with virtual world movement must contend with the limitations of the real world, even if the virtual world has no such limitations. For example, one might hope to walk for a long distance in the virtual world displayed on the device, but encounter something in the

real world that precludes forward motion, e.g., a dead end or a building. In such a situation, if the user wants to continue forward in the virtual world, they or the system needs to change the relative orientation of the real and virtual worlds — in effect they need to change the notion of what "forward" means in the real world. For example, if a user is walking down an alley in the real world, and reaches a dead end, if they want to continue "forward" in the virtual world the only option is to rotate the virtual world by 180° so that the user is able to turn around and walk in the reverse direction down the alley, while seemingly continuing to walk "forward" in the virtual world.

75. As early as 1990 (at least), researchers were developing mechanisms to interactively change one's viewpoint. For example, Colin Ware and Steven Osborne wrote that "[i]t is also possible to use the "scene in hand" metaphor to change viewpoints; by selecting the root object in the heirarchical [sic] scene and twisting the bat, the virtual environment is rotated about the center of the root object." EX1029, 176. The authors describe this as "akin to having an invisible mechanical linkage which converts all hand translations and rotations into translations and rotations of the scene (see Figure 2)." *Id.*, 177. I have reproduced Figure 2 from that 1990 paper below.

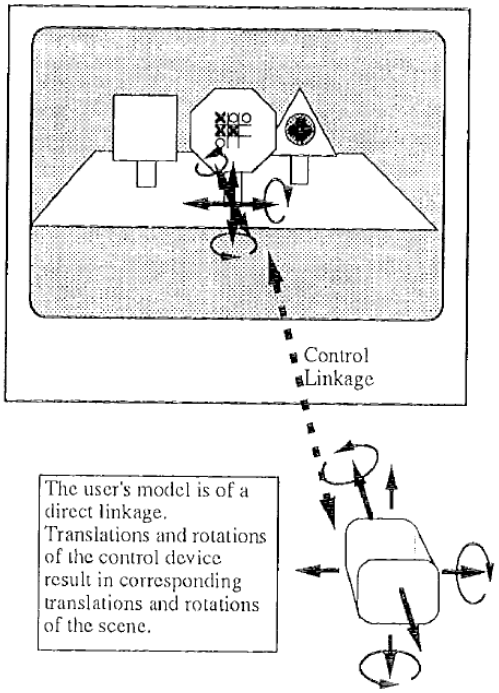


Figure 2. Scene in hand metaphor

76. In his 1999 Ph.D. dissertation, Doug Bowman included "Indicate Orientation" (and "Indicate Position") as a top-level technique in his "Alternate Taxonomy for Travel Techniques." EX1030, Figure 4.7. He described specifying viewpoint orientation (and position), writing "[w]e recognize that the task of viewpoint motion control consists mainly of two parts: setting viewpoint position and **setting viewpoint orientation**. Within each of these parts, there are two quite different methods one might employ. **One might specify the destination or target** position/**orientation**. This is a discrete, one-time selection." *Id.*, 44 (emphasis added).

77. In her 2002 Ph.D. dissertation titled "A new taxonomy for locomotion in virtual environments," Laura Arns writes: "[s]ince we are still subject to this physical limitation while using the VR system, and unable to fully rotate our body with respect to the virtual world, we can instead rotate the virtual world with respect to us." EX1031, 56. Arns went on to describe how this is "most commonly performed," saying "[r]otation of the virtual world is most commonly performed using an interaction device such as a wand. Generally, there is a "home" orientation for the device, so that when the device is in the home position no rotation of the virtual world occurs. However, when the interaction device is changed to a new orientation, it causes the virtual world to rotate around the user or the interaction device." *Id.*, 56.

78. Because necessary manual interventions by the user to change their orientation were found to be disruptive, by 2001 Sharif Razzaque et al. had been working on ways to automatically rotate the virtual world without the user being aware. The approach, which they called *redirected walking* (EX1032, 1), allowed for the continuous imperceptible rotation of the virtual world to address the issue of real-virtual conflicts.

VI. BACKGROUND

A. The '821 Patent

79. I understand that the '821 patent claims priority to a provisional application, U.S. Provisional Application No. 60/499,810, filed September 2, 2003 (EX1036, "the '810 provisional"). EX1001, Cover Page. A patent application claiming priority to the '810 provisional was filed on September 1, 2004 and eventually issued as the '821 patent.

80. The '821 patent describes well-known systems that employ wireless communication devices with locating and directional devices to allow multi-user gameplay in a virtual world. The '821 patent generally focuses on "an actual, reality-based video game in which a user's physical (actual) location on a playfield, reflects a virtual game character's virtual location in a video game environment." EX1001, 2:27-30. For example, the '821 patent describes a multiplayer virtual PACMAN game as an example of such a reality-based video game, where one player may "[c]ontrol…PACMAN…by changing the location of the wireless [device]" and "[a] different player could use a different game system…to control a ghost in the same game." *Id.*, 3:47-54. Each "user may look down at a display screen, see his/her character, and run around his/her physical environment in order to similarly run his/her virtual character through a virtual maze." *Id.*, 3:56-59.

81. The '821 patent explains that the "[m]ultiple type[s] of displays are provided that realize a variety of different types of location-based games." *Id.*, 2:37-38. For example, a user's gaming device may be a wireless telephone with a display screen (*id.*, 10:29-33) or a device incorporating a head-mounted display (*id.*, 2:51-58). The '821 patent explains that "[l]ocation information may be utilized, for example, to determine a virtual character's location (e.g., a particular first-person perspective) in the virtual realm." *Id.*, 3:15-18. The '821 patent further describes various "locating devices" and "directional devices" that enable the collection of a user's location information during gameplay. *Id.*, 3:42-4:34. For example, a GPS device may be used as a locating device to obtain a user's location (*id.*, 3:44-47, 4:7-10), while a "directional electronic compass…provided through the configuration of two location devices (e.g., two GPS devices)" may be provided on a head-mounted display as a directional device that determines the direction a user's head is pointing (*id.*, 4:14-27).

B. The Challenged Claims

82. The '821 patent has 117 claims, and I understand that six of these claims—independent claims 1 and 102 and dependent claims 4, 11, 16, and 30—are challenged.

83. Independent claims 1 and 102 generally cover a system with a wireless communication device comprising a display, locating device, and processor, where

a user's physical location on a physical playfield corresponds to the virtual character's location on a virtual playfield. Independent claim 1 additionally contains limitations reciting a prompt requesting a manually provided direction of gameplay. Independent claim 102 additionally contains limitations reciting a directional device and a prompt requesting a manually provided root of gameplay.

84. Dependent claims 4, 11, 16, and 30 further require a perimeter selected by user inputs, a directional device, a speaker and microphone, and human communications between a wireless communications device and wireless telephonic device during gameplay.

1. Priority of the Challenged Claims

85. In my opinion, the '810 provisional does not provide written description for independent claims 1 and 102 of the '821 patent, nor their dependent claims. Claim 1 requires "recording a manually provided direction in response to a prompt requesting said manually provided direction." EX1001, 24:5-9. Claim 4, which is dependent on claim 1, requires that "said video game utilizes a perimeter selected by user-inputs." EX1001, 24:14-15. In my opinion, there is no written description support for either of those claim 1 or claim 4 limitations in the '810 provisional. *See generally* EX1036. Neither a "manually provided direction in response to a prompt requesting said manually provided direction," nor "a perimeter

selected by user-inputs" is described or even discussed in the '810 provisional– support for the limitations is completely absent. *Id.*

86. Moreover, in my opinion, there is no written description support for claim 102 of the '821 patent, which requires that a "locating device comprises a movement measuring device operable to be utilized, at least in part, to determine said physical location." EX1001, 30:27-29. The '810 provisional does not describe a "movement measuring device" that can "determine said a physical location." *See generally* EX1036. The '810 provisional does not describe a movement measuring device or movement measurement at all. *Id.*

87. Instead, the '810 provisional solely discloses "location" sensing via, for example "a GPS device (or any type of locating device)." EX1036, 6. But a POSITA would understand that "movement" typically would not mean the same thing as "location" – "location" generally describes a point in space, whereas "movement" typically means more than one point in space over time, or continuous position change over time, e.g., velocity or acceleration.

88. The '821 patent specification itself makes this distinction clear where it refers to "**devices that measure movement (e.g., an accelerometer) may be utilized as a locating device**. Accordingly, acceleration information may be translated into location information and this location information may be utilized as a control signal (e.g., for changing the location of a video game character.)".

EX1001, 7:14–20. As a POSITA would expect, then, the '821 patent differentiates between "devices that measure movement" (*a movement measuring device*) from devices that measure "location." And because the specification makes it clear that "movement" can be used to estimate "location," the two are not the same thing; the specification is referring to distinct devices. *See e.g.*, *id*; *id.*, 12:37-41 ("[O]ne of the many ways in determining **virtual character movement** may be by determining the difference and direction between **the user's current location and his/her origin location**. Such information may be stored, retrieved, and/or processed as a vector.").

89. As such, it is my opinion that the inventor did not consider "location" and "movement" to be synonymous as the patent makes it clear that a "movement measuring device" is not the same as a location sensing or measuring device. Because the '810 provisional discloses only a location sensing device, it is my opinion that the '810 provisional lacks written description support for the claim 102 limitation a "locating device [that] comprises a movement measuring device operable to be utilized, at least in part, to determine said physical location." *See* EX1001, 30:27-29.

90. Accordingly, in my opinion, the '810 provisional does not contain any written description support for the "manually provided direction" of claim 1, nor the "perimeter selected by user-inputs" limitation of claim 4, challenged claim 1 and its challenged dependent claims (claims 4, 11, 16, and 30 *see* Sec. VI.B. *infra*) are not

entitled to claim the benefit of priority to the '810 provisional. Additionally, as I describe above, it is my opinion, that claim 102 lacks written description support because the '810 provisional does not provide support for the limitation a "locating device comprises a movement measuring device operable to be utilized, at least in part, to determine said physical location." I understand that this means that the earliest effective priority date for the claims 1, 4, 11, 16, 30, and 102 is no earlier than September 1, 2004.

C. The Prosecution History

91. I understand that the initial application for the '821 patent is U.S. Patent Application No. 10/932,536, which was filed on September 1, 2004, and was rejected in a series of non-final and final rejections from 2004 until 2019. EX1002, 307-54, 405-54, 507-56, 606-55, 711-60, 811-60, 913-62, 1011-60, 1110-58, 1208-56, 1318-58, 1408-40, 1496-30, 1584-93. I understand that for the majority of prosecution, claims 1, 4, 11, 16, 30 (corresponding to prosecution claim 32), and 102 (corresponding to prosecution claim 100) were subject to minimal amendments and largely recited limitations that resemble the final language of the claims. *Id.*, 383-403, 464-84, 562-82, 664-84, 767-87, 867-87, 966-86, 1067-87, 1166-86, 1271-91, 1369-89, 1548-67, 1658-61. Mullen was not able to overcome the rejections under anticipation and obviousness until Mullen amended all claims to recite a *wireless communication device* rather than a *wireless telephone*, and amended claim 1 to

additionally recite *a direction of gameplay of said video game is operable to be established by recording a manually provided direction in response to a prompt requesting said manually provided direction*, and claim 102 (original claim 100) to additionally recite *an origin of gameplay of said videogame is operable to be established by recording a manually provided origin in response to a prompt requesting said manually provided origin*. *Id.*, 265-68, 271, 283. I understand that the claims were ultimately allowed on February 17, 2021 (*id.*, 10-14), and the '821 patent issued on June 15, 2021 (EX1001, 1).

VII. LEVEL OF SKILL IN THE ART AND PERSPECTIVE APPLIED IN THIS DECLARATION

92. I understand that certain issues relating to validity must be judged from the perspective of a person of ordinary skill in the relevant art, as I discussed below.

93. The purported invention of the '821 patent generally relates to well-known systems and methods of using wireless communication devices with locating and directional devices to allow multi-user gameplay in a virtual world.

94. In determining the level of ordinary skill, I have been asked to consider, for example, the types of problems encountered in the field, prior solutions to those problems, the rapidity with which innovations are made, the sophistication of the technology, and the educational level of active workers in the field. In my opinion, it would have taken at least two years of experience in the field for a person to

become familiar with the problems encountered in the field and the prior and current solutions to those problems.

95. A person of ordinary skill in the art ("POSITA") in 2004 would have had at least a bachelor's degree in electrical engineering, computer science, or a similar field, with at least two years of relevant experience working with VR and AR systems. Additional experience could substitute for less education, and additional education could likewise substitute for less experience.

96. My opinions do not turn on the precise definition, and the challenged claims would be unpatentable from the perspective of any reasonable POSITA.

97. I believe that I would have qualified as a person of at least ordinary skill in the art as of the earliest September 1, 2004 priority date of the '821 patent. I believe that I have a sufficient level of knowledge, experience, and education to provide an expert opinion in the field of the '821 patent.

VIII. OVERVIEW OF THE PRIOR ART

A. Cheok (EX1006)

98. I understand that Cheok, A. et al., *Human Pacman: A Sensing-based Mobile Entertainment System with Ubiquitous Computing and Tangible Interaction* (May 2003) ("Cheok") is a research paper authored by Adrian D. Cheok et al. of National University of Singapore, published in the NetGames'03 Proceedings of the

2nd workshop on Network and system support for games, a conference held on May 22-23, 2003 in Redwood City, California.

99. In my opinion, Cheok discloses many of the features recited in independent claims 1 and 102, except it does not expressly disclose *a manually provided direction of gameplay*, as recited in limitation 1[a]-3, or *a manually provided origin of gameplay*, as recited in limitation 102[d]. However, as I show in this declaration, these features were well known and ubiquitous especially in early augmented reality (AR) and virtual reality (VR) gaming systems. Cheok is presented as a primary reference below. *See* Secs. X-XII.

100. Generally, Cheok discloses a "Human Pacman" AR and VR gaming system like the '821 patent. *Compare* EX1006, 106-108, *with* EX1001, 3:11-5:15. Cheok's location-based Human Pacman game "allows players to…physically and immersively role-play the characters of the Pacmen and Ghosts as they move about freely in the real world over wide area outdoor spaces." EX1006, 106. Human Pacman closely resembles original Pacman, such that "the goal of the Pacman team is to collect all virtual plain cookies and hidden ingredients in Pac-World while avoiding the Ghosts," while "the aim of the Ghost team is to devour all Pacmen in the Pac-World." *Id.*, 110. As shown below in Figures 5 and 6, the virtual Pac-World is designed to closely correspond to the outdoor area chosen for gameplay. *Id.*, 110-11.

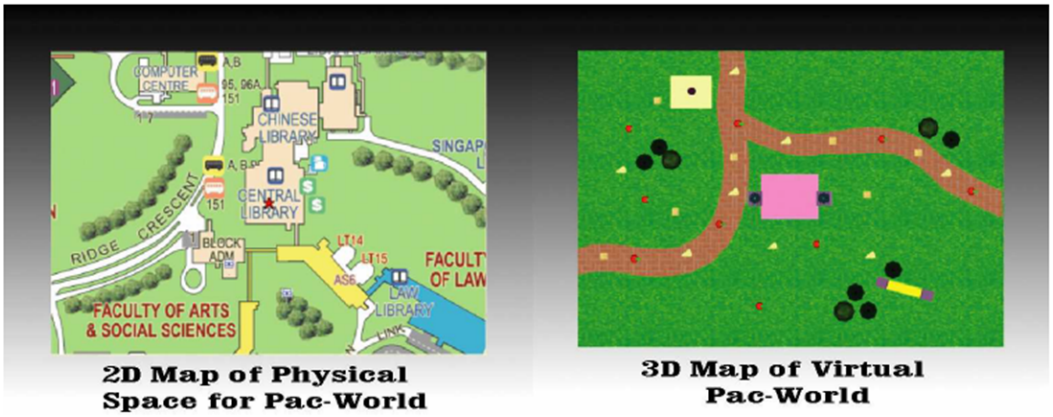


Figure 5. 2D map of game play area and its corresponding 3D map of Pac-world



Figure 6. Correspondence between the physical world and the virtual Pac-world

101. Cheok's Human Pacman employs an "interactive ubiquitous and mobile entertainment system that is built upon position and perspective sensing via Global Positioning System and inertia sensors; and tangible human-computer interfacing with the use of Bluetooth and capacitive sensors." *Id.*, 106. Cheok's system features "Pacmen and Ghosts" as "real human players in the real world experiencing mixed computer graphics fantasy-reality provided by using wearable computers that are equipped with GPS and inertia sensors for players' position and

perspective tracking." *Id.*, 106. An example of a user's wearable computer is shown in Figure 4 below. *Id.*, 110.



Figure 4. Detail configuration of wearable computer

Id., FIG. 4. The wearable computer also incorporates a head-mounted display which enables users to switch between AR and VR modes. *Id.* Figure 11 below shows an example of the two modes available to users.



Figure 11: HMD display and the corresponding label under VR mode when Pacman gains power

Id., FIG. 11.

102. Cheok further discloses that "[v]irtual cookies and actual tangible physical objects with Bluetooth devices and capacitive sensors are incorporated into the game play to provide novel experiences of seamless transitions between real and virtual worlds." *Id.*, 106. For example, Pacmen players collect virtual cookies and collect Ingredients that are Bluetooth embedded objects. *Id.*, 106, 109. As shown in Figure 9 below, when a player collects a cookie, the cookie disappears from the virtual world in real-time. *Id.*, 112.

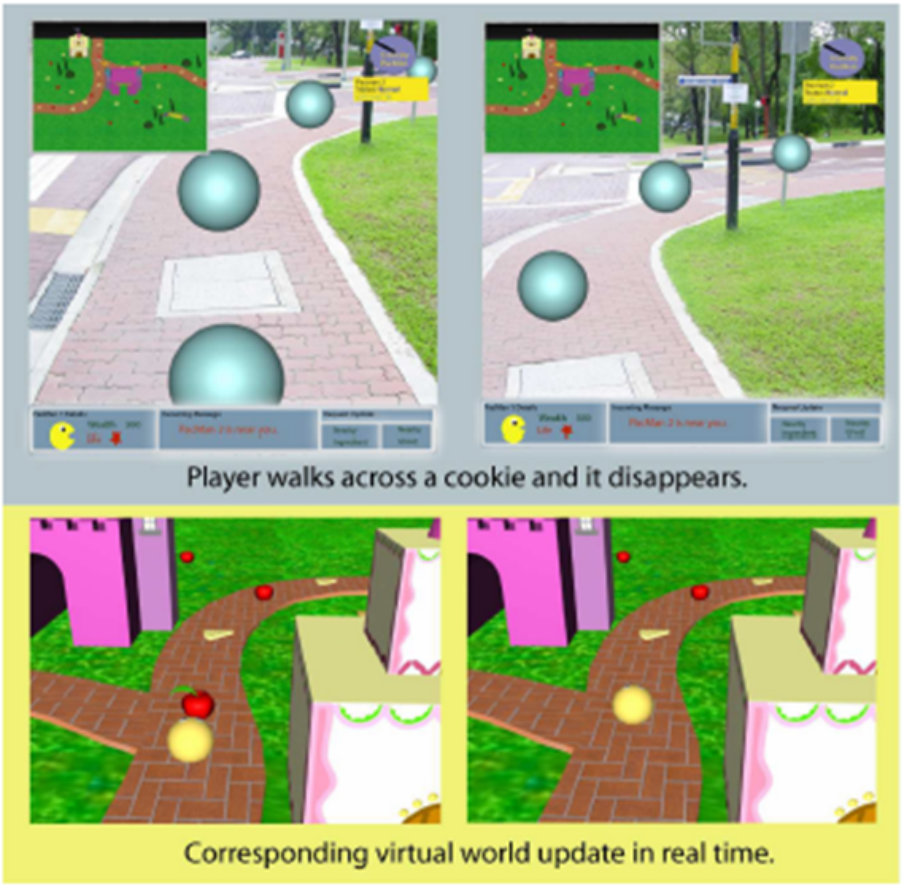


Figure 9: Pacman collecting cookies

Id., FIG. 9.

103. While Cheok's Human Pacman largely resembles original Pacman, it also introduces a third type of player — Helpers. As shown in Figure 8 below, Helpers participate in the game remotely via a computer terminal and exclusively use the "VR mode" — a mode where the user only sees the *virtual* scene and objects — to help Pacmen and Ghosts with identifying enemy mobile units and hidden ingredients. *Id.*, 106, 111.



Figure 8. Close collaboration between the outdoor Pacman and her Helper

Id., FIG. 8.

104. The above-described Human Pacman system "features a centralized architecture that is made up of four main entities, namely the central server, wearable computers, Sony VAIO laptops, and Bluetooth embedded objects," as shown in Figure 3 below. *Id.*, 109. Cheok discloses that "[t]he Wireless Lan serves as a communication highway between the wearable computers, the helper computers (Sony VAIOs laptops), and the server desktop computer." *Id.* "The underlying program is built on a client/server model with wearable computers and helper laptops as clients, and the desktop computer as a central server." *Id.*, 109-10. "The server

maintains up-to-the minute players' information (location, status etc.), and presides over any communication between Bluetooth objects and the wearable computers." *Id.*, 110.

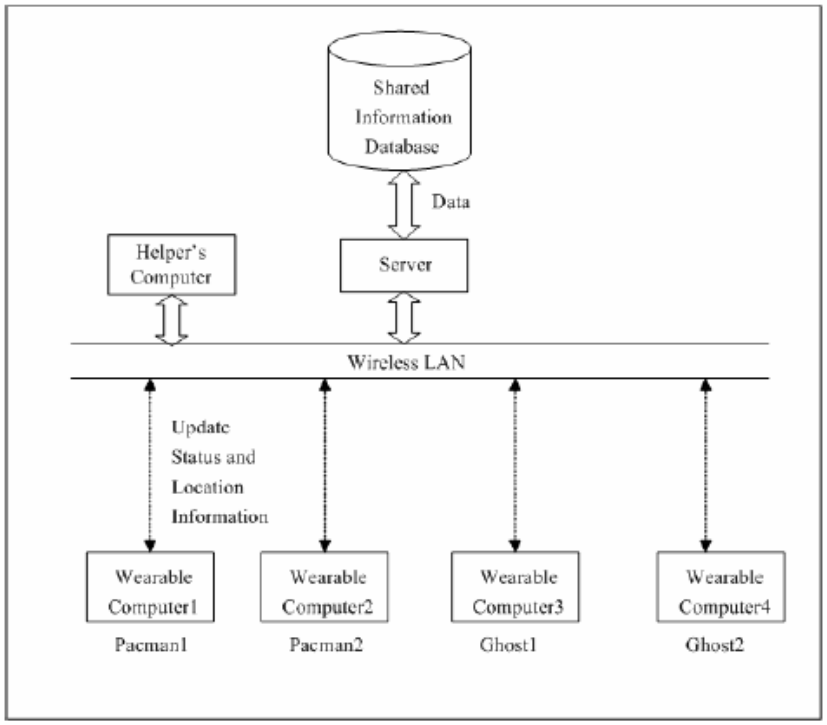


Figure 3. Complete system overview of Human Pacman

Id., FIG. 3.

105. As I discuss in my opinions on Grounds 1 and 2 (*see* Secs. X-XI), Cheok, like the '821 patent, discloses a *system* comprising *a wireless communication device* with a *locating device*, where a virtual character's *virtual location on said virtual playfield corresponds to said physical location on said physical playfield*, as recited in independent claim 1 and similarly in independent claim 102. *See also* Secs. VI.A-C (overview of '821 patent and challenged claims). Indeed, as I

discussed above, Cheok discloses a location-based gaming system comprising a wireless-enabled wearable computer device with GPS and inertial sensors, in which a user's location is tracked in the real world and their corresponding virtual character (e.g., a Pacman or Ghost) is shown in corresponding positions in the virtual world displayed on the user's head-mounted display. However, Cheok recognizes that there are vast sensor tracking issues that its paper does not address and would lead one to look to other sources that have addressed these issues. EX1006, 108, 115.

B. Nakamura (EX1007)

106. I understand that Japanese Patent Application Publication No. JP2001070658A to Nakamura ("Nakamura") was published on March 21, 2001.

107. In my opinion, Nakamura discloses many of the features disclosed in independent claims 1 and 102, except that it does not expressly disclose *a manually provided direction of gameplay*, as recited in limitation 102[d]. Nakamura is presented as a primary reference in Ground 4 (Sec. XIII) and Ground 5 (Sec. XIV). and also as a secondary reference in combination with Cheok in Ground 3 (Sec. XII).

108. Generally, Nakamura discloses "a system for controlling a computer based on location information," which involves a virtual role-playing game with virtual characters on a virtual playfield with virtual locations. EX1007, [0001]. As such, "new scenes or worlds automatically open depending on certain conditions." EX1007, [0005]. For example, "by utilizing current location information, which can

be obtained through technologies such as GPS, a new virtual world is opened." *Id.* A user walks, runs, or bicycles through the real world, and the user's current location in the real world is reflected in the virtual world, allowing the role-playing game to progress. *Id.*, [0015]. This enhances the game playing environment by combining real location information with conventional gaming methods. *Id.*, Abstract.

109. Nakamura implements its system on a mobile terminal equipped with a GPS unit for acquiring the user's current location. *Id.*, [0016], [0019]. The mobile terminal "connect[s] to a server system 20 that provides the role-playing game through the general internet 1 as the computer network." *Id.*, [0018]. Nakamura further discloses that "[i]n the role-playing game executed by the game system 10, a position icon (such as an illustration resembling a human figure) displayed on the screen moves in response to the movements of the user holding terminal 6." *Id.*, [0031]. This display of virtual position allows the user to feel as if they are "entering and moving through the virtual world of the role-playing game screen." *Id.* The virtual world also allows for the display of "event icons representing other users who are accessing the same role-playing game," as well as "communication (chat) through the screen" with the other users of the role-playing game. *Id.*, [0029].

110. As I discuss in my opinions on Grounds 4 and 5 (*see* Sec. XIII-XIV), Nakamura, like the '821 patent, discloses a *system* comprising *a wireless communication device* with a *locating device*, where a virtual character's *virtual*

location on said virtual playfield corresponds to said physical location on said physical playfield, as recited in independent claim 1 and similarly in independent claim 102. *See also* Secs. VI.A-C (overview of '821 patent and challenged claims). Indeed, as I discussed above, Nakamura discloses a gaming system comprising a mobile terminal with a GPS unit, in which a user's location is tracked in the real world and their corresponding position icon (a human figure illustration) is shown in corresponding positions in the virtual world displayed on a mobile terminal.

111. Also, like the '821 patent, Nakamura discloses *recording a manually provided origin [of gameplay] in response to a prompt*, as recited in independent claim 102. Nakamura discloses an initialization process in which the user's movable position icon (representing a virtual character) is displayed on the mobile terminal's screen in an initial position, thereby prompting a user to further manually arrange the position icon in order to set a desired initial position for gameplay. EX1007, [0005], [0009], [0015]-[0016], [0019], [0025], [0034]-[0036].

C. Foxlin077 (EX1008)

112. I understand that U.S. Patent No. 5,645,077 to Foxlin ("Foxlin077") published on July 8, 1997, from an application filed on June 16, 1994. EX1008, 1. I personally know the inventor (Eric Foxlin). I remember his related M.S. work at the Massachusetts Institute of Technology (MIT), which served as the basis for Foxlin077, and is embodied in the commercial InertiaCube2 that I discuss below.

113. Foxlin077 discloses an inertial sensor for use in VR and AR applications. EX1008, Abstract, 1:16-22, 5:7-9, 6:20-22. Specifically, it is my opinion that Foxlin077 discloses features associated with *a direction of gameplay of said videogame is operable to be established by recording a manually provided direction in response to a prompt requesting said manually provided direction*, as recited in limitation 1[a]-3. Foxlin077 is presented as a secondary reference in combination with Cheok. *See* Secs. X-XI.

114. Foxlin077's inertial sensor addresses drift issues and "track[s] the orientation of a body to which it is mounted, without interaction with radiation, energy, signals, or physical connections from any other apparatus." *Id.*, 1:63-66. In particular, Foxlin077 recognizes "[a] difficulty with using gyroscopes for head-orientation tracking is drift," which "arises from integrating over time, a signal that is noisy, or has a bias." *Id.*, 2:56-58. Foxlin077 explains that "[d]rift would make the virtual world appear to gradually rotate about the user's head even when the user is not moving." *Id.*, 2:58-60. Foxlin077 resolves this with a "drift compensator" component that automatically corrects drift. *Id.*, 6:27-32, 9:1-23.

115. Drift compensation requires using parameters measured during an initialization process, as shown in red in Figure 4A below. *Id.*, 11:1-7; *see also id.*, 9:61-67.

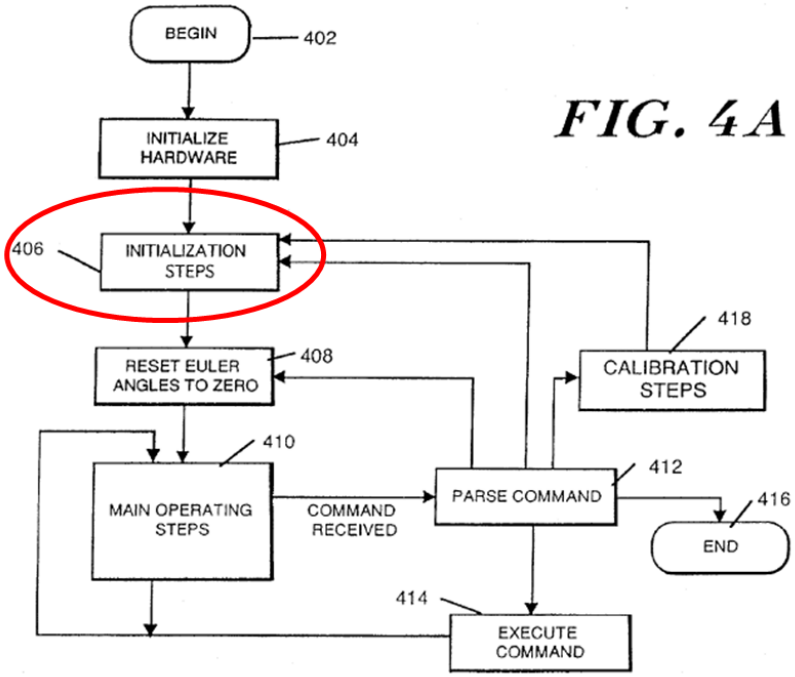


FIG. 4A

Id., FIG. 4A (annotated). The initialization steps "establish the rest position, from which orientation is measured and measure biases for the rate sensors," after which "the main operating steps 410 are performed." *Id.*, 9:67-10:7. Foxlin077 explains that "[i]nitialization must be conducted with the sensor assembly held stationary in a known reference orientation." *Id.*, 10:29-31. Foxlin077 explains that a "user is instructed 432 to place the sensor assembly in such a position by a message delivered to the apparatus input/output devices or implicitly by the fact of starting the tracker." *Id.*, 10:31-35. After initialization, the operating steps are repeated until a command is received, where a command may be user-generated and includes operations such as a reinitialization process. *Id.*, 10:9-11, 10:17-20.

116. As I discuss in my opinions on Ground 1 (*see* Sec. X), Foxlin077, like the '821 patent, discloses *recording a manually provided direction in response to a prompt*, as recited in limitation 1[a]-3, because as discussed above, a user is instructed to manually place the inertial sensor assembly in a known reference orientation in order to establish the rest position from which orientation is measured.

D. Benini (EX1009)

117. I understand that Benini, L. et al., *Palmtop Computer for managing Interaction with Immersive Virtual Heritage* (2002) ("Benini") is an article authored by Benini et al. of the University of Bologna and CINECA Supercomputing Centre, published in the Euromedia'2002 Conference Proceedings for the 7th Annual Euromedia Conference, held April 15-17, 2002 in Modena, Italy. EX1009, 1.

118. Benini discloses wireless portable devices for exploring virtual environments. EX1009, 1-4. Specifically, Benini discloses features associated with *a direction of gameplay of said videogame is operable to be established by recording a manually provided direction in response to a prompt requesting said manually provided direction*, as recited in limitation 1[a]-3. Benini is presented as a secondary reference in combination with Nakamura. *See* Sec. XIII.

119. Benini discloses a "hardware/software system for PDA-based interaction with IVEs [(immersive virtual environments)] realized in the field of Virtual Heritage (VH): Virtual Reality applied to Cultural Heritage." EX1009, 2.

Benini aims to "reconstruct[] cultural heritage objects and environments" in an immersive virtual reality environment. *Id.*, 2. For example, "Virtual Heritage" applications may allow scholars to explore an archaeological site or the general public to explore a virtual museum. *Id.*, 2. Benini discloses the use of "standard, consumer-market wearable interactive terminals, such as palmtop computers (Pocket PC and PDAs), as the preferred interfacing device with IVEs…in the field of Cultural Heritage." *Id.* As shown below in Figure 3, the system consists of portable terminals for interfacing with the virtual environment (e.g., a virtual theatre) over a wireless network, along with client-server software that runs on the terminals (client) and virtual reality engine (server). *Id.* at 4.

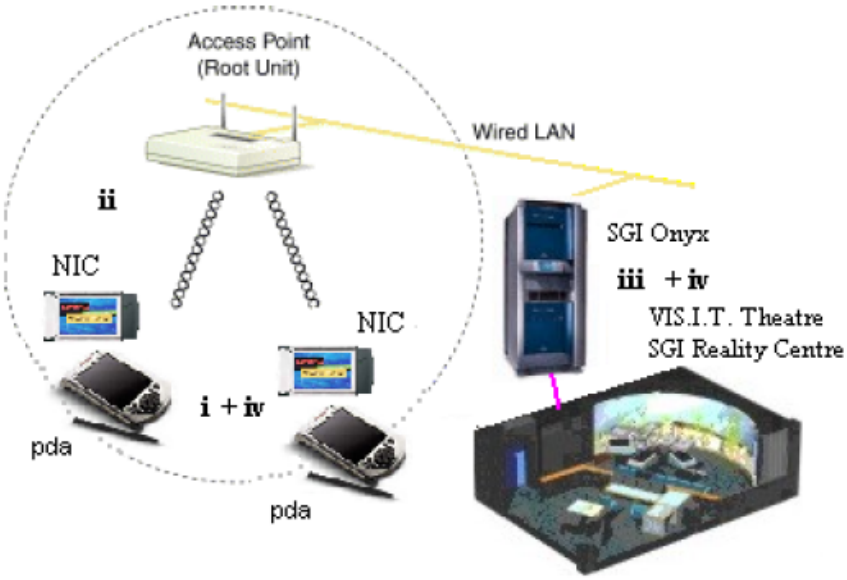


Figure 3: Components of the interactive system: portable terminals(i), wireless network(ii), virtual theater (iii), client-server software (iv).

Id., FIG. 3.

120. Benini additionally explains how the portable palmtop computers / PDAs can be used to support the basic interaction tasks in the field of 3D user interfaces—navigation, selection/manipulation, and system controls. *Id.*, 2-3. For example, a PDA may incorporate a "'2D map' in which the users visualize their position and orientation in the virtual world," to allow users to see "which regions can be reached by their current position." *Id.*, 3. Benini explains that "[t]he UI features a two-dimensional map abstraction of the VR world, augmented with various navigation controls," including "eight arrows to more intuitively navigate in the environment." *Id.*, 3. The 2D map reproduces a view of the virtual environment, "enabl[ing] the user to visualize his/her position in the virtual world with a red rectangle and the direction of observation with a green rectangle…." *Id.*, 4. Figure 2 below shows an example PDA with arrows (in green) for visualizing position and direction in the virtual environment.



Figure 2: The User Interface developed for interacting via PDA with the Nu.M.E. VE

Id., FIG. 2 (annotated). "[F]our arrows realize[] the metaphor of moving forward, backward, left and right the avatar in the VE as if it is walking into it; and four arrows are used to turn around and to look up and down…." *Id.*, 4. As shown above in green, the display prompts a user to use four of the arrows to "walk," i.e., change position, and four of the arrows to "look," i.e., change orientation/direction. *Id.*, FIG. 2. Benini further discloses that the user interface arrows can be used to "change [the] camera's position and orientation (interacting with the 2D map or with the arrows)," thereby changing the view in the virtual environment. *Id.*, 4. When "requesting to change camera's position and orientation" according to interaction

with the map/arrows, the portable terminal (client) has to send to the server (virtual reality engine) "a 6-dimensional vector that includes world coordinates (*x, y, z*) and the three angles: heading – the rotation about the Z axis – pitch – the rotation about the X axis – and roll – the rotation about the Y axis." *Id.*, 5. This allows the server "to increment [the] current camera's position and orientation" to show a new view in the virtual environment. *Id.*

121. As I discuss in my opinions on Ground 3 (*see* Sec. XII), Benini, like the '821 patent, discloses *recording a manually provided direction in response to a prompt*, as recited in limitation 1[a]-3, because as discussed above, the portable terminal prompts a user to use directional arrows that allow a user to manually change the position and orientation of a virtual world on the display. *See also* Secs. VI.A-C (overview of '821 patent and challenged claims).

E. Rallison (EX1014)

122. I understand that U.S. Patent No. 5,991,085 to Rallison et al. ("Rallison") published on November 23, 1999, from an application filed on July 12, 1996.

123. Rallison discloses a head mounted display device that includes numerous features and displays an image to provide "virtual reality" or a "simulated environment" for a user. EX1014, Abstract, 17:21-26. In my opinion, Rallison discloses the HMD as *a wireless communication device* with *a speaker* and a

microphone that provides *human-communications to a second wireless telephonic device*, as recited in claims 16 and 30 (EX1014, 18:21-28; 20:7-12). Rallison is presented as a secondary reference in combination with Cheok and Foxlin077.

IX. CLAIM CONSTRUCTION

124. I have applied the plain meaning of the terms and phrases in the claims in my analysis, as a POSITA would have understood those terms and phrases at the relevant time (around 2003). I understand that the Board will construe the claims using the same claim construction standard that would be used in district courts. My declaration will establish that the prior art meets each of the claim limitations under any reasonable construction. I have not been asked to consider any express constructions.

X. OPINIONS ON GROUND 1: CHEOK IN VIEW OF FOXLIN077 RENDERS OBVIOUS CLAIMS 1, 4, AND 11

A. A POSITA Would Have Been Motivated to Combine

125. In my opinion, a POSITA would have been motivated to modify the Cheok Human Pacman system based on the teachings of Foxlin077, for example, to implement an inertial sensor initialization/reinitialization process for improved accuracy and reduced drift. It is my opinion that a POSITA would have been motivated to implement these teachings for the following reasons, as I explain further in Sec. X.C.5.b. Cheok suggests that its wearable computer's sensors, including the inertial sensor, are subject to an initialization process, but does not

disclose any specific initialization processes. EX1006, 108-09. A POSITA would have thus been motivated to rely on Foxlin077's initialization/reinitialization process, in which a user manually sets an orientation in response to a prompt, because a POSITA would understand that establishing an initialization point is a necessary step in any such system. Indeed, a POSITA would have been motivated to consult Foxlin077 for these inertial sensor features because both Cheok and Foxlin077 describe an InertiaCube2 inertial sensor. *See* Sec. X.C.5.b; EX1006, 109, 116; EX1013, 2. It would have been natural for a POSITA using the InertiaCube2 inertial sensor of the system of Cheok to look at other references that provided greater details on how that inertial sensor functions.

126. A POSITA would have been further motivated to implement the Cheok system based on Foxlin077's initialization/reinitialization teachings because Cheok states that its sensors may be subject to tracking issues not addressed by the scope of the Cheok paper, *see* EX1006, 108, 115. Foxlin077 explains how to handle one common issue with inertial sensors—drift—with a drift compensation component that requires an inertial sensor initialization/reinitialization process. A POSITA would have also recognized that Foxlin077's initialization/reinitialization process would have improved user experience when interacting with the real environment.

127. Moreover, if a user using Cheok's system encounters a physical obstacle in the real world that is not represented in the virtual word, the user is unable

to avoid the obstacle without the avoidance (e.g., moving around the obstacle or in a different direction) being reflected in the virtual world. The combination of Cheok with Foxlin077 improves and enhances Cheok by permitting the user to adjust the virtual world so that the desired virtual route is aligned with the real world route a user is able or wants to take, so they can start walking again yet remain aligned with the virtual world.

B. A POSITA Would have Had a Reasonable Expectation of Success

128. In my opinion, a POSITA would have had a reasonable expectation of success combining the teachings of Cheok and Foxlin077, as I explain further in Sec. X.C.5.c. Specifically, a POSITA would have relied on Foxlin077's inertial sensor initialization/reinitialization process to improve Cheok's Human Pacman system. Implementing such a combination would have involved modifying the Cheok system in a manner that Cheok suggests is feasible—implementing the real-time tracking system such that an inertial sensor initialization process is performed.

C. Independent Claim 1

1. Preamble: *"A system comprising:"*

129. It is my opinion that Cheok discloses the preamble. As I discussed further above in Sec. VIII.A (Cheok overview), Cheok discloses a "Human Pacman"

gaming *system*[1] that brings existing iterations of Pacman into an augmented and virtual reality environment, allowing for human players representing Pacmen and Ghosts to engage in a physical role-playing game in a wide outdoor physical area. *See* Sec. V.A. Human Pacman supports both augmented reality (AR) and virtual reality (VR) modes, with Pacman and Ghosts equipped with wearable computers and head-mounted displays to enable them to switch between the two modes. *Id.* The wearable computers are also equipped with GPS and inertial sensors to track players' position and orientation. *Id.* Unlike original Pacman, Human Pacman also introduces a third type of player—Helpers, who participate in the game remotely via a computer terminal and exclusively use the VR mode to help Pacmen and Ghosts with identifying enemy mobile units and hidden ingredients. *Id.*

130. As shown in Figure 3 (which I have reproduced below), "Human Pacman features a centralized architecture that is made up of four main entities, namely the central server, wearable computers, Sony VAIO laptops, and Bluetooth embedded objects." EX1006, 109. Cheok discloses that "[t]he Wireless Lan serves as a communication highway between the wearable computers, the helper computers (Sony VAIOs laptops), and the server desktop computer." *Id.* "The underlying

[1] When mapping the prior art to the language in the claims, I use italics to indicate the recited claim language.

program is built on a client/server model with wearable computers and helper laptops as clients, and the desktop computer as a central server." *Id.*, 109-10. "The server maintains up-to-the minute players' information (location, status etc.), and presides over any communication between Bluetooth objects and the wearable computers." *Id.*, 110.

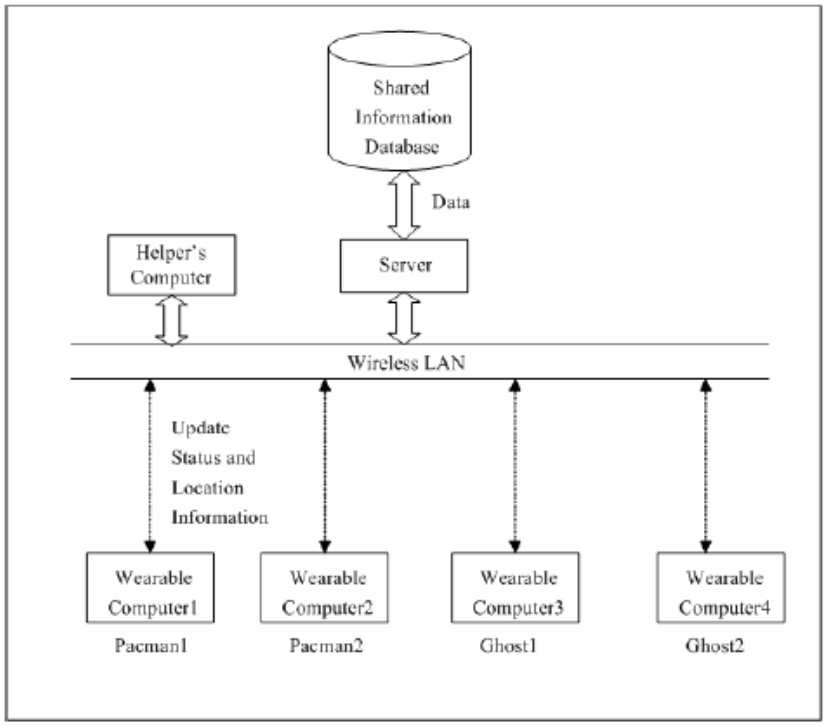


Figure 3. Complete system overview of Human Pacman

Id., FIG. 3.

2. 1[a]: *"a wireless communication device, wherein said wireless communication device comprises:"*

131. In my opinion, Cheok discloses this limitation.

132. Cheok discloses that each human player, whether playing as a Pacman or a Ghost, wears a wearable computer *device* that tracks movement through the real

world. EX1006, 106 ("Pacmen and Ghosts are now real human players in the real world experiencing mixed computer graphics fantasy-reality provided by using **wearable computers** that are equipped with GPS and inertia sensors for players' position and perspective tracking."), 107 ("In Human Pacman, players are provided with custom-built **wearable computers** that are designed, built, and developed in our lab especially for this application."), 107 ("Coupling [ubiquitous games] with the development in Wireless LAN technology and mobile computing using **wearable computers**, we have combined connected mobility with elements in ubicomp (i.e., natural interfaces, context-awareness, and automated capture and access) for realizing social gaming components in Human Pacman."), 108 ("The real-time position of each mobile user is sent periodically to the server through wireless LAN. Upon receiving the position data, the server sends an update to each **wearable computer** the position of other mobile players, as well as the positions of all 'non-eaten' plain cookies."), 109 ("Human Pacman features a centralized architecture that is made up of four main entities, namely the central server, **wearable computers**, Sony VAIO laptops, and Bluetooth embedded objects. An overview of the system is shown in Figure 3.").

133. Cheok discloses that a wireless LAN network is used to enable wireless communication between the wearable computers and the helper computers and server. *Id.*, 109 ("**The Wireless LAN serves as a communication highway**

between the wearable computers, the helper computers (Sony VAIOs laptops), and the server desktop computer."). I have reproduced below Figure 4, which shows a detailed configuration of a wearable computer. As shown in Figure 4, each wearable computer has a wireless LAN card (circled in red). A POSITA would have understood that each wearable computer is thus a *wireless communication device* because each wearable computer has a wireless LAN card that enables wireless communication (via the wireless LAN network) in the system.



Figure 4. Detail configuration of wearable computer

Id., FIG. 4 (annotated)

3. 1[a]-1: *"a display,"*

134. In my opinion, Cheok discloses this limitation. As circled in red in Figure 4 below, each wearable computer (*wireless communication device*) has a Cy-

Visor Head Mounted Display ("HMD") (*a display*). EX1006, 110 ("Since the wearable computers were designed and developed in the lab, we proceed to discuss its detail configuration as seen in Figure 4. The main components are Transmeta Single Board Computer (PC104 plus compliant motherboard running on Crusoe processor), Twiddler2 (handheld keyboard and mouse), **Cy-Visor Head Mounted Display (video see-through HMD)** with FireWire camera attached, two Sony F960 InfoLithium batteries, InertiaCube2 (inertia sensor), DRMIII module (GPS and Dead-Reckoning device from Point Research Corporation), and JVC Bluetooth device."). I have also reproduced below Figure 8, which shows the game player donning the wearable computer installed on the vest and the HMD on the player's head. *Id.*, 111-12.



Figure 4. Detail configuration of wearable computer



Figure 8. Close collaboration between the outdoor Pacman and her Helper

Id., FIG. 4 (annotated), FIG. 8.

4. 1[a]-2: *"a locating device operable to determine the physical location of said locating device on a physical playfield; and,"*

135. In my opinion, Cheok discloses this limitation.

136. Cheok discloses that the wearable computer incorporates a dead-reckoning module (*a locating device*) to enable location tracking of users, where the dead-reckoning module may contain a dead-reckoning device, GPS, digital compass, inertial sensors, and other components. EX1006, 106 ("There is a seamless merging of the fantasy computer digital world with the real physical world realized using **location and body tracking technologies,** namely the Global Positioning System (GPS), **Dead-Reckoning module (DRM)**, and inertia sensors, to provide the necessary context-awareness of the system for the game play."), 108 ("**Numerous sensors and tracking devices that are used in the system—dead reckoning module (DRM) with GPS and digital compass, inertia sensor, Bluetooth device, and capacitive sensor**—are vital to the manifestation of Human Pacman.), 110 ("The main components [of a wearable computer] are…**[a] DRMIII module (GPS and Dead-Reckoning device from Point Research Corporation)**…."). The dead-reckoning module is circled in red in Figure 4, which I have reproduced below.



Figure 4. Detail configuration of wearable computer

Id., FIG. 4 (annotated).

137. Cheok further discloses that the dead-reckoning module (*a locating device*) is used to track the real-time position of the user wearing the wearable computer (and thus the dead-reckoning module itself) (*operable to determine the physical location of said locating device*) as the user moves through the physical world (*on a physical playfield*). *Id.*, 108 ("**The DRM measures the displacement of the user from an initialization point** by measuring the direction (with data obtained from the compass), and distance traveled (using accelerometer data) with each footstep taken. Although the DRM is a self-contained navigation unit, when GPS position data is available, it can be used to correct both the distance and

direction calculations with the help of a Kalman filter algorithm….**The real-time position of each mobile user is sent periodically to the server through wireless LAN**. Upon receiving the position data, the server sends an update to each wearable computer the position of other mobile players, as well as the positions of all 'non-eaten' plain cookies."); *see also id.*, 108 (describing the calculation of "[t]he position of a player with respect to another player or location in the physical world").

5. **1[a]-3:** *"a processor coupled to said display and said locating device, wherein said processor is operable to provide a video game comprising a virtual character with a virtual location on a virtual playfield, said virtual character is displayed on said display, said virtual location on said virtual playfield corresponds to said physical location on said physical playfield, and a direction of gameplay of said videogame is operable to be established by recording a manually provided direction in response to a prompt requesting said manually provided direction."*

138. In my opinion, Cheok in view of Foxlin077 renders obvious this limitation.

a. Teachings of Cheok

139. **First**, Cheok discloses *a processor coupled to said display and said locating device*. Cheok discloses that the wearable computer, which is shown in Figure 4 below, has a single board computer which runs on a processor (*processor*), as well as a head-mounted display (*display*) and a dead-reckoning module (*locating device*). EX1006, 110 ("Since the wearable computers were designed and developed

in the lab, we proceed to discuss its detail configuration as seen in Figure 4. The main components are **Transmeta Single Board Computer (PC104 plus compliant motherboard running on Crusoe processor)**, Twiddler2 (handheld keyboard and mouse), **Cy-Visor Head Mounted Display (video see-through HMD) with FireWire camera attached**, two Sony F960 InfoLithium batteries, InertiaCube2 (inertia sensor), **DRMIII module (GPS and Dead-Reckoning device from Point Research Corporation)**, and JVC Bluetooth device.").

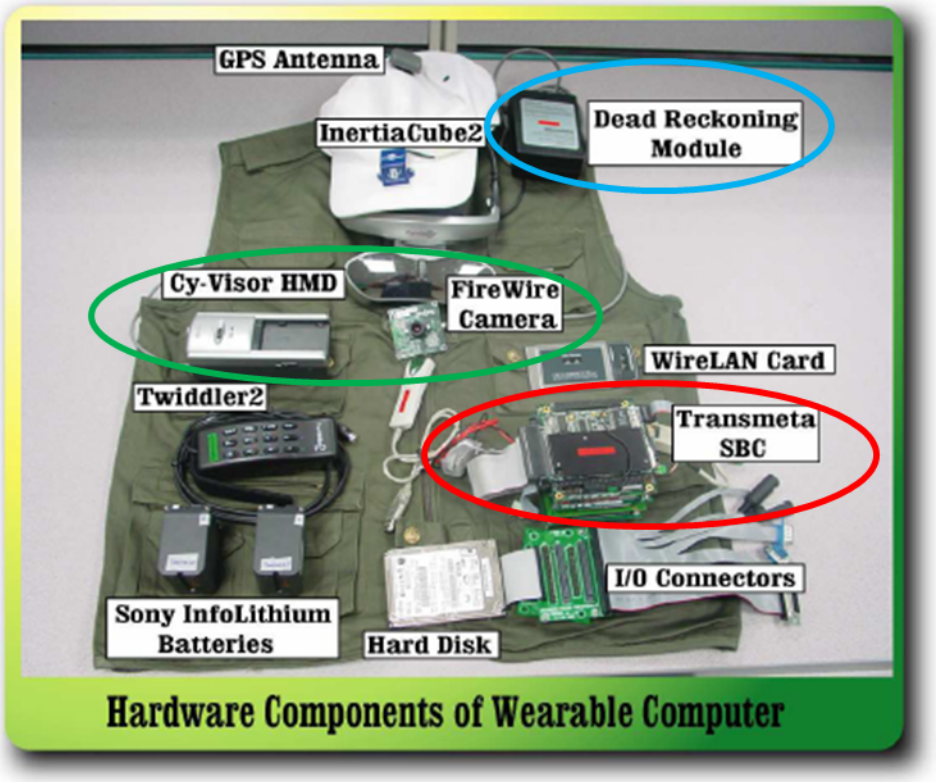


Figure 4. Detail configuration of wearable computer

Id., FIG. 4 (annotated). As shown in Figure 4 above, the wearable computer's single board computer (circled in red, and including a processor (*processor*) as discussed

above) is connected to the head-mounted display (circled in green) (*coupled to said display*) and the dead-reckoning module (circled in blue) (*said locating device*). Indeed, a POSITA would have understood that the single board computer (with processor), HMD, and dead-reckoning module would have had to be coupled to one another in order for the wearable computer to be operable.

140. **Second**, Cheok discloses *wherein said processor is operable to provide a video game comprising a virtual character with a virtual location on a virtual playfield*. Cheok discloses that Human Pacman is a *video game* because the wearable computer uses the camera to provide the game as a video stream through the video see-through head-mounted display. *Id.*, 109 ("Consequently using the player's position and head movement, the wearable computer calculates the relative position of each plain cookie within the view of the **camera** and superimposes a 3-D virtual cookie image of a proportionate size on corresponding position on the **video stream**. The position of other mobile players obtained from the server is used to **update the 2-D virtual map in the HMD view of the player**."), 110 ("The main components [of the wearable computer] are…**Cy-Visor Head Mounted Display (video see-through HMD) with FireWire camera attached**…."). A POSITA would have understood that the wearable computer's *processor is operable to provide a video game* because the processor executes the software that controls the

game. *Id.*, 110 (discussing the "software architecture…as the backbone of the game engine and the hardware as enabling tools").

141. Cheok further discloses that each player of the Human Pacman game is represented either as a Pacman or a Ghost *virtual character*. *Id.*, 106 ("**Human Pacman allows players to be physically and immersively role-play the characters of the Pacmen and Ghosts** as they move about freely in the real world over wide area outdoor spaces."). As shown in Figure 6 below, these Pacman and Ghost *virtual character[s]* are tracked in real-time such that each character's physical location in the real world corresponds to their *virtual location* in the virtual Pac-World (*on a virtual playfield*) at all times. *Id.*, 110 ("[T]here is a **direct and real time link between the wide-area physical world and the virtual Pac-Word at all times**, thus providing the users with a ubiquitous and seamless merging of the fantasy digital world and the realistic physical world."), 111 ("Despite being physically separated from one another and highly mobile, **each player is constantly tracked and her identity as unique entity in Pac-world is maintained in real time**.").



Figure 6. Correspondence between the physical world and the virtual Pac-world

Id., FIG. 6. For example, Cheok explains that each Pacman and Ghost (*virtual character*) starts the game from a Pac-castle or Ghost-house location (*virtual location*) in Pac-world (*on a virtual playfield*). *Id.*, 112 ("Pacmen and Ghosts start from the Pac-castle and Ghost-house in Pac-world respectively. These two places correspond to two different physical locations in the game area."). In other words, Cheok discloses that during gameplay, each Pacman or Ghost *virtual character* has a *virtual location* in the virtual Pac-world (*on a virtual playfield*).

142. **Third**, Cheok discloses *said virtual character is displayed on said display*. I have reproduced Figure 10 below and circled in red the virtual world (i.e., Pac-World) view visible to a user through the head-mounted display and corresponding to the user's real-world view. As shown in this Pac-World view, a

player's *virtual character* (e.g., a Pacman) *is displayed on said display* of the head-mounted display.



Figure 10: Sequence of pictures showing the collection of an ingredient

Id., FIG. 10 (annotated).

143. **Fourth**, Cheok discloses *said virtual location on said virtual playfield corresponds to said physical location on said physical playfield.* As I discussed above for limitation 1[a]-2, the physical location of a player on the physical playfield (i.e., the location of the user's dead-reckoning module on the wearable computer) is tracked in real-time. *See* Sec. X.C.4. As shown above for Figure 10, a player's real-

time movement is reflected in corresponding virtual movement. For example, as shown, when a player walks in certain directions, such as when exploring an area to find an ingredient (e.g., walking towards and then away from the sugar jar shown in Figure 10), the player's Pacman virtual character also moves in corresponding directions, such that the real world and virtual view correspond to one another at all times. *Id.*, FIG. 10. Similarly, as shown in Figure 9, which I have reproduced below, a movement by a player (e.g., walking across a cookie) is reflected with a corresponding virtual world update in real time (e.g., the cookie disappears and the Pacman advances forward).

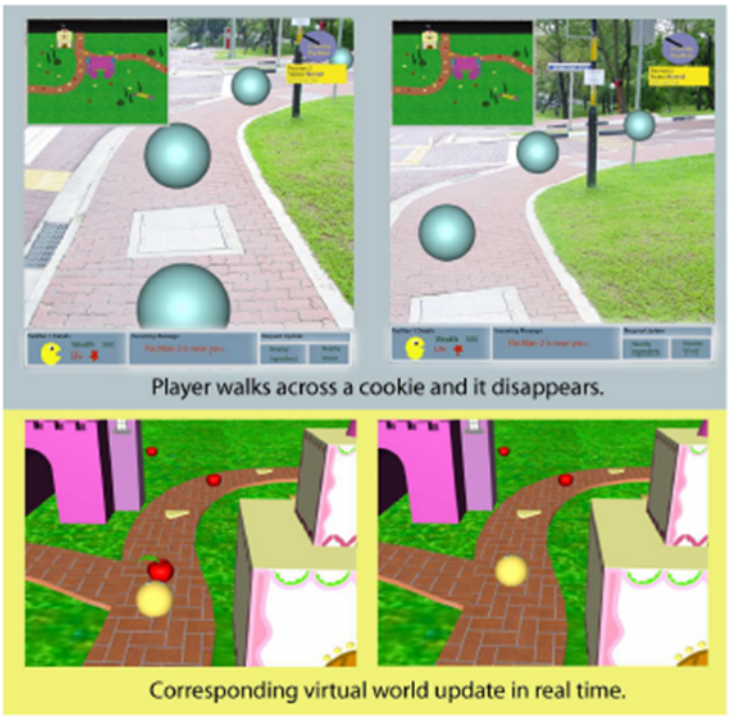


Figure 9: Pacman collecting cookies

Id., FIG. 9. Thus, a player's Pacman representation has a virtual location in Pac-world (*said virtual location on said virtual playfield*) that corresponds to the player's physical location in the real world (*corresponds to said physical location on said physical playfield*).

144. **Fifth**, Cheok in view of Foxlin077 renders obvious *a direction of gameplay of said videogame is operable to be established by recording a manually provided direction in response to a prompt requesting said manually provided direction*. As I discussed above for limitation 1[a]-2, Cheok discloses that the dead-reckoning module includes component parts such as a dead-reckoning device, GPS, digital compass, and inertial sensors to enable tracking of users. *See* Sec. X.C.4; EX1006, 106, 108. Cheok further discloses that it uses both the digital compass and inertial sensor of the dead-reckoning module to help establish a user's direction during gameplay (*a direction of gameplay of said videogame is operable to be established*). For example, Cheok discloses that the dead-reckoning module measures displacement from an initialization point by measuring direction and distance traveled, where direction is measured using data from the digital compass. EX1006, 108 ("**The DRM measures the displacement of the user from an initialization point by measuring the direction (with data obtained from the compass)**, and distance traveled (using accelerometer data) with each footstep taken. Although the DRM is a self-contained navigation unit, **when GPS position data is**

available, it can be used to correct both the distance and **direction calculations** with the help of a Kalman filter algorithm."). Cheok also d that the inertial sensor (i.e., an InertiaCube2) is used to determine the direction/orientation a user's head is facing to calculate the user's view perspective. *Id.*, 109 ("Since augmented reality is implemented as an interface feature between the players and their wearable computers, **head tracking for the calculation of view perspective of each player is important. We use Inertiacube2 from InterSense [InterSense01] for this purpose.** It is an inertial three degree-of-freedom orientation tracking system that gives yaw, pitch and roll of the object that it is attached on. **By placing the sensor on the cap of each player, her head movement and orientation is tracked to high accuracy.**"). Cheok discloses that "the point-of-view of each mobile player is sent to the computer of a helper through the server, and the corresponding view in the virtual PacWorld can be displayed." *Id.*, 109. In other words, the direction/orientation of a user's Ghost or Pacman virtual character is established (*a direction of gameplay of said videogame is operable to be established*) based on the direction the user is facing on the physical field.

145. While Cheok does not explicitly disclose (as underlined) that *a direction of gameplay of said videogame is operable to be established by recording a manually provided direction in response to a prompt requesting said manually*

provided direction, it is my opinion that a POSITA would have been motivated and found it obvious to implement the underlined features in view of Foxlin077.

b. Teachings of Foxlin077

146. Like Cheok, Foxlin077 relates to motion tracking in VR and AR applications. *See* Secs. VIII.A, VIII.C. Foxlin077 discloses an "inertial angular orientation tracking apparatus" (EX1008, 6:20-22) which may be used, for example, in applications in which "it is important to track the motions of parts of a human body,' such as "virtual reality ('VR') applications" and "for other head-mounted display ('HMD') applications" (*id.*, 1:16-22).

147. For example, Foxlin077 discloses that the inertial sensor may be incorporated in "an apparatus for simulating a virtual environment that is displayed to a user." *Id.*, 5:7-9. The apparatus "can be used with opaque virtual environments, where the entire environment is presented to a display," as well as "in a see-through environment, where the user has visual access to the real environment, but in addition, a virtual environment is superimposed on the real environment," i.e., an AR environment. *Id.*, 22:1-18; *see also* Sec. V.A (describing VR and AR environments).

148. Foxlin077 also discloses that its inertial sensor is a "self contained sensor apparatus [that] generates a signal that corresponds to at least two of the three orientational aspects of yaw, pitch and roll of a human-scale body, relative to an

external reference frame." EX1008, Abstract. Foxlin077's inertial sensor "track[s] the orientation of a body to which it is mounted, without interaction with radiation, energy, signals, or physical connections from any other apparatus." *Id.*, 1:63-66. Thus, in my opinion, Foxlin077 relates to similar concepts as Cheok, which as I discussed further above, discloses a virtual environment gaming system, compatible with both VR and AR modes, in which inertial sensors are incorporated into users' wearable computer devices in order to facilitate orientation/direction tracking. EX1006, 108-10. Indeed, it is my opinion that a POSITA would have understood that the inertial sensors described in Foxlin077 and those described in Cheok are InertiaCube2 inertial sensors, since the InertiaCube2 manual cited in Cheok identifies that the product is covered by the Foxlin077 patent. *Id.*, 109 ("We use Inertiacube2 from InterSense [InterSense01]…."), 116 (citing InertiaCube 2 manual); EX1013, 2 (identifying the Foxlin077 patent as covering the InertiaCube2). A POSITA would have therefore been motivated to consider the teachings of Foxlin077 when implementing Cheok's Human Pacman system.

149. Foxlin077 further discloses that its inertial sensor is designed to address drift issues. In particular, Foxlin077 explains that "[a] difficulty with using gyroscopes for head-orientation tracking is drift," which "arises from integrating over time, a signal that is noisy, or has a bias." EX1008, 2:56-58. Foxlin077 explains that "[d]rift would make the virtual world appear to gradually rotate about

the user's head even when the user is not moving." *Id.*, 2:58-60. To address this issue, Foxlin077 discloses that its inertial angular orientation tracking apparatus incorporates a "drift compensator" component that attempts to automatically correct drift. *Id.*, 6:27-32 ("To correct this drift, compensating sensors, such as gravimetric tilt sensors and sometimes also geomagnetic heading sensor(s) periodically measure the angular position, and this directly measured position signal is used to correct the drift of the integrated position signal."), 9:1-23 ("[T]he compensating angular position sensors and compass are used periodically, at times when the user's head is not moving….This compass information and inclinometer information is used to reset the signals that are output from the drift compensator 108, which signals represent the angular orientation of the head. Thus, all of the drift that has accumulated since the beginning, or last reset, is removed. To prevent sudden orientation shifts from jarring the user, the drift is removed from the output gradually, rather than all at once. Thus, the drift compensator 108 generates a set of signals over time that gradually approach the correct signal.").

150. Drift compensation requires using parameters measured during an initialization process, which I have annotated in a red circle in Figure 4A reproduced below. *Id.*, 11:1-7 ("Compensation is made 464 for certain types of 'errors' typical of angular rate sensors. These types of errors include temperature sensitivity, acceleration sensitivity, bias, scale factor, misalignment, cross-axis sensitivity,

nonlinearity, hysteresis, etc. **Compensation is made using parameters measured during the calibration 418 and initialization 406 steps.**"); *see also id.*, 9:61-67 ("An overall view of the operating steps of the invention is shown by the flow chart of FIG. 4A. The process begins 402 and initializes 404 the hardware….Next, **initialization steps 406 are conducted**, shown in more detail in FIG. 4B.").

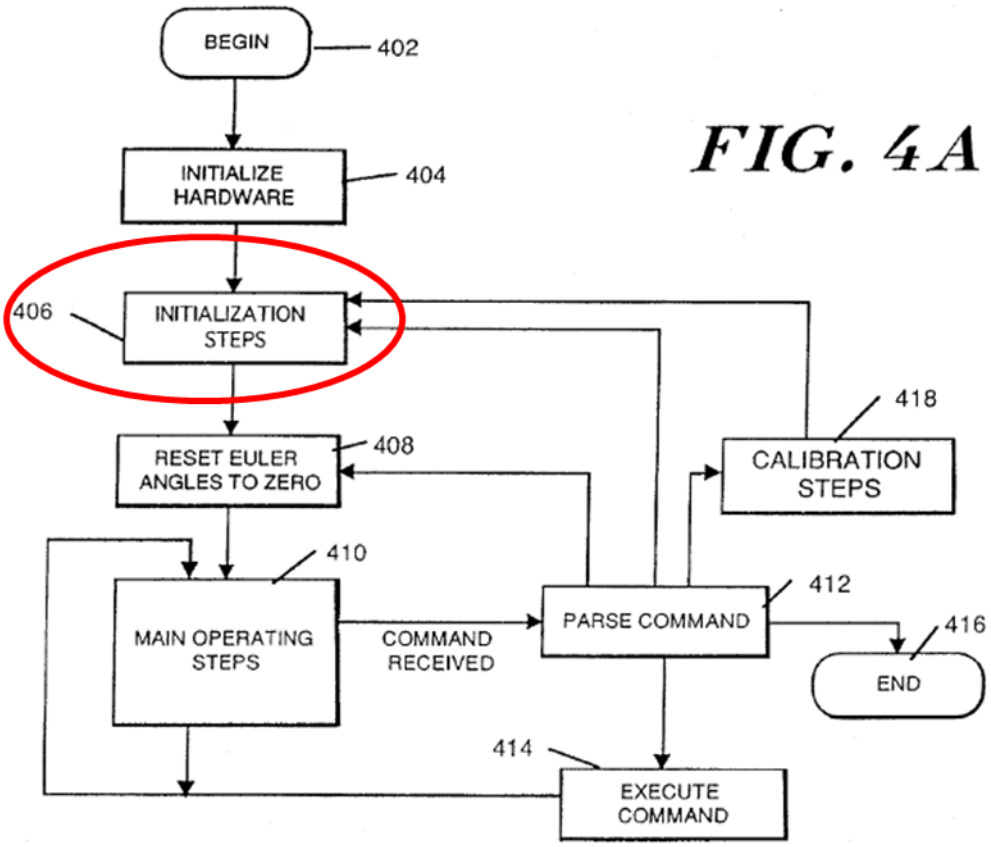


FIG. 4A

Id., FIG. 4A (annotated). The initialization steps "establish the rest position, from which orientation is measured and measure biases for the rate sensors," after which "the main operating steps 410 are performed." *Id.*, 9:67-10:7. Foxlin077 explains

that "[i]nitialization must be conducted with the sensor assembly held stationary in a known reference orientation." *Id.*, 10:29-31. Foxlin077 explains that a "user is instructed 432 to place the sensor assembly in such a position by a message delivered to the apparatus input/output devices or implicitly by the fact of starting the tracker." *Id.*, 10:31-35.

151. In my opinion, a POSITA would have readily understood from these disclosures that in such an initialization process, the user is establishing a reference orientation (*a direction of gameplay ... is ... established*). The user provides a manual orientation by, for example, holding the sensor assembly stationary in a known reference orientation/direction (*manually provided direction*). *Id.*, 10:29-31 ("[i]nitialization must be conducted with the sensor assembly held stationary in a known reference orientation"). The user provides this manual orientation in response to a message delivered to the apparatus instructing the user to hold the sensor stationary in a known reference orientation (*in response to a prompt requesting said manually provided direction*). *Id.*, 10:31-35 (the "user is instructed 432 to place the sensor assembly in such a position by a message delivered to the apparatus input/output devices or implicitly by the fact of starting the tracker"). Indeed, it is my opinion that Foxlin077's process for manually setting a direction of gameplay in response to a prompt is consistent with that described in the '821 patent, which explains that a "user may be prompted to select a direction for gameplay,"

which "may be determined by the device prompting the user to point the device in a particular direction…and recording this direction." EX1001, 16:2-8.

152. In my opinion, Foxlin077 also discloses that *a direction of gameplay* may be established in an additional way—during a reinitialization process. Foxlin077 explains that after the initialization process is complete, the operating steps are repeated until a command is received, where a command may be user-generated and includes operations such as a reinitialization process. EX1008, 10:9-11 ("Typically, the operating steps are repeated again and again through a loop, until a command has been received. During the execution of the operating steps, the user may generate commands, or a command may be generated by the host computer to which the orientation tracker is connected."), 10:17-20 ("Typical commands include:…resetting the origin; reinitializing the operation….Execution of some of the commands are indicated in the flow chart [of Figure 4A] as separate steps….[or] are indicated by routings to stages in the overall operation already identified, such as: to reinitialize 406; reset Euler angles 408;…."). I have reproduced Figure 4A below and annotated several steps to show this process. For example, as shown in Figure 4A below, a command (e.g., a user-generated command, as discussed above) may be received and parsed while the main operating steps (circled in blue) are being performed.

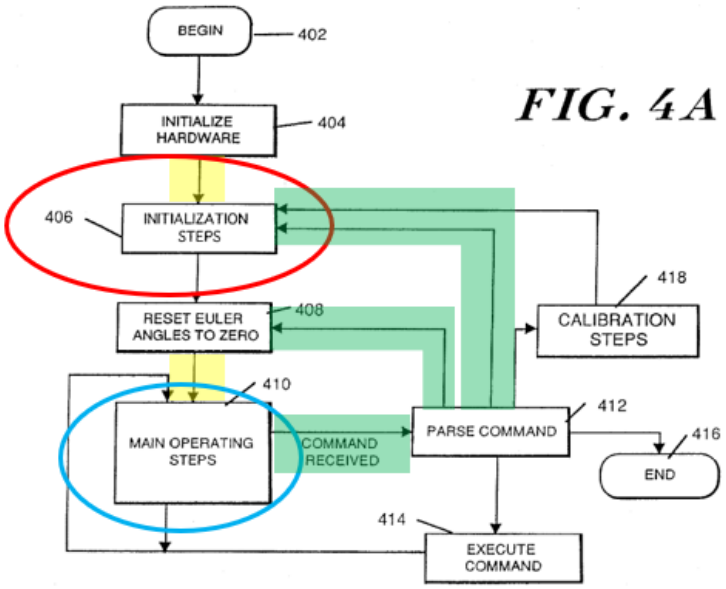


FIG. 4A

Id., FIG. 4 (annotated). As shown by the highlighted green arrows, when a command (e.g., a user-generated command) for "reinitializing the operation" is received, *see id.*, 10:17-20, the same initialization steps (circled in red) that I discussed above (i.e., those involving the initialization of an inertial sensor to establish a reference orientation) are performed again, and the Euler angles are reset to zero. Or if a command for "resetting the origin" is received, *see id.*, the Euler angles are reset to zero. And as shown by the highlighted orange arrows, the main operating steps resume when the reinitialization process is complete. In other words, the inertial sensor may be reinitialized through this process in response to a user command, thereby updating the reference orientation in the middle of the performance of the main operating steps. Because Figure 4A shows that the reinitialization process

operates akin to the original initialization process, a POSITA would have understood that both processes operate in the same manner.

153. Accordingly, in my opinion a POSITA would have understood that the reinitialization process, like the original initialization process, also establishes *a direction of gameplay of said videogame…by recording a manually provided direction in response to a prompt requesting said manually provided direction*.

c. Motivation to Combine Cheok and Foxlin077

154. In my opinion, a POSITA implementing Cheok's Human Pacman system would have been motivated to rely on the teachings of Foxlin077's initialization features to enhance Cheok. As I discussed above, Cheok discloses that an InertiaCube2 inertial sensor is used and cites to the product manual, which further cites to Foxlin077 as covering the product. *See* Sec. X.C.5.a; EX1006, 109, 116; EX1013, 2. Thus, a POSITA looking to implement the InertiaCube2 inertial sensor in Cheok's wearable computer would have looked to Foxlin077 for further information on the inertial sensor implementation and been instructed that the inertial sensor must be initialized through Foxlin077's described procedures.

155. Furthermore, Cheok discloses that its wearable computer uses "an inertial three degree-of-freedom orientation tracking system that gives yaw, pitch and roll of the object that it is attached on" and is "plac[ed]…on the cap of each player" to track head movement and orientation. EX1006, 109. Cheok also

discloses that the wearable computer's dead-reckoning module "measures the displacement of the user from an initialization point by measuring the direction…and distance traveled…with each footstep taken." *Id.*, 108. Because Cheok discloses tracking movement with respect to an "initialization" point, Cheok suggests that the sensors must be initialized prior to use. However, Cheok does not specifically disclose any particular initialization processes for the inertial sensors. A POSITA would have thus found it beneficial to modify Cheok based on Foxlin077's teachings to implement an inertial sensor initialization/reinitialization where a user can manually set an orientation in response to a prompt. A POSITA would have consulted Foxlin077's initialization/reinitialization process would have been a natural fit since Foxlin077 since it discloses the InertiaCube2 inertial sensor also disclosed by Cheok.

156. In my opinion, a POSITA would have been further motivated to rely on Foxlin077's teachings in order to address sensor issues discussed by Cheok. Cheok suggests that the sensors incorporated in the wearable computer may have tracking issues, including unaddressed issues that Cheok notes exceed the scope of the paper. EX1006, 115 (discussing "sensor tracking issues" but noting that those sensor issues not related to "Human Computer Interface design" exceed the scope of the paper); *see also id.*, 108 (disclosing that GPS position data can be used to correct direction calculations from the dead-reckoning module), 115 (noting that GPS further "suffers

from accuracy and selective availability"). Thus, Cheok provides express motivation for a POSITA to explore avenues to compensate for potential sensor issues, including issues associated with the inertial sensor. As I discussed above, Foxlin077 discloses that drift is a problem associated with inertial trackers and offers a solution—a drift compensator, which uses parameters measured during an initialization/reinitialization process to help correct drift. *See* Sec. X.C.5.a. A POSITA would have thus recognized it would be beneficial to improve the Cheok system by implementing a similar inertial sensor initialization/reinitialization process to address any potential accuracy or user experience issues associated with drift.

157. A POSITA would have also understood that Foxlin077's initialization/reinitialization process would have improved user experience when interacting with the real environment. Foxlin077 discloses that while drift rates associated with certain embodiments are "tolerable for opaque VE applications with no interaction with the real environment," that same drift rate may result in "drift accumulated after several minutes [that] would be enough to make contact with the real environment confusing." EX1008, 17:30-35. Thus, in a virtual environment application like the Cheok system, in which a user must interact with the real environment, a POSITA would have understood that Foxlin077's manual

reinitialization process would be beneficial to address accumulated drift when an automatic drift compensator component is not sufficiently removing drift.

158. Finally, a POSITA would have appreciated that if the game is to exist over a long period of time, unforeseen circumstances could result in a user reaching a point in the game where they are unable to proceed in the current direction. For example, a region of the game area might be temporarily closed off for construction or a community event. As such a POSITA would appreciate the need for a user to be able to adapt to the circumstances by temporarily adjusting the direction of gameplay to establish a new (temporary) alignment of the real world and virtual world directions and then restoring the original direction of gameplay when past the obstacle. Similar to my discussion in Sec. X.C.5.a, the initialization/reinitialization process disclosed by Foxlin077 could be used to adjust and then restore the direction of gameplay.

159. *See also* Sec. X.A, where I provide a higher-level overview of the motivation to combine Cheok and Foxlin077.

d. Reasonable Expectation of Success

160. In my opinion, a POSITA would have also had a reasonable expectation of success combining the teachings of Cheok and Foxlin077. As I discussed above, both references are in the same field of art. *See* Sec. X.C.5.a. Indeed, as I also discussed above, Cheok discloses using an InertiaCube2 inertial sensor, which is

also disclosed in Foxlin077. *Id.* Furthermore, a POSITA would have understood that implementing the combination would have involved implementing the Cheok system in a manner that Cheok suggests is feasible—implementing the real-time tracking system such that an initialization process for the inertial sensors is performed. *See* Sec. X.C.5.b. Indeed, any real-time tracking system would require an initialization process to set reference locations and directions. Cheok suggests that a POSITA would necessarily look to other references like Foxlin077 for greater details on how to implement that initialization process. As I indicated above, a POSITA would have further recognized that Cheok already includes a GUI system with manual inputs (e.g., see Sec. VIII.A and ¶ 134), and already includes software to transform InertiaCube2 measurements into a direction for the virtual scene camera, and thus a combination to include an InertiaCube2 reset/initialization feature would only require adding an additional GUI element and adjusting the transformation angles, making the combination relatively straightforward and low risk. It is my opinion that a POSITA would have also had the skill to implement and reasonable expectation of success in achieving such a combination, because it would have involved a combination of known technologies (e.g., known system of real-time tracking with respect to an initialization point (Cheok)) according to known methods (e.g., known methods of inertial sensor initialization (Foxlin077)) to yield

the predictable result of a system in which inertial sensors are initialized by manually providing a direction of gameplay in response to a prompt.

161. Accordingly, Cheok in view of Foxlin077 renders obvious *a direction of gameplay of said videogame is operable to be established by recording a manually provided direction in response to a prompt requesting said manually provided direction*.

162. *See also* Sec. X.B, where I provide a higher level overview of a POSITA's reasonable expectation of success in combining Cheok and Foxlin077.

D. Dependent Claim 11

1. Claim 11: *"The system of claim 1, wherein said communication device further comprises a directional device, wherein said directional device is operable to determine the physical direction of said directional device on said physical playfield."*

163. In my opinion, Cheok discloses this limitation. As I discussed for limitation 1[a]-3, a user's wearable computer (*communication device*) includes a dead-reckoning module (*directional device*) which uses its inertial sensor and digital compass component devices to determine a user's direction in the real world (i.e., by determining the direction the devices (which are part of the user's wearable computer) are facing) (*wherein said directional device is operable to determine the physical direction of said directional device on said physical playfield*). *See* Sec. X.C.5; EX1006, 108-109. In my opinion, a POSITA would have understood that

the inertial sensor and digital compass components of the dead-reckoning module (itself a *directional device*) are both also *directional device[s]* as claimed. Indeed, as I discussed for limitation 1[a]-3, the inertial sensor and digital compass are both part of the wearable computer (*communication device*) and are used to determine the direction of the user in the real world (*determine the physical direction of said directional device on said physical playfield*). *See* Sec. X.C.5.

XI. OPINIONS ON GROUND 2: CHEOK IN VIEW OF FOXLIN077 AND RALLISON RENDERS OBVIOUS CLAIMS 16 AND 30

A. Claim 16: "*The system of claim 1, wherein said wireless communication device further comprise: a speaker; and a microphone.*"

164. In my opinion a POSITA would have been motivated to modify the Cheok Human Pacman with the inertial sensor of Foxlin077 to implement an initialization/reinitialization process as I describe in Sec. X.A and X.C.5.b above, and would have been further motivated to modify the Cheok-Foxlin077 HMD (*wireless communication device*) with the speaker and microphone of Rallison. Incorporation of Rallison's speaker and microphone into Cheok's HMD would allow players of Human Pacman to better collaborate and communicate.

165. Rallison discloses a HMD which can be used to "collect information regarding the position, posture, orientation, attitude, location and/or movement of the user's head" to "provide a 'virtual reality' or simulated environment to the user, to allow the user to navigate through various displayed images" in the use of, for

example, game applications. EX1014, 2:13-22. Rallison discloses "[h]eadphone-like speakers [that] are positionable near the user's ears." *Id.*, 3:61-63. The speakers generate "audio to be heard by the user, e.g., through earphones" (*speakers*) of a player wearing a HMD that is capable of generating image (video) data on the display. Rallison also discloses a microphone can be "coupled to the HMD" which "provide[s] input" for "telecommunications" (*wireless communications device*). *Id.*, 20:7-12.

166. Like Rallison, Cheok also a discloses a HMD where users playing the game are "given instructions visually through the head mounted display or verbally through speaker/earphone." EX1006, 116. It is my opinion that a POSITA would have found it obvious to incorporate a *speaker* and *microphone* into the Cheok HMD because it would allow for verbal communication between players of the game. Indeed, a stated goal of Cheok's Human Pacman game is "team collaboration" and "interaction between the users" (e.g., Pacmen, Ghosts, and Helpers). EX1006, 110, 111, 114, 116. The addition of a speaker and microphone to the Cheok HMD would be an improvement over the "real-time messaging" "via the Wireless LAN network" that Cheok describes for communication between Helpers in VR mode and the Pacmen/Ghosts in AR mode that they guide. *Id.*, 108. Speaker and microphone-based communication through the HMD would also provide a more efficient, fluid, and flexible communication means between the Pacmen/Ghosts and their Helpers

compared to the "preset message[s]" Cheok discloses that players "sen[d] to helpers." *Id.*, 114. Cheok describes players in the field (e.g., Pacmen and/or Ghosts) being able to interact directly when in "physical proximity," however, indirect communication via Cheok's "Wireless LAN network" through a speaker and microphone on a HMD would allow real-time communications between Pacmen and/or Ghost players not in "physical proximity." *Id.*, 115 and 116.

167. It is my opinion that a POSITA would have recognized that modifying Cheok's HMD system with the *speaker and microphone* of Rallison's HMD headset would have allowed for more flexible and rapid collaboration between players of Human Pacman physically distant from one another during gameplay- a clear advantage over Cheok's "real-time messaging" or "pre-set messaging." A player would have used a *speaker* and *microphone* in the headset of the HMD to speak one-on-one with allied users on the playing field and/or Helpers, promoting increased efficiency, collaboration, and likely success in playing the game.

168. It is also my opinion that a POSITA would have had a reasonable expectation of success in modifying Cheok's HMD with the speaker and microphone incorporated into Rallison's HMD. As discussed above, Cheok already discloses expanding the use of Human Pacman technology (e.g., a wearable computer with HMD) using wireless telephonic-like capabilities (e.g., messaging over a wireless LAN) that enable communication among players. EX1006, 116. Further, as I

indicated above, Cheok discloses a "Transmeta Single Board Computer (PC104 plus compliant motherboard running on Crusoe processor)." *id*, 110. At the time of the alleged invention, the Transmeta Crusoe TM5800, TM5900, and TM8600 System Development Kits, which served as exemplar reference platforms for developers, included built-in audio codecs and connectors for line-in, line-out, and a microphone. Use of such Development Kits would likely be attractive and increase the expectation of success. (EX1039, 1). In my opinion, a POSITA would have understood that the Cheok-Rallison combination could be implemented in a way that both references suggest is feasible, because the combination would merely be a combination of known HMD devices, using known methods of verbal communication (speakers, microphone) to yield the predictable result of a VR/AR game that allows users to verbally collaborate and communicate with each other through a HMD. In my opinion, then, the Cheok-Foxlin077 combination in view of Rallison renders obvious claim 16 (*wherein said wireless communication device further comprise: a speaker; and a microphone*).

B. Claim 30: "*The system of claim 1, wherein said wireless communications device is operable to provide human-communications to a second wireless telephonic device while said video game is being played.*"

169. In my opinion a POSITA would have been motivated to modify the Cheok-Foxlin077 HMD (*wireless communication device*) (*see* Sec. X.A and

X.C.5.b) with the player communication (*human-communications*) capabilities of Rallison via telecommunications (*speaker and microphone*) so that players of the game could better collaborate and communicate as described by Cheok.

170. As I discuss above (*see* Sec. XI.A), the combination of Cheok and Rallison enables one-on-one verbal communications (*speaker and microphone*) between players (*human-communications*) during gameplay (*while said video game is being played*), and at least some Transmeta Crusoe development kits included built-in audio codecs and connectors for line-in, line-out, and a microphone. EX1039, 1. Wireless communication from the HMD of one player to the HMD of another player (*second wireless telephonic device*) allow for communications between players on the field, promoting closer collaboration and strategizing opportunities between the players. In my opinion, the limitation of claim 30 (*wherein said wireless communications device is operable to provide human-communications to a second wireless telephonic device while said video game is being played*) is obvious in view of the Cheok-Foxlin077 system in combination with Rallison.

XII. OPINIONS ON GROUND 3: CHEOK IN VIEW OF NAKAMURA RENDERS OBVIOUS CLAIM 102

A. A POSITA Would Have Been Motivated to Combine

171. In my opinion, a POSITA would have been motivated to modify the Cheok Human Pacman system based on the teachings of Nakamura, for example, to

implement an initialization process to set an initial location. It is my opinion that a POSITA would have been motivated to implement these teachings for the following reasons, as I explain further in Sec. XII.C.5.b. Cheok discloses that when tracking real-time position of a player, the system determines location with respect to an initialization points but does not disclose the specific processes for an initialization step to set an initial location reference. A POSITA would have thus been motivated to rely on the teachings of Nakamura's initialization step, in which a user manually inputs an initialization point since a POSITA would understand that establishing an initialization point is a requisite step in such a system. A POSITA would have also been motivated to implement the teachings of Nakamura's initialization feature in Cheok's system because it would have helped establish the real and virtual world correspondence.

172. To the extent the Cheok-Nakamura combination's initialization is not found to disclose a *prompt* as claimed, it is my opinion that a POSITA would have been further motivated to implement the initialization feature as a manual input in response to a written prompt because both Cheok and Nakamura disclose using prompts to receive manual user inputs, and Cheok discloses that written prompts help alert a user that the system is ready and waiting for their actions.

B. A POSITA Would have Had a Reasonable Expectation of Success

173. In my opinion, a POSITA would have had a reasonable expectation of success in combining the teachings of Cheok and Nakamura, as I explain further in Sec. XII.C.5.c. Specifically, a POSITA would have relied on Nakamura's initialization process for setting an origin location to improve Cheok's Human Pacman system. Implementing such a combination would have involved modifying the Cheok system in a manner that Cheok suggests is feasible—implementing the real-time tracking system such that it operates with respect to an initialization point and such that a prompt requests user feedback. Indeed, any real-time tracking system would require an initialization process to set reference locations and directions. Cheok suggests that a POSITA would necessarily look to other references like Foxlin077 for greater details on how to implement that initialization process. Further, a POSITA would have recognized that Cheok already includes a GUI system with manual inputs (e.g., see Sec. VIII.A), and thus a combination to include Nakamura's manual initialization feature would only require an additional input, making the combination relatively straightforward and low risk.

C. Independent Claim 102

1. Preamble: *"A system comprising:"*

174. To the extent the preamble is limiting, it is my opinion that Cheok discloses the preamble for the same reasons as I discussed for Ground 1, claim 1's preamble. *See* Sec. X.C.1.

2. 102[a]: *"a non-transparent display;"*

175. In my opinion, Cheok discloses this limitation. As I discussed for Ground 1, limitation 1[a]-1, Cheok discloses that the wearable computer has a video see-through head-mounted *display*. *See* Sec. X.C.3; EX1006, 110 ("The main components [of the wearable computer] are…[a] Cy-Visor Head Mounted Display (video see-through HMD) with FireWire camera attached…."). A POSITA would have further understood that while an optical see-through head-mounted display is transparent, a video see-through head-mounted display, such as that disclosed by Cheok, is non-transparent (*a non-transparent display*) because the attached FireWire camera provides the real world view upon which the virtual world is superimposed in an augmented reality mode.

3. 102[b]: *"a locating device operable to determine the physical location of said locating device on a physical playfield, wherein said locating device comprises a movement measuring device operable to be utilized, at least in part, to determine said physical location;"*

176. In my opinion, Cheok discloses this limitation. Cheok discloses that the wearable computer's dead-reckoning module is *a locating device operable to determine the physical location of said locating device on a physical playfield* for the same reasons as I discussed for Ground 1, limitation 1[a]-2. *See* Sec. X.C.4.

177. Cheok further discloses *wherein said locating device comprises a movement measuring device operable to be utilized, at least in part, to determine said physical location*. As I discussed for Ground 1, limitation 1[a]-2, Cheok explains that while the dead-reckoning module contains several different components (e.g., various sensors), one of the main components is a GPS receiver. *See* Sec. X.C.4; EX1006, 110 ("The main components [of the wearable computer] are…**DRMIII module (GPS and Dead-Reckoning device from Point Research Corporation)**…."). Cheok's dead-reckoning module, which includes a GPS receiver (*locating device*) and inertial sensors (*movement measuring device*), is a self-contained navigation unit that measures displacement from an initialization point by measuring direction and distance traveled, and that uses this data in order to determine the user's position (*operable to be utilized, at least in part, to determine said physical location*). EX1006, 108 ("**The DRM measures the displacement of**

the user from an initialization point by measuring the direction (with data obtained from the compass), and **distance traveled (using accelerometer data) with each footstep taken.** Although **the DRM is a self-contained navigation unit**, when GPS position data is available, it can be used to correct both the distance and direction calculations with the help of a Kalman filter algorithm."), 108 (describing calculation of real-time position data using dead-reckoning module data).

4. 102[c]: *"a directional device operable to determine the physical direction of said directional device on said physical playfield; and"*

178. In my opinion, Cheok discloses this limitation for the same reasons as I discussed for Ground 1, claim 11. *See* Sec. X.D.1.

5. 102[d]: *"a processor coupled to said display and said locating device, wherein said processor is operable to provide a video game comprising a virtual character with a virtual location and facing a virtual direction on a virtual playfield said virtual location on said virtual playfield corresponds to said physical location on said physical playfield, an origin of gameplay of said videogame is operable to be established by recording a manually provided origin in response to a prompt requesting said manually provided origin, and said virtual direction on said virtual playfield corresponds to said physical direction on said physical playfield."*

179. In my opinion, Cheok in view of Nakamura renders obvious this limitation.

180. **First**, Cheok discloses *a processor coupled to said display and said locating device, wherein said processor is operable to provide a video game*

comprising a virtual character with a virtual location and facing a virtual direction on a virtual playfield said virtual location on said virtual playfield corresponds to said physical location on said physical playfield for the same reasons as I discussed for Ground 1, limitation 1[a]-3, which recites substantially similar limitations. *See* Sec. X.C.5.

181. **Second**, Cheok in view of Nakamura renders obvious *an origin of gameplay of said videogame is operable to be established by recording a manually provided origin in response to a prompt requesting said manually provided origin*.

182. As an initial matter, it is my opinion that Cheok discloses *an origin of gameplay of said videogame*. As I further discussed for Ground 1, limitation 1[a]-2, Cheok discloses that the wearable computer (*device*) incorporates a dead-reckoning module and GPS, among other sensors, to enable location tracking of users. *See* Sec. X.C.4; EX1006, 106 ("There is a seamless merging of the fantasy computer digital world with the real physical world realized using **location and body tracking technologies, namely the Global Positioning System (GPS), Dead-Reckoning module (DRM)**, and inertia sensors, to provide the necessary context-awareness of the system for the game play."), 108 ("**Numerous sensors and tracking devices that are used in the system—dead reckoning module (DRM) with GPS and digital compass, inertia sensor, Bluetooth device, and capacitive sensor**—are vital to the manifestation of Human Pacman."), 110 ("The main

components [of a wearable computer] are…**[a] DRMIII module (GPS and Dead-Reckoning device from Point Research Corporation)**….").

183. Cheok further discloses that the dead-reckoning module and GPS track the device's position in real time with respect to an initialization point (*origin of gameplay*) by measuring displacement (as a function of direction and distance traveled) from that point. EX1006, 108 ("**The DRM measures the displacement of the user from an initialization point by measuring the direction (with data obtained from the compass), and distance traveled (using accelerometer data) with each footstep taken.** Although the DRM is a self-contained navigation unit, **when GPS position data is available, it can be used to correct both the distance and direction calculations** with the help of a Kalman filter algorithm."). Cheok discloses that by calculating the location with respect to an initialization point, the real-time position data of each user may be communicated to the server and other players. *Id.*, 108 ("**The real-time position of each mobile user is sent periodically to the server** through wireless LAN. Upon receiving the position data, **the server sends an update to each wearable computer the position of other mobile players**, as well as the positions of all 'non-eaten' plain cookies."). Cheok discloses that this real-time tracking of a player's movement in the physical world is reflected in real time in the corresponding virtual character's movement in the virtual Pac-World. *Id.*, 112 (describing that a Pacman's movement (e.g., when walking through

a cookie), is "**reflected in the virtual Pac-World in real time**…in the corresponding location"), 112 ("[A] Pacman['s]…**physical interaction with the real world (i.e. movement) can be digitally reflected in the virtual world**….").

184. Thus, a POSITA would have understood that the Human Pacman system (*video game*) tracks location data for each user with respect to an initialization point (*origin of gameplay of said video game*).

185. Cheok does not explicitly disclose that the initialization point is *operable to be established by recording a manually provided origin in response to a prompt requesting said manually provided origin*, but in my opinion, a POSITA would have been motivated and found it obvious to implement this feature in view of Nakamura.

a. Teachings of Nakamura

186. Like Cheok, Nakamura relates to a wireless location-based gaming system for interacting with a virtual space. *See* Secs. VIII.A-B. Nakamura discloses a system for providing a role-playing game in a virtual world. EX1007, [0005], [0018]. In the role-playing game, a user moves "through the real world, and the user's current location in the real world is reflected in the virtual world, allowing the role-playing game to progress." *Id.*, [0015]. Further, a GPS may be used as the positioning system to track the location of a user's device (e.g., a mobile phone or some computer-readable recording medium) and that communication with the server

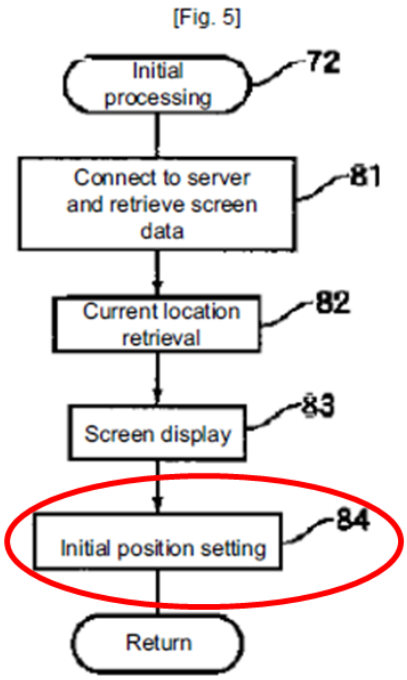
system may occur wirelessly. *Id.*, [0016]. Nakamura also discloses that the role-playing game may be played by multiple "users who are accessing the same role-playing game" (*id.*, [0029]), and that users may compete with each other (*id.*, [0009]). Thus, Nakamura is similar to Cheok, which as I discussed for Sec. VIII.A (Cheok overview) and claim 1's preamble, discloses an interactive multi-person gaming system in a virtual environment where users role play as Pacmen, Ghosts, or Helpers and locations are tracked in real-time and communicated wirelessly. *See* Sec. X.C.1. A POSITA would have therefore been motivated to consider the teachings of Nakamura when implementing Cheok's Human Pacman system.

187. Nakamura additionally discloses a feature for manually setting, in response to a prompt, a user's current location in the real world as a predetermined initial position in the virtual world. Nakamura explains that "new scenes or worlds automatically open depending on certain conditions." EX1007, [0005]. For example, "by utilizing current location information, which can be obtained through technologies such as GPS, a new virtual world is opened." *Id.* Nakamura explains that this system for displaying virtual worlds may be provided on a mobile terminal equipped with a GPS unit to track the user's current location. *Id.*, [0016] ("A system for displaying such a virtual world…can be installed on a mobile terminal equipped with positioning systems such as a GPS unit, methods for acquiring the user's current location (e.g., through PHS units, mobile phones, etc. that utilize location

information from base stations), and communication means for connecting to a server system via wireless, PHS, mobile phones, dial-up Internet, or other computer networks."), [0019] ("[T]he mobile terminal 6 in this example is equipped with a system for obtaining data indicating its current location (typically coordinates including latitude and longitude information). There are several such systems, and the one currently considered to have the highest accuracy uses a GPS unit…."). Nakamura further explains that "initial settings [can] be configured to reflect movements in the real world within the virtual world." *Id.*, [0009]. Nakamura discloses that "it is desirable to perform an initial setup that defines the correspondence between the current location and the virtual position, as well as the ratio for converting actual displacement into virtual displacement, prior to starting the role-playing game." *Id.*, [0025]. The "function 33 for performing the initial setup is provided as one of the features of the display control unit 30, and the settings defined there are stored in a memory such as ROM or RAM." *Id.*

188. As part of this initial setup, "it is desirable to set the current location in the real world as a predetermined position (the initial value of the virtual position) within the first virtual world." *Id.*, [0009]. The initial position may represent "the starting point of the game or, if the game was interrupted, the point where it was paused." *Id.* While it is possible "to use the parameters that are set by default" (*id.*, [0025]), it is also possible to manually set the initial position setting (*an origin of*

gameplay of said videogame is operable to be established by recording a manually provided origin) in response to the display of a position icon that prompts the user to manually adjust the position icon on the display to a suitable initial position setting (*in response to a prompt requesting said manually provided origin*). I have reproduced Figure 5 below, which shows in red circle the initial position setting of step 84.



Id., FIG. 5 (annotated). Nakamura explains that "[i]n step 84, the function 32 for displaying the virtual position and virtual displacement displays the position icon 113 corresponding to the current location at the initial position 112 of the screen 111," where the position icon may be "an icon in the shape of a human figure or even an icon representing the user's face." *Id.*, [0035].

189. After the position icon is initially displayed on the screen, the "position icon 113, or position display icon, can be arranged according to the user's preference." *Id.*, [0035]. Once the user has chosen a suitable initial position, the user performs an operation on the display to trigger an initial setting function that sets the current location as the initial position parameter (*an origin of gameplay of said videogame is operable to be established by recording a manually provided origin*). *Id.*, [0036] ("If the position icon 113 is displayed at a virtual position that is appropriate to be set as the initial position, the user can perform a suitable operation, and the initial setting function 33 will set that current location as the initial position 112 on the screen 111 and store it as the parameter 13.") A POSITA would have understood that the display of a movable position icon is a *prompt requesting said manually provided origin* because it indicates to a user that the user should either change the initial position setting or confirm that the current position is correct. In other words, the display of the icon *prompts* the user to manually move the icon to a desired origin position to start gameplay.

190. Accordingly, Nakamura discloses *an origin of gameplay of said videogame is operable to be established by recording a manually provided origin in response to a prompt requesting said manually provided origin*.

b. Motivation to Combine Cheok and Nakamura

191. In my opinion, a POSITA would have been motivated to rely on Nakamura's initialization features to enhance Cheok's Human Pacman system. As I discussed above, Cheok discloses that when tracking real-time position of a player, the system determines location with respect to an initialization point. However, Cheok does not disclose the specific processes for an initialization step to set an initial location reference, a step that a POSITA would understand as necessary for any such system. A POSITA would have thus found it beneficial to modify Cheok based on Nakamura's teachings of an initialization step wherein a player manually inputs an initialization point in response to a movable icon prompt.

192. As I further discussed above, Nakamura also discloses that its initialization function is desirable because it allows for the alignment of real and virtual worlds. EX1007, [0025]. Thus, a POSITA would have recognized that Nakamura's initialization function would be a natural fit with Cheok's system, which also relies on a real and virtual world correspondence during gameplay. Consistent with the above and in such a combined system, for example, an initial position for gameplay would be set (*an origin of gameplay of said videogame is operable to be established*) by manually arranging (*by recording a manually provided origin*) a movable position icon on the head-mounted display (*in response to a prompt requesting said manually provided origin*).

193. To the extent the Cheok-Nakamura combination's movable position icon on a display is found to not be *a prompt requesting said manually provided origin*, it is my opinion that a POSITA would have been further motivated and found it obvious to implement this feature in the Cheok-Nakamura combination. Cheok discloses various written prompts for requesting manual input. For example, as shown in Figure 7 below, the head-mounted display includes a panel showing incoming alert messages (circled in red), such as those indicating nearby Ghost players, nearby ingredients, or recently acquired special powers. EX1006, 109 ("When a player is within range of [a virtual ingredient] Bluetooth object…**an alert message will be shown on the player's HMD display**."), 114 ("When a Pacman consumes a special cookie, she will see **an alert message in her HMD**, informing her of the power she acquired.").

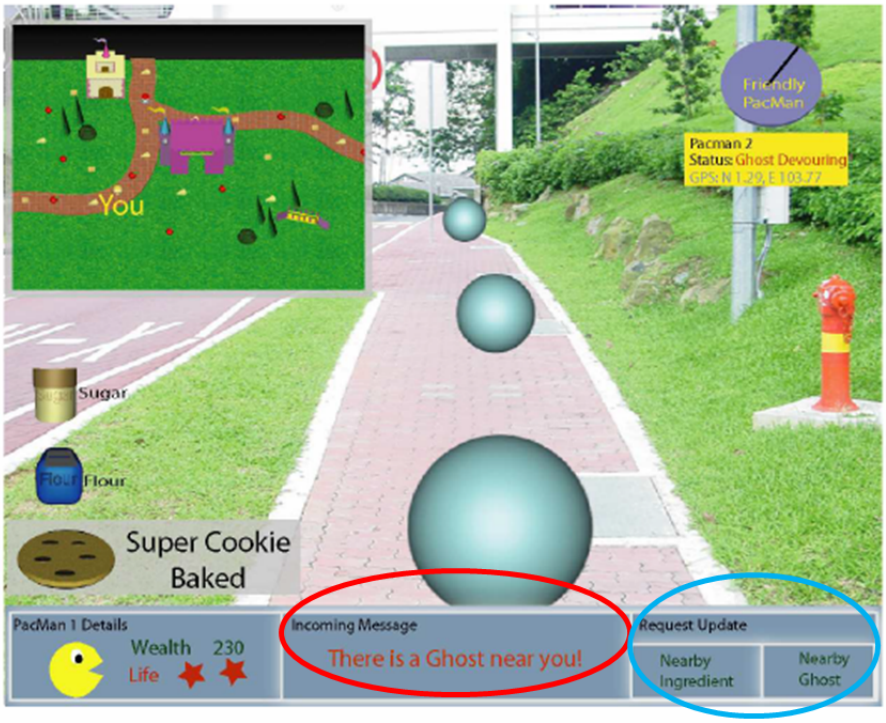


Figure 7. First person view as presented in HMD display of Pacman

Id., FIG. 7 (annotated). As circled in blue in Figure 7 above, the display also includes a prompt that says "request update," along with clickable buttons that allow a Pacman user to manually request updates from Helpers on nearby ingredients or nearby Ghosts. These buttons circled in blue are consistent with Cheok's disclosures describing how players may request information related to ingredients and send preset messages to Helpers. *Id.*, 114 ("Pacman players can collaborate through transferring of ingredient between them, even if they are physically far from each other with the support of Wireless LAN. For example Pacman A can **initiates request for the list of unused ingredients** Pacman B has. Upon approval, A can

request for transfer of ingredient from B, subjected to approval by B."), 115 ("The Pacman/Ghost **click on preset messages** to be sent to Helpers.").

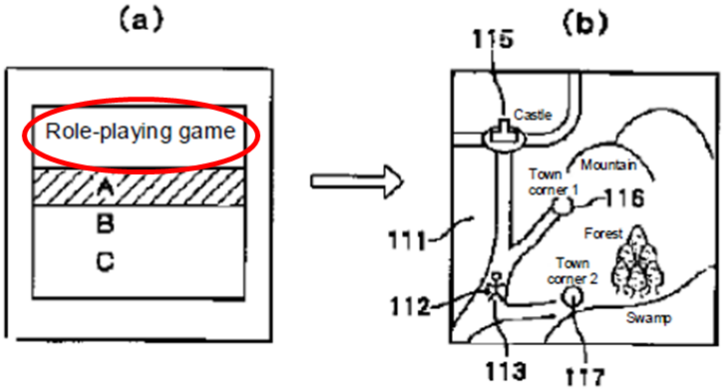
194. Cheok discloses that the wearable computer user may respond to prompts on the display (e.g., by manually clicking)—for example, prompts relating to messaging and selection of ingredients—by using the Twiddler2 component which consists of a handheld keyboard and a mouse. *Id.*, 110 ("The main components [of the wearable computer] are…Twiddler2 (handheld keyboard and mouse)…."), 115 ("Keyboard and mouse are used for messaging and selection of the 'Ingredients' to be exchanged between Pacmen."). Cheok explains that the benefit of "[g]raphical feedback…from providing alert message[s] in popped up window[s]," is that the messages allow a user to know that "the system is ready and attending to [their] actions." *Id.*, 115. Moreover, alert messages are "highly effective" because the "graphical information is provided…directly in the zone of the user's attention." *Id.* In my opinion, a POSITA would have thus understood the benefits of further modifying the Cheok-Nakamura system, based on Cheok's teachings of a written alert message (*a prompt requesting said manually provided origin*), to request that a user manually arrange the movable position icon on the screen to set an initial position/origin.

195. A POSITA would appreciate that having a prompt requesting said manually provided origin when the game begins would provide more flexibility. For

example, it would allow players to start somewhere other than the Pac-castle or the Ghost-house as disclosed in Cheok. EX1006, 112 ("Starting the game: Pacmen and Ghosts start from the Pac-castle and Ghost-house in Pac-world respectively. These two places correspond to two different physical locations in the game area."). It would also allow players to resume a game beginning at a position where they had previously stopped, e.g., because it was getting dark.

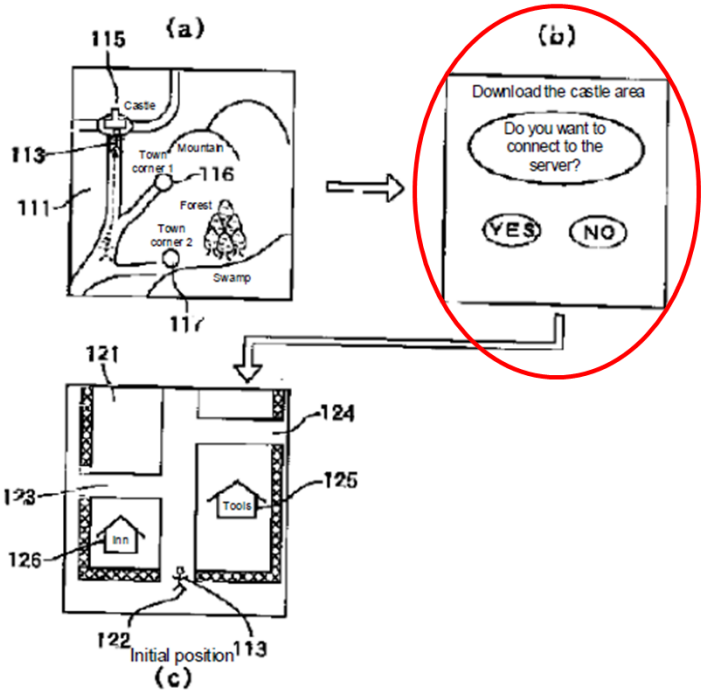
196. Such an additional combination would also be consistent with Nakamura, which discloses that written prompts for manual user input are provided on the mobile terminal in various scenarios. For example, in Figure 9(a) reproduced below, "a screen to select the role-playing game is displayed," which allows "[t]he user [to] select[] one of the games." EX1007, [0033]. I have circled the prompt to select a role-playing game in red below.

[Fig. 9]

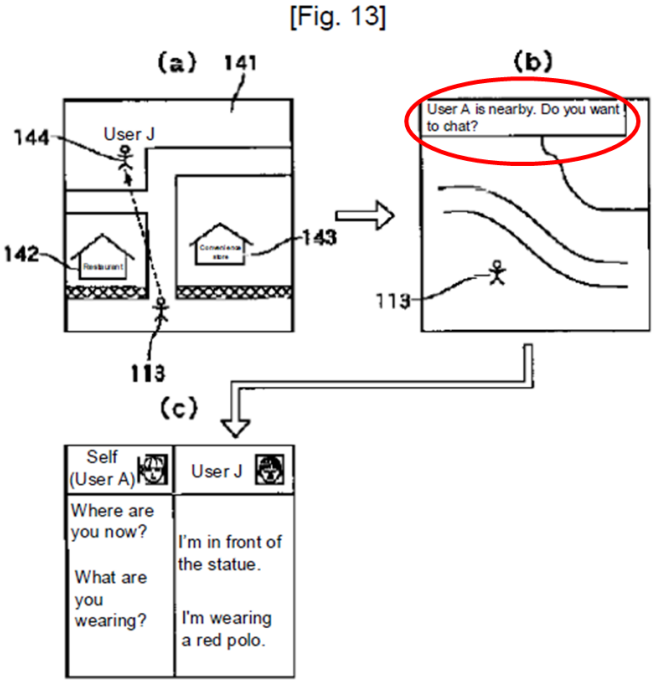


Id., FIG. 9 (annotated). In Figure 10(b) below (circled in red), a user is asked whether they would like to connect to the server to download the screen corresponding to the castle area, such that the screen advances to Figure 10(c) if yes is selected, or reverts to the screen in Figure 10(a) is no is selected. *Id.*, [0042]-[0044].

[Fig. 10]



Id., FIG. 10 (annotated). In Figure 13(b) below, a prompt (circled in red) "is displayed on user J's terminal, informing him/her that user A, who is playing the same role-playing game nearby, has made a chat request," and asking "if user J grants permission for the connection." *Id.*, [0056].



Id., FIG. 13 (annotated).

197. Accordingly, to the extent the Cheok-Nakamura combination's movable position icon on a display is found to not be *a prompt requesting said manually provided origin*, it is my opinion that it would have been obvious to further modify the combined system such that a written prompt is used to request a user arrange the movable position icon on the display.

198. *See also* Sec. XII.A, where I provide a higher level overview of the motivation to combine Cheok and Nakamura.

c. Reasonable Expectation of Success

199. In my opinion, a POSITA would have also had a reasonable expectation of success combining the teachings of Cheok and Nakamura. As I discussed above,

both references are in the same field of art. *See* Sec. XII.C.5.a. Furthermore, a POSITA would have understood that implementing the combination would have involved modifying the Cheok system in a manner that Cheok suggests is feasible—implementing the real-time tracking system such that it operates with respect to an initialization point and such that a prompt requests user feedback. A POSITA would have also had the skill to implement and reasonable expectation of success in achieving such a combination, because it would have involved a combination of known technologies (e.g., known system of real-time tracking with respect to an initialization point (Cheok)) according to known methods (e.g., known methods of initialization using a movable icon prompt (Nakamura)) to yield the predictable result of a system in which a manual input for origin of gameplay is provided in response to a prompt, as discussed above. Accordingly, Cheok in view of Nakamura renders obvious *an origin of gameplay of said videogame is operable to be established by recording a manually provided origin in response to a prompt requesting said manually provided origin*.

200. *See also* Sec. XII.B, where I provide a higher level overview of a POSITA's reasonable expectation of success in combining Cheok and Nakamura.

201. **Third**, Cheok discloses *said virtual direction on said virtual playfield corresponds to said physical direction on said physical playfield*. As I discussed for Ground 1, claim 11 and Ground 3, limitation 102[c], Cheok discloses that a user's

wearable computer includes a dead-reckoning module that is used for tracking a user's changing position and an Inertiacube2 for tracking a user's changing direction. *See* Secs. X.D.1, XII.C.4; *see also* EX1006, 109 ("Since augmented reality is implemented as an interface feature between the players and their wearable computers, **head tracking for the calculation of view perspective of each player is important. We use Inertiacube2 from InterSense [InterSense01] for this purpose.** It is an inertial three degree-of-freedom orientation tracking system that gives yaw, pitch and roll of the object that it is attached on. **By placing the sensor on the cap of each player, her head movement and orientation is tracked to high accuracy.**"). Cheok discloses that this real-time tracking of a player's movement in the physical world is reflected in the corresponding virtual character's movement in the virtual Pac-World. EX1006, 112 (describing that a Pacman's movement (e.g., when walking through a cookie), is "**reflected in the virtual Pac-World in real time**…in the corresponding location"), 112 ("[A] Pacman['s]…**physical interaction with the real world (i.e. movement) can be digitally reflected in the virtual world**…."). Indeed, as shown below in Figure 10, when a player turns in certain directions (i.e., pointing with their head) in the real world, such as when exploring an area to find an ingredient, the player's Pacman virtual character also points itself and turns in corresponding directions in the virtual world (*said virtual direction on said virtual playfield corresponds to said physical direction on said*

physical playfield), such that the real world and virtual view correspond to one another at all times.



Figure 10: Sequence of pictures showing the collection of an ingredient

Id., FIG. 10.

XIII. OPINIONS ON GROUND 4: NAKAMURA IN VIEW OF BENINI RENDERS OBVIOUS CLAIMS 1, 4, 11, 16, AND 30

A. A POSITA Would Have Been Motivated to Combine

202. In my opinion, a POSITA would have been motivated to modify the Nakamura system based on the teachings of Benini, for example, to implement a method of manually rotating the virtual environment map on a mobile terminal display to align real and virtual displacement. It is my opinion that a POSITA would

have been motivated to implement these teachings for the following reasons, as I explain further in Sec. XIII.C.5.b. A POSITA would have been motivated to rely on the teachings of Benini, which discloses a method for manually changing the view of a virtual world map (e.g., to rotate the map), because Nakamura discloses a display rotation feature to align real and virtual displacement but does not disclose the specific processes for rotating the display. A POSITA would have also found it obvious to rely on Benini's teachings to improve Nakamura's system because both systems use similar components, e.g., a mobile terminal with directional buttons which displays a 2D map of a virtual world.

203. A POSITA would have further recognized that manually aligning a display such that virtual displacement points upwards would have been obvious because it would have been one of only several alignment options available (e.g., a north-up or forward-up alignment, and further set manually or automatically). Furthermore, it is my opinion that a POSITA would have been motivated to implement Nakamura's system with a manual rotation feature because it would have given users a choice in alignment, consistent with Nakamura's disclosure of manual positioning features, and a POSITA's knowledge of alignment modes at the time of the alleged invention.

B. A POSITA Would have Had a Reasonable Expectation of Success

204. In my opinion, a POSITA would have had a reasonable expectation of success in combining the teachings of Nakamura and Benini, as I explain further in Sec. XIII.C.5.c. Specifically, a POSITA would have relied on Benini's method for manually changing the view (e.g., rotating) of a mobile terminal's 2D map display to improve Nakamura's system. Nakamura and Benini use similar features, such as 2D maps on mobile terminals that have directional buttons, and thus a POSITA would have had a reasonable expectation of success in combining these teachings.

C. Independent Claim 1

1. Preamble: *"A system comprising:"*

205. To the extent the preamble is limiting, it is my opinion that Nakamura discloses the preamble. Nakamura discloses that "[t]he present invention relates to a system for controlling a computer based on location information." EX1007, [0001]. In particular, Nakamura's *system* for controlling a computer involves a virtual role-playing game in which "new scenes or worlds automatically open depending on certain conditions." *Id.*, [0005]. For example, "by utilizing current location information, which can be obtained through technologies such as GPS, a new virtual world is opened." *Id.* A user walks, runs, or bicycles through the real world, and the user's current location in the real world is reflected in the virtual world, allowing the role-playing game to progress. *Id.*, [0015] ("In this way, in the

system and method for displaying a virtual world according to the present invention, the current location or real displacement is reflected in the virtual world, allowing the game to progress. Therefore, the user must physically move by walking, running, or using a bicycle, for example.").

206. Nakamura explains that the system may be provided on a mobile terminal equipped with a GPS unit for acquiring the user's current location. *Id.*, [0016] ("A system for displaying such a virtual world can be provided on a computer-readable recording medium, which contains a program with instructions to implement each step of the method. The system can be installed on a mobile terminal equipped with positioning systems such as a GPS unit, methods for acquiring the user's current location (e.g., through PHS units, mobile phones, etc. that utilize location information from base stations), and communication means for connecting to a server system via wireless, PHS, mobile phones, dial-up Internet, or other computer networks."), [0019] ("[T]he mobile terminal 6 in this example is equipped with a system for obtaining data indicating its current location (typically coordinates including latitude and longitude information). There are several such systems, and the one currently considered to have the highest accuracy uses a GPS unit…."). The mobile terminal "connect[s] to a server system 20 that provides the role-playing game through the general internet 1 as the computer network." *Id.*, [0018]. Nakamura further explains that "[i]n the role-playing game executed by the

game system 10, a position icon (such as an illustration resembling a human figure) displayed on the screen moves in response to the movements of the user holding terminal 6." *Id.*, [0031]. This display of virtual position allows the user to feel as if they are "entering and moving through the virtual world of the role-playing game screen." *Id.* The virtual world also allows for the display of "event icons representing other users who are accessing the same role-playing game," as well as "communication (chat) through the screen" with the other users of the role-playing game. *Id.*, [0029].

2. 1[a]: *"a wireless communication device, wherein said wireless communication device comprises:"*

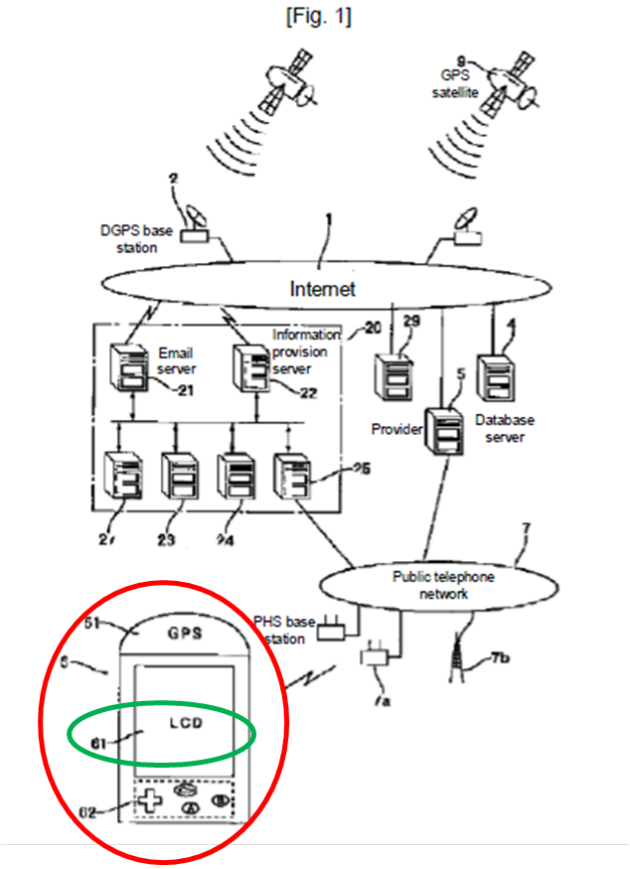
207. In my opinion, Nakamura discloses this limitation. Nakamura discloses that the game system for displaying virtual world information is installed on a mobile terminal (*wireless communication device*), which may be equipped with a wireless communication means to enable communication with a server system. EX1007, [0012] ("[I]t is desirable to include means or steps for obtaining virtual world information via **communication with a server system through wireless or computer networks**."), [0016] ("A system for displaying such a virtual world can be provided on a computer-readable recording medium, which contains a program with instructions to implement each step of the method. **The system can be installed on a mobile terminal equipped with** positioning systems such as a GPS unit,

methods for acquiring the user's current location (e.g., through PHS units, mobile phones, etc. that utilize location information from base stations), and **communication means for connecting to a server system via wireless**, PHS, mobile phones, dial-up Internet, or other computer networks."), [0018] ("Figure 1 shows an example of the environment in which the **mobile terminal 6**, on which the virtual world (described here with a role-playing game as an example) according to the present invention is displayed, operates.").

3. 1[a]-1: *"a display,"*

208. Nakamura discloses this limitation. Nakamura discloses that the mobile terminal (*wireless communication device*) further has an LCD display (*a display*) and an operational panel with a touch panel or pointing device and switches. EX1007, [0018] ("Figure 1 shows an example of the environment in which the **mobile terminal 6**, on which the virtual world (described here with a role-playing game as an example) according to the present invention is displayed, operates."), [0022] ("Furthermore, as an input/output mechanism, **the terminal is equipped with an LCD 61** and an operational panel 62 consisting of a touch panel or pointing device and switches."). Nakamura explains that the mobile terminal's game system operates using a "display control unit 30 for displaying the virtual world, and this display control unit 30 has several functions" for operating the game system in conjunction with the display. *Id.*, [0024]; *see also id.*, [0024]-[0031] (describing

functions). Figure 1 below shows the mobile terminal (circled in red) having an LCD *display* (circled in green).

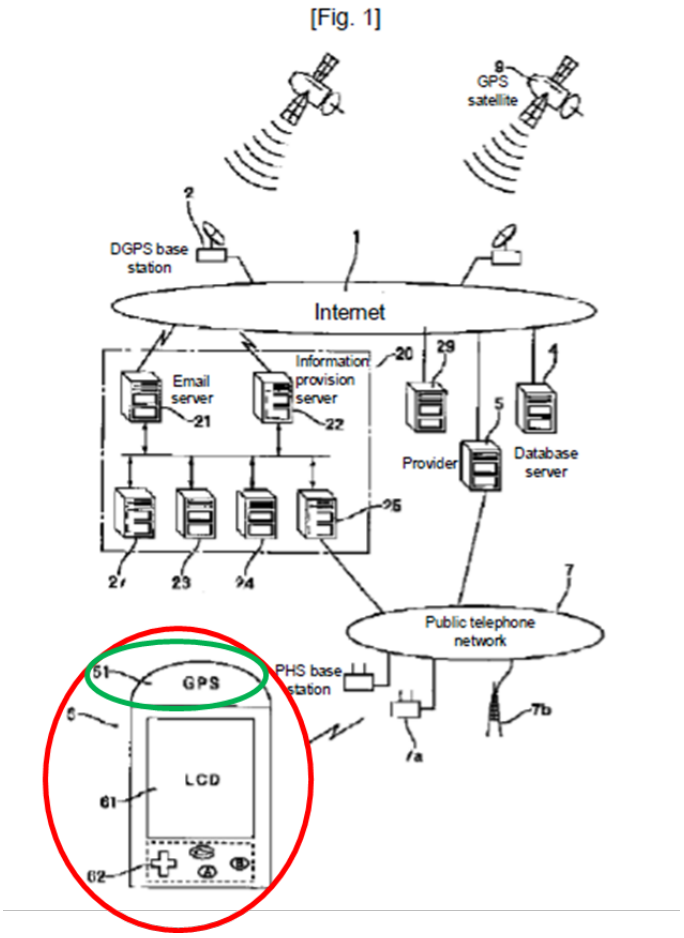


Id., FIG. 1 (annotated).

4. 1[a]-2: *"a locating device operable to determine the physical location of said locating device on a physical playfield; and,"*

209. In my opinion, Nakamura discloses this limitation. As shown in Figure 1 below, Nakamura discloses that the mobile terminal (circled in red) has a GPS (*a locating device*) (circled in green) which determines the location of the GPS (*to determine the physical location of said locating device*), and thus the location of the

user's mobile terminal in which the GPS is found. EX1007, [0016] ("The system can be installed on a **mobile terminal equipped with positioning systems such as a GPS unit**, methods for acquiring the user's current location (e.g., through PHS units, mobile phones, etc. that utilize location information from base stations), and communication means for connecting to a server system via wireless, PHS, mobile phones, dial-up Internet, or other computer networks."), [0019] ("Furthermore, the **mobile terminal 6 in this example is equipped with a system for obtaining data indicating its current location** (typically coordinates including latitude and longitude information). There are several such systems, and **the one currently considered to have the highest accuracy uses a GPS unit, which receives signals from GPS satellites 9 to perform positioning and determine the coordinates of the current location** through radio signal measurements."), [0022] ("**Figure 2 shows an example of the environment in which the mobile terminal 6 running the game system 10** according to the present invention operates. First, **the mobile terminal 6 in this example is equipped with a GPS unit 51 that acquires the terminal's current location**.")



Id., FIG. 1 (annotated).

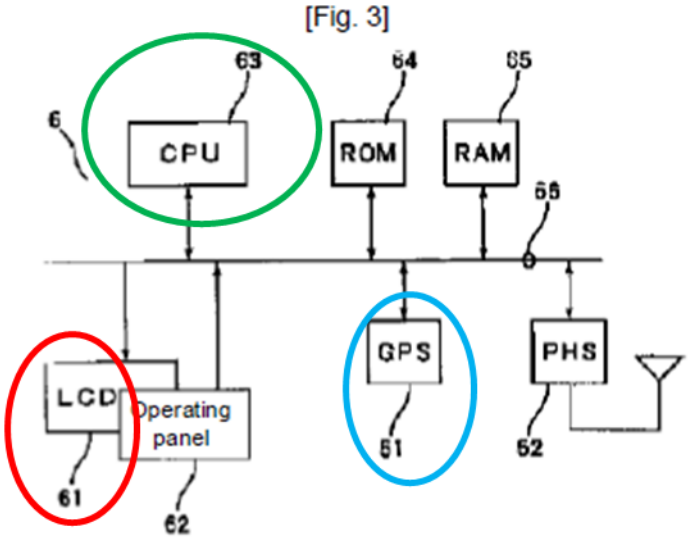
210. Nakamura explains that the mobile terminal's GPS is used to track a user's movement through the real world (*on a physical playfield*) so that the user's corresponding virtual position in a virtual world can be calculated and displayed on the mobile terminal, such that the virtual position icon moves in accordance with changes in actual location. *Id.*, [0006] ("[I]n the system and method for displaying a virtual world according to the present invention, **a new virtual world cannot be opened unless the user physically moves to a degree sufficient to produce a**

significant difference in the current location obtained via means such as GPS."), [0023] ("[T]he **game system 10 is equipped with a function 11 that acquires the current location using the GPS unit 51…The obtained current location is** summed up by the distance counter 12, provided to the display control unit 30, and **displayed as the position (virtual position) and displacement (virtual displacement) in the virtual world** of the role-playing game on the LCD 61."), [0039] ("When the game starts, in step 73, **the current location is acquired using the location acquisition function 11. This location is then converted, and the function 32 for displaying virtual positions and virtual displacements will show them on the screen**. As a result, **the user's movement with the terminal 6 will be displayed as virtual positions and virtual displacements on the screen** of the first screen of the role-playing game. In other words, based on the initial settings or the default pre-set values (for example, 1 dot = 1 meter on the screen), **the position icon 113 on the screen moves in accordance with the changes in the actual location or movement (actual displacement) provided by the GPS unit 51**.").

5. **1[a]-3:** *"a processor coupled to said display and said locating device, wherein said processor is operable to provide a video game comprising a virtual character with a virtual location on a virtual playfield, said virtual character is displayed on said display, said virtual location on said virtual playfield corresponds to said physical location on said physical playfield, and a direction of gameplay of said videogame is operable to be established by recording a manually provided direction in response to a prompt requesting said manually provided direction."*

211. In my opinion, Nakamura in view of Benini renders obvious this limitation.

212. **First**, Nakamura discloses *a processor coupled to said display and said locating device*. As shown in Figure 3, which I have reproduced below, the mobile terminal includes a central processing unit ("CPU") (*a processor*) (circled in green) which is *coupled to* the LCD (*said display*) (circled in red) and the GPS (*said locating device*) (circled in blue) via an internal bus connecting all components. EX1007, [0030] ("[T]his role-playing game can be provided by pre-recording the software onto the ROM of the mobile terminal 6 as a dedicated gaming device. In either case, **such software (application program) can be executed on an information processing terminal, as shown in Figure 3, which includes a CPU 63, ROM 64, and RAM 65 connected via an internal bus 66. The information processing terminal 6 also includes, as needed, features such as GPS 51**, PHS 52, **LCD 61**, and an operation panel 62.").



Id., FIG. 3 (annotated).

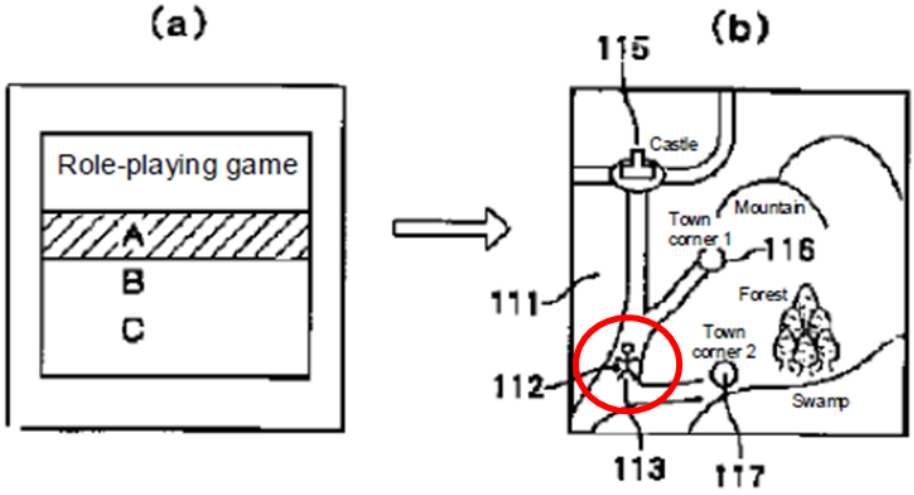
213. **Second**, Nakamura discloses *wherein said processor is operable to provide a video game comprising a virtual character with a virtual location on a virtual playfield*. In my opinion, a POSITA would have understood that the CPU (*processor*) is *operable to provide a video game* comprising the features of Nakamura's location-based game discussed below. Indeed, Nakamura discloses that the "role-playing game can be provided by pre-recording the software onto the ROM of the mobile terminal," and "such software (application program) can be executed on an information processing terminal…which includes a CPU…." *Id.*, [0030]. In other words, the role-playing game software is executed using the CPU, such that the CPU (*processor*) is *operable to provide* the game.

214. Nakamura further discloses that its game provides for a position icon representing a human figure or face (*virtual character*) that has a virtual position

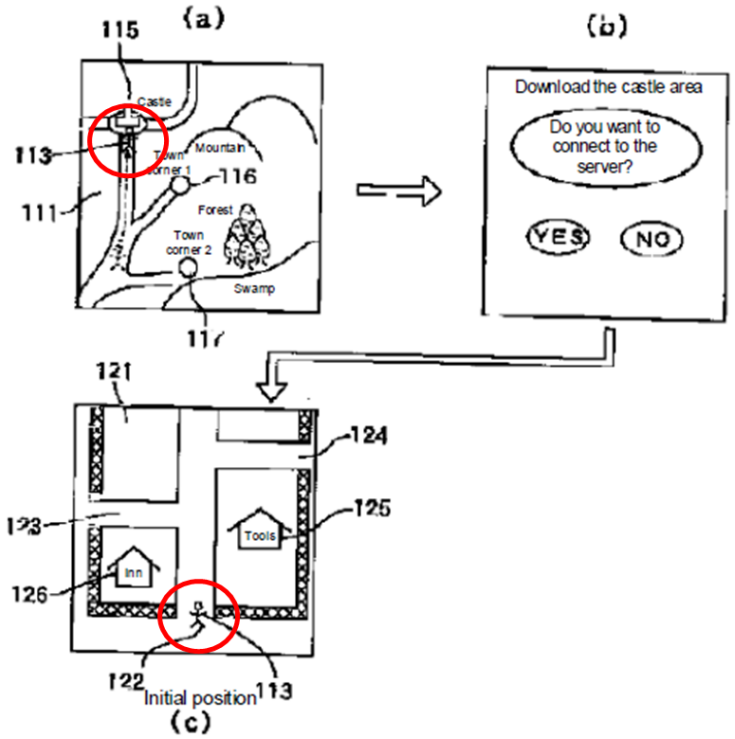
(*virtual location*) in the virtual world (*virtual playfield*). *Id.*, [0035] ("Next, in step 83, as shown in Figure 9(b), the function 31 for displaying the virtual world displays the first screen (the first virtual world) 111 of the role-playing game. In step 84, the function 32 for displaying the virtual position and virtual displacement displays the position icon 113 corresponding to the current location at the initial position 112 of the screen 111. This position icon 113, or position display icon, can be arranged according to the user's preference. It could be an icon in the shape of a human figure or even an icon representing the user's face.").

215. **Third**, Nakamura discloses *said virtual character is displayed on said display*. As discussed above, Nakamura discloses a *virtual character* that is a position icon in the form of a human figure or face. *Id.*, [0035]. Nakamura explains that a "function 32…displays the position icon 113 corresponding to the current location at the initial position 112 of the screen 111." *Id.* Indeed, as shown in Figures 9 through 13 below, which show the mobile terminal's display at various stages of gameplay, the position icon 113 representing a human figure (circled in red) is displayed on the mobile terminal's display (*said virtual character is displayed on said display*). EX1007, [0033]-[0036] (describing FIG. 9 displays), [0041]-[0045] (describing FIG. 10 displays), [0046]-[0054] (describing FIG. 11 displays), [0051]-[0052] (describing FIG. 12 displays), [0054]-[0056] (describing FIG. 13 displays).

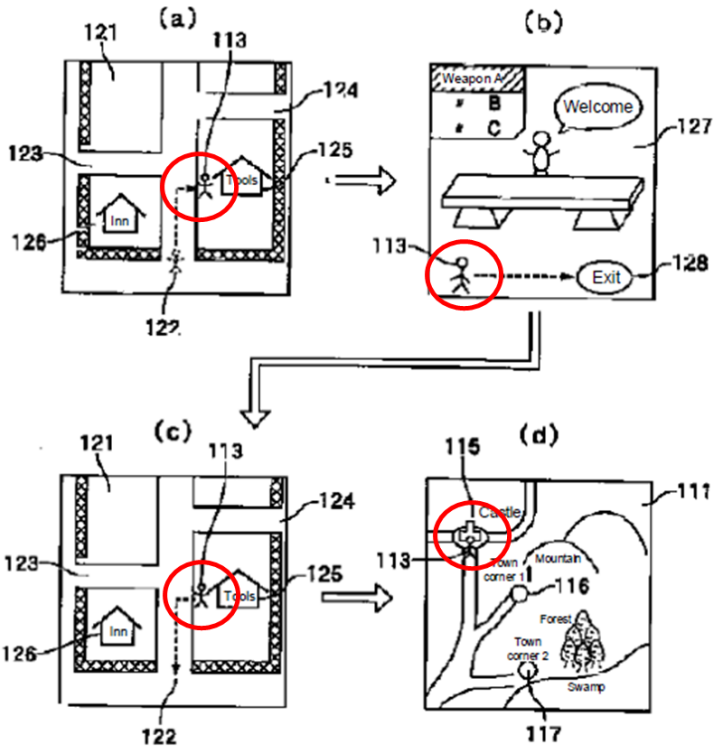
[Fig. 9]


(a)
Role-playing game
A
B
C
(b)
115
Castle
Town corner 1
Mountain
116
Forest
111
Town corner 2
112
Swamp
113
117

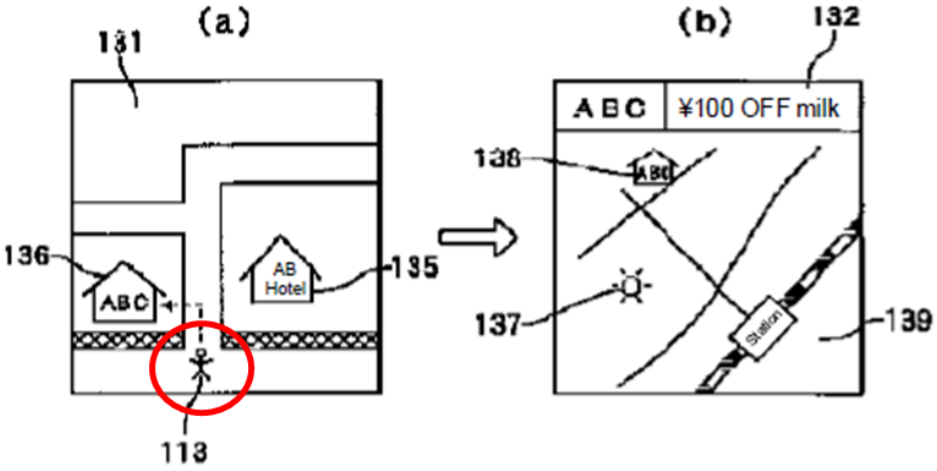
[Fig. 10]


115
(a)
Castle
113
Town corner 1
Mountain
116
111
Forest
Town corner 2
Swamp
117
(b)
Download the castle area
Do you want to connect to the server?
YES
NO
121
124
123
125
Tools
Inn
126
122
Initial position
113
(c)

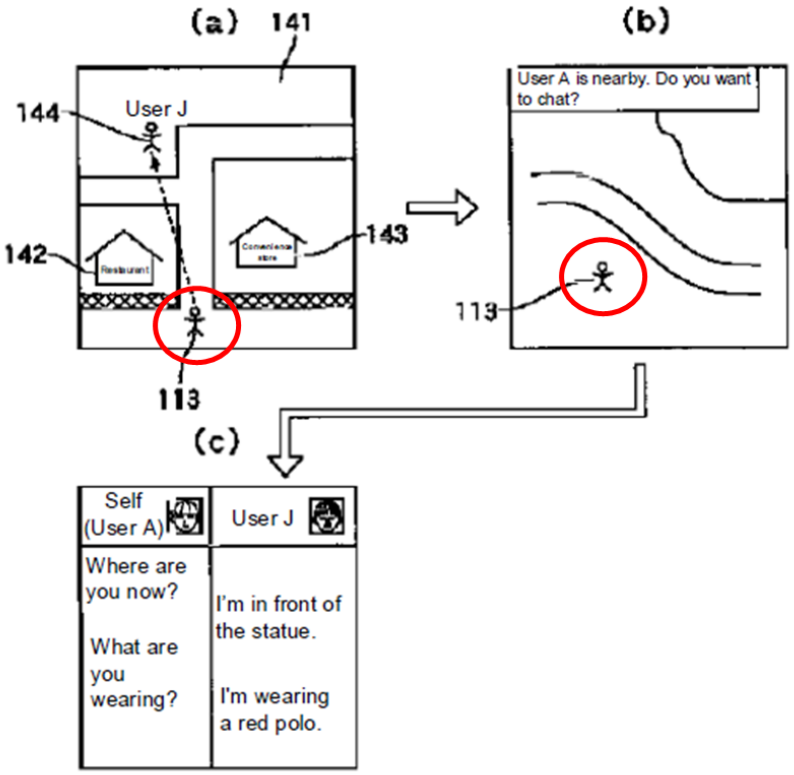
[Fig. 11]


(a)
(b)
(c)
(d)
121
113
124
123
125
126
122
Tools
Inn
Weapon A
B
C
Welcome
127
Exit
128
115
111
Castle
Town corner 1
Mountain
116
Forest
Town corner 2
Swamp
117

[Fig. 12]


(a)
(b)
131
132
136
AB Hotel
135
ABC
¥100 OFF milk
138
137
Station
139
113

[Fig. 13]

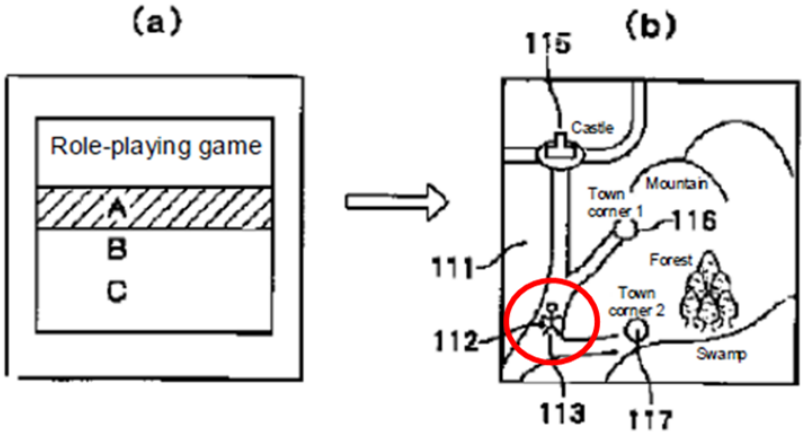


Id., FIGs. 9-13 (annotated).

216. **Fourth**, Nakamura discloses *said virtual location on said virtual playfield corresponds to said physical location on said physical playfield*. As shown in Figure 9(b), which is reproduced below and shows a mobile terminal display, the position icon (circled in red) is shown on the virtual world display (*said virtual location on said virtual playfield*). Nakamura further discloses that the location of the position icon displayed on the screen (*virtual location on said virtual playfield*) corresponds to the user's current location in the real world (*corresponds to said physical location on said physical playfield*). *Id.*, [0035] ("Next, in step 83, as shown

in Figure 9(b), the function 31 for displaying the virtual world displays the first screen (the first virtual world) 111 of the role-playing game. In step 84, the function 32 for displaying the virtual position and virtual displacement displays the position icon 113 corresponding to the current location at the initial position 112 of the screen 111.").

[Fig. 9]



Id., FIG. 9 (annotated).

217. Nakamura explains that during gameplay, the user's current location as the user moves in the real world is acquired and converted to a virtual location in order to display a corresponding virtual position icon moving through the real world. *Id.*, [0039] ("When the game starts, in step 73, the current location is acquired using the location acquisition function 11. This location is then converted, and the function 32 for displaying virtual positions and virtual displacements will show them on the screen. As a result, the user's movement with the terminal 6 will be displayed as

virtual positions and virtual displacements on the screen of the first screen of the role-playing game."). In particular, Nakamura explains that the position icon 113's location in the virtual world (*said virtual location on said virtual playfield*) corresponds to the user's actual location in the actual world (*corresponds to said physical location on said physical playfield*), such that "the position icon 113 on the screen moves in accordance with the changes in the actual location or movement (actual displacement) provided by the GPS unit 51." *Id.*, [0039]; *see also id.*, [0038] ("[T]he user moves the position icon 113…by physically moving in the real world, thus advancing in the role-playing game.").

218. **Fifth**, Nakamura in view of Benini renders obvious *a direction of gameplay of said videogame is operable to be established by recording a manually provided direction in response to a prompt requesting said manually provided direction*. Nakamura discloses that the mobile terminal is a "device equipped with a direction sensor." *Id.*, [0017]. Nakamura explains that with such device, "it is possible to rotate the display of the virtual world so that the direction of real displacement aligns with the direction of virtual displacement." *Id.* Rotating the displayed virtual world allows for the "virtual displacement [to] always[] points upwards, based on the direction of movement (actual displacement) obtained from the GPS unit 51." *Id.*, [0024]. In other words, Nakamura discloses rotating a display to set the directions of real and virtual displacement in alignment with one another,

thereby establishing the direction of gameplay (*a direction of gameplay of said videogame is operable to be established*).

219. While Nakamura does not explicitly disclose that *a direction of gameplay of said videogame is operable to be established by recording a manually provided direction in response to a prompt requesting said manually provided direction*, it is my opinion that a POSITA would have been motivated and found it obvious to implement the underlined features in view of Benini.

a. Teachings of Benini

220. Like Nakamura, Benini relates to the use of wireless portable devices for exploring virtual environments. *See* Secs. VIII.B, VIII.D. For example, Benini discloses a "hardware/software system for PDA-based interaction with IVEs [(immersive virtual environments)] realized in the field of Virtual Heritage (VH): Virtual Reality applied to Cultural Heritage." EX1009, 2. Benini aims to "reconstruct[] cultural heritage objects and environments" in an immersive virtual reality environment. *Id.*, 1. For example, "Virtual Heritage" applications may allow scholars to explore an archaeological site or the general public to explore a virtual museum. *Id.*, 2. Benini discloses the use of "standard, consumer-market wearable interactive terminals, such as palmtop computers (Pocket PC and PDAs), as the preferred interfacing device with IVEs…in the field of Cultural Heritage." *Id.* As shown in Figure 3, which I have reproduced below, Benini's system consists of

portable terminals for interfacing with the virtual environment (e.g., a virtual theatre) over a wireless network, along with client-server software that runs on the mobile terminals (client) and a virtual reality engine (server). *Id.*, 4.

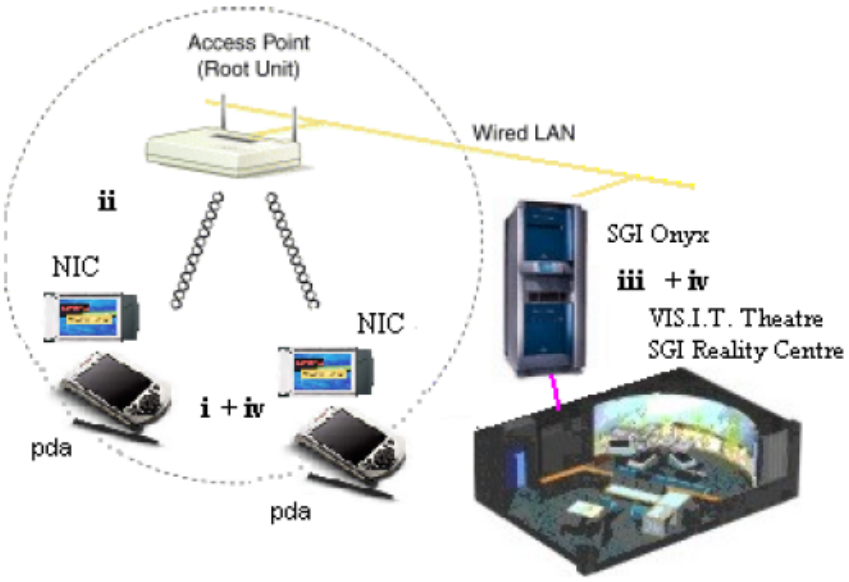


Figure 3: Components of the interactive system: portable terminals(i), wireless network(ii), virtual theater (iii), client-server software (iv).

Id., FIG. 3. Thus, in my opinion, Benini's use interface device is similar to Nakamura's, which as discussed in Sec. VIII.B (Nakamura) and Ground 4, limitation 1[a], discloses portable mobile terminals for interfacing with a virtual environment. *See* Sec. XIII.C.2. A POSITA would have therefore been motivated to consider the teachings of Benini when implementing the Nakamura system.

221. Benini additionally explains how the portable palmtop computers / PDAs can be used to support the basic interaction tasks in the field of 3D user

interfaces—navigation, selection/manipulation, and system controls. EX1009, 2-3. For example, a PDA may incorporate a "'2D map' in which the users visualize their position and orientation in the virtual world," to allow users to see "which regions can be reached by their current position." *Id.*, 3. Benini explains that "[t]he UI features a two-dimensional map abstraction of the VR world, augmented with various navigation controls," including "eight arrows to more intuitively navigate in the environment." *Id.*, 3. The 2D map reproduces a view of the virtual environment, "enabl[ing] the user to visualize his/her position in the virtual world with a red rectangle and the direction of observation with a green rectangle…." *Id*. Figure 2 below shows an example PDA with arrows (circled in green) for visualizing position and direction in the virtual environment.



Figure 2: The User Interface developed for interacting via PDA with the Nu.M.E. VE

Id., FIG. 2 (annotated). As shown above in green, the display prompts a user to use four of the arrows to "walk," i.e., change position, and four of the arrows to "look," i.e., change orientation/direction. *Id.*, FIG. 2.

222. Benini further discloses that the user interface arrows can be used to "change [the] camera's position and orientation (interacting with the 2D map or with the arrows)," thereby changing the view in the virtual environment. *Id.*, 4. When "requesting to change camera's position and orientation" according to interaction with the map/arrows, the portable terminal (client) has to send to the server (virtual reality engine) "a 6-dimensional vector that includes world coordinates (*x, y, z*) and

the three angles: heading – the rotation about the Z axis – pitch – the rotation about the X axis – and roll – the rotation about the Y axis." *Id.*, 4-5. This allows the server "to increment [the] current camera's position and orientation" to show a new view in the virtual environment. *Id.*, 5.

223. Thus, for the reasons discussed above, Benini discloses that a direction of exploration in the virtual environment may be established (*a direction of gameplay of said videogame is operable to be established*) by using a user interface that has arrows for manually providing a direction (*by recording a manually provided direction*) in response to a prompt on the display (both the arrows themselves and the written prompt to "look") informing the user to use the arrows to change orientation (*in response to a prompt requesting said manually provided direction*).

b. Motivation to Combine Nakamura and Benini

224. In my opinion, a POSITA implementing Nakamura's system would have been motivated to rely on Benini's user interface features to enhance Nakamura. As I discussed further above, Nakamura discloses a rotation feature to align the directions of real and virtual displacement so that virtual displacement always points upwards, based on the direction the user (and the user's device with a direction sensor) is moving. *See* Sec. XII.C.5. However, Nakamura does not disclose the specific processes for rotating the display of the virtual world. A

POSITA would have thus been motivated to rely on the teachings of Benini's user interface with 2D map, in which a user is prompted to use arrows to manually change the view of a virtual world map (e.g., to rotate the map) in order to establish a new viewing direction. In my opinion, a POSITA would have understood that the 2D map feature of Benini would have been a natural complement to Nakamura's system since both systems use a portable/mobile terminal to display a 2D map of a virtual world. For example, I have reproduced Nakamura's Figure 1 and Figure 9 below, where Figure 9(b) (which I have circled in green) shows a particular screen displayed on Nakamura's mobile terminal, which is shown in Figure 1. I have also reproduced below Benini's Figure 2, which similarly shows a mobile terminal display screen.

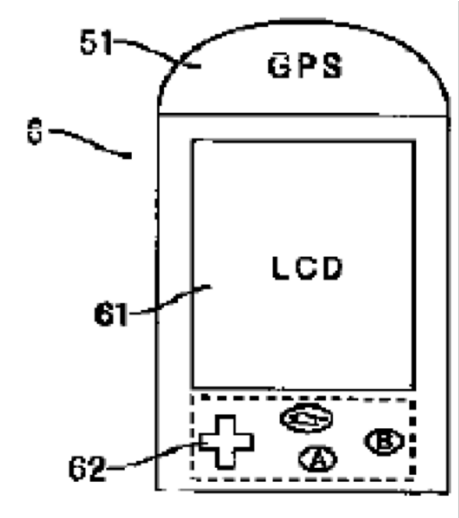


Figure 1 (excerpted)

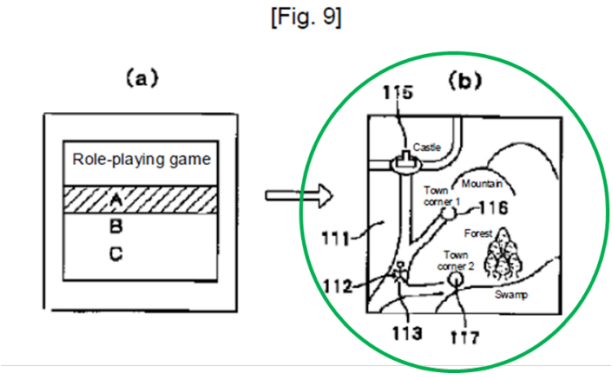




Figure 2: The User Interface developed for interacting via PDA with the Nu.M.E. VE

EX1007, FIG. 1 (excerpted), FIG. 9 (annotated); EX1009, FIG. 2 (annotated); *see also* EX1007, [0008] ("The first virtual world may simply be a world represented by a map corresponding to the real world (including deformed or stylized maps) that shows a destination or target area."); EX1009, 3 ("The UI features a two-dimensional map abstraction of the VR world…."). Moreover, as I discussed above, Benini uses manual directional arrows to manipulate position and orientation on the map, similar to the prior art systems described in Nakamura, in which "players progress in the game by moving through the virtual world using directional buttons, joysticks, or other pointing devices." EX1007, [0005]. In my opinion, POSITA would have thus understood that Nakamura's system would have been easily

improved by relying on features similar to Benini's map user interface, since Benini uses components already disclosed by Nakamura.

225. For example, if a user using Nakamura's system encounters a physical obstacle in the real word that is not represented in the virtual word, the user is unable to avoid the obstacle without the avoidance (e.g., turning around) being reflected in the virtual world. The combination with Benini improves and enhances Nakamura by permitting the user to adjust the virtual world map so that the avoidance of the physical obstacle is not reflected in the virtual world.

226. Similarly, a POSITA would understand that just as a user might start a Nakamura game that has a pre-determined initial virtual position, and that the possible gameplay associated with that virtual position might not be compatible with the user's real-world position, the game might also choose a pre-determined initial virtual rotation, and the possible gameplay associated with that virtual rotation might not be compatible with the user's real world position. The combination with Benini improves and enhances Nakamura by permitting the user to adjust the virtual world map so that the direction of virtual game play is compatible with the directions they are able to safely walk in the real world.

227. Further, a POSITA would understand that while in some places Nakamura focuses on position, Nakamura refers to both position and displacement (direction) together throughout and discloses an optional rotation feature to align the

directions of real and virtual displacement. A POSITA would therefore understand that if they were to implement that optional rotation feature to align the directions of real and virtual displacement, it would make sense to also allow the user to manually choose a rotation during initialization and at other times, just as Nakamura discloses for position. EX1007, [0036] ("If the position icon 113 is displayed at a virtual position that is appropriate to be set as the initial position, the user can perform a suitable operation, and the initial setting function 33 will set that current location as the initial position 112 on the screen 111 and store it as the parameter 13."). Indeed, a POSITA would understand that setting the appropriate position and direction for a particular user's circumstances would be crucial to making the game enjoyable and safe.

228. Because Nakamura already includes the ability to rotate the virtual scene content by some specified angle (*id.*, [0017], [0024]), including the mathematical rotations of the coordinate frames, a POSITA would have understood that all they would need to add was some suitable input mechanism, such as the screen-based arrows disclosed by Benini, to let the user control the value of an angular offset to the existing Nakamura virtual scene rotation function. This ability to adjust the direction would nicely match the ability to adjust position as disclosed by Nakamura. *See, e.g.*, EX1007, [0035] ("This position icon 113, or position

display icon, can be arranged according to the user's preference. It could be an icon in the shape of a human figure or even an icon representing the user's face.").

229. It is my opinion that a POSITA would have further understood that a manual method to rotate the display, such as disclosed by Benini, would have been one of only several options available for displaying Nakamura's map display. Indeed, a POSITA would have understood that at the time of the alleged invention of the '821 patent (i.e., 2003), virtual maps used for navigation in virtual environments could be displayed in either a north-up configuration, in which north is always at the top of the map, or a forward-up configuration, in which the map is rotated to correspond to the forward direction. EX1011, 2 ("The two primary categories of map orientation are *north-up* which, as the name implies, always has north at the top, and *forward-up* (or *track-up*) which is always rotated so as to be congruent with the forward direction."); EX1012, 2-3 (describing a "reader aligned" or "north-up aligned" map where "north is presented up on the map" and an "environment aligned" or "forward-up (or track-up) aligned" map as a map that is "oriented consistently with regard to the environment"); *see also* Sec. VI.A (background on virtual map configurations). A POSITA would have understood that Nakamura's rotated display feature, in which virtual displacement is always pointing up, would have corresponded to a forward-up map configuration. A POSITA would have also understood that during the relevant timeframe (i.e., 2003), the alignment

(e.g., forward-up) could be set automatically or could be updated manually by a user, and that it was beneficial to give a user a choice between automatic and manual modes. EX1012, 3 (describing alignment that is either "automatic" or "static until the user manually updates the map"), 3 ("Our results showed that neither automatic nor manual mode should be preferred….Therefore, the users should be offered both methods."), 10 ("In the manual orientation mode, the user had to align the map to forward-up manually, whereas in the automatic orientation mode the map was continuously aligned to forward-up."). Thus, manually aligning a display in a forward-up configuration, as contemplated by the Nakamura-Benini combination, would have been obvious because it would have been one of only several alignment options available (e.g., north-up or forward-up, and further set manually or automatically)

230. Nakamura also describes the rotation feature as an optional feature, and thus in my opinion, a POSITA would have understood that implementing the feature with manual rotation, so as to give users a choice in alignment (between forward-up and north-up alignment), would have been beneficial. EX1007, [0017] ("[I]t is **possible** to rotate the display of the virtual world so that the direction of real displacement aligns with the direction of virtual displacement."), [0024] ("[I]t is **possible** to add a feature that rotates and displays the virtual world so that virtual displacement always points upwards."). Indeed, a POSITA would have recognized

that allowing a user to manually manipulate the viewpoint of a map (e.g., to rotate it from one orientation to another), similar to the method disclosed by Benini, would have beneficially provided a user of the Nakamura system with the option to change/update the alignment direction during gameplay, depending on user preference and environmental constraints (e.g., a dead end). For example, because of the constraints of the physical world compared to the virtual world, a user would encounter a situation where one cannot or does not want to proceed in a particular physical world direction that is necessary or desired in the virtual world, thus necessitating a rotation to change/update the alignment direction during gameplay.

231. *See also* Sec. XIII.A, where I provide a higher level overview of the motivation to combine Nakamura and Benini.

c. Reasonable Expectation of Success

232. In my opinion, a POSITA would have also had a reasonable expectation of success combining the teachings of Nakamura and Benini. As I discussed above, both references are in the same field of art. *See* Sec. XIII.C.5.a. Furthermore, as discussed above, Nakamura and Benini have similar features, such as 2D maps on mobile terminals that have directional buttons, and thus a POSITA would have had a reasonable expectation of success in combining these teachings. *See* Sec. XIII.C.5.b. It is my opinion that a POSITA would have also had the skill to implement and reasonable expectation of success in achieving such a combination,

because it would have involved a combination of known technologies (e.g., known system of exploring and displaying virtual environments using a map on a mobile terminal and rotating the display to align real and virtual displacement (Nakamura)) according to known methods (e.g., known methods of rotating/changing the orientation of a map viewpoint on a mobile terminal in response to a prompt (Benini)) to yield the predictable result of a gaming system for exploring a virtual environment where a rotation feature to align real and virtual displacement (e.g. in a forward-up alignment) is implemented by manually rotating the map (e.g., with directional buttons) to the appropriate orientation in response to a prompt. Further, by using the existing Nakamura virtual world rotation capabilities as I discuss above (*see* Sec. XIII.C.5.b), which already carries out the appropriate mathematical transforms, a POSITA would further increase the expectation of success in combining Nakamura and Benini.

233. Accordingly, Nakamura in view of Benini renders obvious *a direction of gameplay of said videogame is operable to be established by recording a manually provided direction in response to a prompt requesting said manually provided direction*.

234. *See also* Sec. XIII.B, where I provide a higher level overview of a POSITA's reasonable expectation of success in combining Nakamura and Benini.

D. Dependent Claims

1. Claim 4: *"The system of claim 1, wherein said video game utilizes a perimeter selected by user-inputs."*

235. In my opinion, Nakamura discloses this limitation. Nakamura discloses "means for displaying a second virtual world when the position within the first virtual world reaches a destination or target area." EX1007, [0005]. Nakamura discloses that a user may establish predefined areas (*said video game utilizes a perimeter selected by user inputs*) for these destinations or target areas, such as a predefined range surrounding an event icon (i.e., *a perimeter*), to trigger transition conditions to the second virtual world. In particular, when a user's virtual position icon overlaps with a predefined area or range (*perimeter*) surrounding an event icon, the transition condition is triggered and a new screen of the virtual world may be displayed. *Id.*, [0026] ("In the role-playing game screen, a position or **area is set for transitioning to the next screen**, and the destination or **target area is displayed using icons or similar indicators**. Therefore, in the following, examples of such destinations or target areas displayed as icons will be shown, and these icons will be referred to as event icons. To this end, **the display control unit 30 is equipped with a function 34 to determine whether the converted virtual position of the current location or the converted virtual displacement of the actual displacement** matches the event icon or **falls within a predefined range**; in other words, it is to determine the transition conditions for the virtual world. **When the virtual position**

overlaps with the event icon (indicating a match or **entry into the predefined range), the next screen is obtained and displayed** by the function 31 that retrieves and displays the virtual world."). For example, Nakamura explains that a predefined area or range can be established around a castle event icon, such that when a user's position icon overlaps with this predefined area or range around the castle icon, the layout inside the castle gate is displayed as the new virtual world screen. *Id.*, [0042]-[0044]. In my opinion, a POSITA would have understood that a predefined range (e.g., a radius) from a particular event icon is *a perimeter selected by user inputs* before gameplay occurs. Indeed, a user would have had to input such a predefined range before gameplay in order to define the transition conditions that would be in effect for transitioning to a new virtual world screen.

236. Further, Nakamura discloses a user can adjust the ratio between real-world movement and virtual-world movement (*perimeter selected by user-inputs*). EX1007, [0009] ("Additionally, it is possible to enable the adjustment of the ratio between real-world displacement and the corresponding virtual displacement displayed in the game. If the ratio of virtual displacement to real displacement is small, the user must move a considerable distance in the real world to traverse the virtual world, increasing physical activity."). When a user adjusts the ratio of virtual displacement to real displacement, they are directly adjusting the locations of and perimeters around any predefined areas or ranges such as I discuss above, e.g., the

location of and perimeter around a castle event icon. If the user is short on time they could specify or select a ratio that is larger than the default, which would allow them to arrive at the castle in the virtual world sooner as they are walking in the real world. Conversely if they have time, and want more exercise, they can specify or select a ratio of virtual displacement to real displacement that is smaller, so they have to move farther in the real world before they arrive at the castle in the virtual world.

237. To the extent Nakamura is found not to disclose this limitation, it is obvious in view of Benini. A POSITA would have been motivated to rely on the teachings of Benini's user interface with 2D map, in which a user is prompted to use arrows to manually change the ratio in order to adjust the scale of the virtual world to match their use circumstances and desires.

2. Claim 11: *"The system of claim 1, wherein said communication device further comprises a directional device, wherein said directional device is operable to determine the physical direction of said directional device on said physical playfield."*

238. In my opinion, Nakamura discloses this limitation. As I further discussed for Ground 4, limitation 1[a]-3, Nakamura discloses that the mobile terminal (*said communication device*) may have a "direction sensor" (*a directional device*) that enables a user to "rotate the display of the virtual world so that the direction of real displacement aligns with the direction of virtual displacement." EX1007, [0017]; *see also* Sec. XIII.C.5.a. A POSITA would have understood that

in order to align the direction of real displacement (i.e., displacement on the *physical playfield*) with the direction of virtual displacement, then the direction sensor (*directional device*) must actually be able to determine the direction of real displacement. In other words, the direction sensor (*directional device*) must be *operable to determine the physical direction of said directional device on said physical playfield*.

3. Claim 16: *"The system of claim 1, wherein said wireless communication device further comprise: a speaker; and a microphone."*

239. In my opinion, Nakamura discloses this limitation. Nakamura explains that its mobile terminal (*wireless communication device*) may be equipped with a mobile phone unit that can connect to a public telephone network. EX1007, [0018] ("The mobile terminal 6, in many cases, is equipped with a PHS unit or a **mobile phone unit**. Through these units, it **connects to the public telephone network 7** via PHS base station 7a or mobile phone base station 7b, and further connects to the server system 20 via dial-up server 25."), [0021] ("a mobile terminal 6 can **connect to the public telephone network 7**"), [0021] ("the mobile terminal 6 is equipped with the **functionality of a mobile phone**"), [0022] ("[T]he mobile terminal 6 is equipped with a PHS unit 52 and a dial-up connection function 53 to **connect to the service provider via the public telephone network 7** or the internet 1."). A POSITA would have understood that the mobile terminal's mobile phone unit would

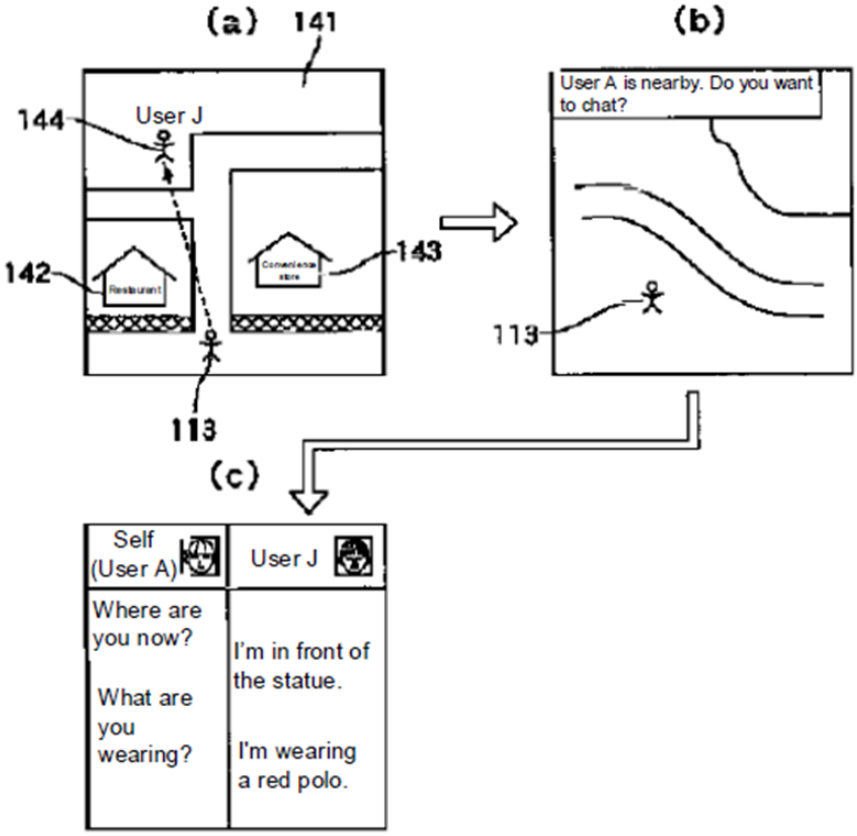
have contained *a speaker* and *a microphone* in order to enable communication through a public telephone network. Indeed, telephonic communication between a mobile phone and another telephone over a telephone network would not be possible without both the ability for a mobile phone user to receive verbal communication (via a *speaker*) and transmit verbal communication (via a *microphone*).

4. Claim 30: *"The system of claim 1, wherein said wireless communications device is operable to provide human-communications to a second wireless telephonic device while said video game is being played."*

240. In my opinion, Nakamura discloses this limitation. As I discussed for Ground 4, claim 16, each wireless mobile terminal (*wireless communications device*) is equipped with mobile phone technology and is thus a *wireless telephonic device*. *See* Sec. XIII.D.3. Nakamura further discloses that each mobile terminal is equipped to allow its user to communicate with other users' mobile terminals through an in-game chat function (*operable to provide human-communications to a second wireless telephonic device while said video game is being played*). EX1007, [0029] ("Additionally, by accessing the server system 20, it becomes possible to obtain information about the virtual world with event icons representing other users who are accessing the same role-playing game, using the function 31 for acquiring and displaying the virtual world. Then, **a connection can be established with that user, allowing for communication (chat)** through the screen. Therefore, a chat function

36 is provided as part of the features of the display control unit 30."). Figure 13 below shows the process by which a user (e.g., User J, as shown in Figure 10(a)) is alerted of a nearby user (e.g., User A) and asked if the user wants to chat (Figure 10(b)), and subsequently engages in a chat session with the other user (Figure 10(c)).

[Fig. 13]



Id., FIG. 13; *see also id.*, [0056]-[0057] (describing the detailed process for chat between two users).

XIV. OPINIONS ON GROUND 5: NAKAMURA RENDERS OBVIOUS CLAIM 102

A. Independent Claim 102

1. Preamble: *"A system comprising:"*

241. To the extent the preamble is limiting, it is my opinion that Nakamura discloses the preamble for the same reasons as I discussed for Ground 3, claim 1's preamble. *See* Sec. XII.C.1.

2. 102[a]: *"a non-transparent display;"*

242. In my opinion, Nakamura discloses this limitation. As I discussed for Ground 4, limitation 1[a]-1, Nakamura discloses that the mobile terminal has an LCD *display*. *See* Sec. XIII.C.3. A POSITA would have understood that an LCD screen of a mobile terminal (e.g., a mobile phone) is a *non-transparent display* since a standard LCD screen has a backlight behind the screen to illuminate the pixels, thus blocking the view through the screen.

3. 102[b]: *"a locating device operable to determine the physical location of said locating device on a physical playfield, wherein said locating device comprises a movement measuring device operable to be utilized, at least in part, to determine said physical location;"*

243. In my opinion, Nakamura discloses this limitation. Nakamura discloses that the mobile terminal's GPS is *a locating device operable to determine the physical location of said locating device on a physical playfield* for the same reasons as I discussed for Ground 4, limitation 1[a]-2. *See* Sec. XII.C.4. Nakamura further

discloses a location acquisition function which uses the mobile terminal's GPS (*locating device*) to determine the actual position (*determine said physical location*) of the user as the user (and their mobile terminal with GPS unit) changes position and moves through the real world, and another function that converts actual user movement measured by the GPS (*locating device comprises a movement measuring device*) to movement in the virtual world of the game. EX1007, [0034] ("Next, in step 82, **the current location is obtained using the location acquisition function 11**. As mentioned earlier, information indicating **the current location can be obtained from the GPS unit 51** or the PHS unit 52."), [0039] ("Once the initial processing in step 72 is completed, the role-playing game will in effect start. When the game starts, in step 73, **the current location is acquired using the location acquisition function 11**. This location is then converted, and the function 32 for displaying virtual positions and virtual displacements will show them on the screen. As a result, the user's movement with the terminal 6 will be displayed as virtual positions and virtual displacements on the screen of the first screen of the role-playing game. In other words, based on the initial settings or the default pre-set values (for example, 1 dot = 1 meter on the screen), **the position icon 113 on the screen moves in accordance with the changes in the actual location or movement (actual displacement) provided by the GPS unit 51**."). Thus, the GPS

is a *locating device* that *comprises a movement measuring device operable to be utilized, at least in part, to determine said physical location*.

4. 102[c]: *"a directional device operable to determine the physical direction of said directional device on said physical playfield; and"*

244. In my opinion, Nakamura discloses this limitation for the same reasons as I discussed for Ground 4, claim 11. *See* Sec. XIII.D.2.

5. 102[d]: *"a processor coupled to said display and said locating device, wherein said processor is operable to provide a video game comprising a virtual character with a virtual location and facing a virtual direction on a virtual playfield said virtual location on said virtual playfield corresponds to said physical location on said physical playfield, an origin of gameplay of said videogame is operable to be established by recording a manually provided origin in response to a prompt requesting said manually provided origin, and said virtual direction on said virtual playfield corresponds to said physical direction on said physical playfield."*

245. In my opinion, Nakamura renders obvious this limitation.

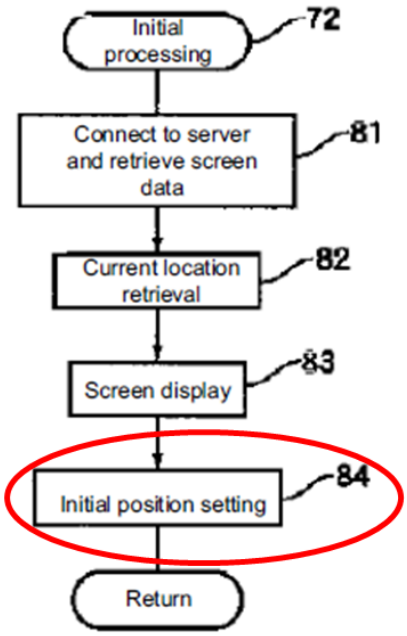
246. **First**, Nakamura discloses *a processor coupled to said display and said locating device, wherein said processor is operable to provide a video game comprising a virtual character with a virtual location and facing a virtual direction on a virtual playfield said virtual location on said virtual playfield corresponds to said physical location on said physical playfield* for the same reasons as I discussed for Ground 3, limitation 1[a]-3, which recites substantially similar limitations. *See* Sec. XII.C.5.

247. **Second**, Nakamura renders obvious *an origin of gameplay of said videogame is operable to be established by recording a manually provided origin in response to a prompt requesting said manually provided origin*. As further discussed for Sec. VIII.B (Nakamura overview) and Ground 3, claim 1's preamble, Nakamura explains that new virtual worlds are displayed by tracking a user's current location information using technologies such as GPS. *See* Sec. XII.C.1; *see also* EX1007, [0005], [0016], [0019]. Nakamura further explains that "initial settings [can] be configured to reflect movements in the real world within the virtual world." EX1007, [0009]. Nakamura discloses that "it is desirable to perform an initial setup that defines the correspondence between the current location and the virtual position, as well as the ratio for converting actual displacement into virtual displacement, prior to starting the role-playing game." *Id.*, [0025]. The "function 33 for performing the initial setup is provided as one of the features of the display control unit 30, and the settings defined there are stored in a memory such as ROM or RAM." *Id.*

248. As part of this initial setup, "it is desirable to set the current location in the real world as a predetermined position (the initial value of the virtual position) within the first virtual world." *Id.*, [0009]. The initial position may represent "the starting point of the game or, if the game was interrupted, the point where it was paused." *Id.* While it is possible "to use the parameters that are set by default" (*id.*,

[0025]), it is also possible to manually set the initial position setting (*an origin of gameplay of said videogame is operable to be established by recording a manually provided origin*) in response to the display of a position icon that prompts the user to manually adjust the position icon on the display to a suitable initial position setting (*in response to a prompt requesting said manually provided origin*). For example, as shown in red circle in Figure 5 below, Nakamura explains that "[i]n step 84, the function 32 for displaying the virtual position and virtual displacement displays the position icon 113 corresponding to the current location at the initial position 112 of the screen 111," where the position icon may be "an icon in the shape of a human figure or even an icon representing the user's face." *Id.*, [0035].

[Fig. 5]



Id., FIG. 5 (annotated). After the position icon is initially displayed on the screen, the "position icon 113, or position display icon, can be arranged according to the user's preference." *Id.*, [0035]. Once the user has chosen a suitable initial position, the user performs an operation on the display to trigger an initial setting function that sets the current location as the initial position parameter (*an origin of gameplay of said videogame is operable to be established by recording a manually provided origin*). *Id.*, [0036] ("If the position icon 113 is displayed at a virtual position that is appropriate to be set as the initial position, the user can perform a suitable operation, and the initial setting function 33 will set that current location as the initial position 112 on the screen 111 and store it as the parameter 13.") A POSITA would have understood that the display of a movable position icon is a *prompt requesting said manually provided origin* because it indicates to a user that the user should either change the initial position setting or confirm that the current position is correct. In other words, the display of the icon *prompts* the user to manually move the icon to a desired origin position to start gameplay.

249. Accordingly, Nakamura discloses *an origin of gameplay of said videogame is operable to be established by recording a manually provided origin in response to a prompt requesting said manually provided origin*.

250. To the extent Nakamura is found not to disclose that the manually provided origin is provided *in response to a prompt requesting said manually*

provided origin, it is my opinion that Nakamura renders this limitation obvious. Indeed, as I discussed for Ground 3, limitation 102[d], Nakamura discloses that written prompts are provided on the mobile terminal in various scenarios in order to request manual user input. *See* Sec. XII.C.5; EX1007, [0033], [0042]-[0044], [0056]; *see also id.*, FIGs. 9, 10, 13. A POSITA would have recognized the benefits of implementing such a prompt in similar scenarios in which a manual user input is desired, such as where a user is asked to move the position icon to a desired initial position to provide a *manually provided origin*. A POSITA would have understood that adding such a prompt would have increased clarity (e.g., by reducing confusion as to the next steps the user should take) and provided for a more seamless user experience at the start of gameplay.

251. In my opinion, a POSITA would have also had a reasonable expectation of success in implementing these teachings in the Nakamura system. As I discussed above, Nakamura already discloses using prompts for numerous scenarios in which manual user input is desired. Thus, a POSITA would have understood that the combination would have involved implementing the Nakamura system a way that Nakamura suggests is feasible. A POSITA would have also had the skill to implement and reasonable expectation of success in achieving such a combination because it would have involved a combination of known technologies (e.g., known system that accepts manual input of an origin of gameplay) according to known

methods (e.g., known methods of using prompts to request manual user input) to yield the predictable result of a system that provides a prompt to request that a user provide a manually provide origin of gameplay.

252. Accordingly, Nakamura renders obvious *an origin of gameplay of said videogame is operable to be established by recording a manually provided origin in response to a prompt requesting said manually provided origin*.

253. **Third**, Nakamura discloses *said virtual direction on said virtual playfield corresponds to said physical direction on said physical playfield*. As further discussed for Ground 3, limitation 1[a]-3, Nakamura discloses a feature in which the virtual world display is rotated such that the direction of virtual displacement in the virtual world (*said virtual direction on said virtual playfield*) is aligned with (*corresponds to*) the direction of real displacement in the real world (*said physical direction on said physical playfield*). *See* Sec. XII.C.5; EX1007, [0017] ("[I]f the installed terminal is a device equipped with a direction sensor, it is possible to rotate the display of the virtual world so that the direction of real displacement aligns with the direction of virtual displacement."), [0024] ("The game system 10 is equipped with a display control unit 30 for displaying the virtual world, and this display control unit 30 has several functions….[I]t is possible to add a feature that rotates and displays the virtual world so that virtual displacement always

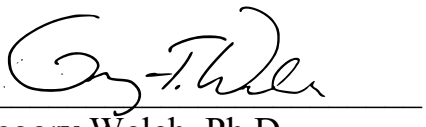
points upwards, based on the direction of movement (actual displacement) obtained from the GPS unit 51.").

XV. CONCLUSION

254. For all the reasons stated above, it is my opinion that the challenged claims of the '821 patent are unpatentable.

This declaration and my opinions are made to the best of my knowledge and understanding, and based on the material available to me at the time of singing this declaration. All statements made herein of my own knowledge are true, and all statements made on information and belief are believed to be true. Further, I am aware that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001. I declare under penalty of perjury that the foregoing is true and correct.

Executed this 25th day of March 2025 in Longwood, FL.



Gregory Welch, Ph.D.

APPENDIX A: DOCUMENTS CONSIDERED

Exhibit No.	Description
1001	U.S. Patent No. 11,033,821 to Mullen ("the '821 patent")
1002	File History of U.S. Patent No. 11,033,821
1004	Curriculum Vitae of Gregory Welch, Ph.D.
1005	Declaration of Scott Delman ("Delman")
1006	Cheok, A. et al., *Human Pacman: A Sensing-based Mobile Entertainment System with Ubiquitous Computing and Tangible Interaction* (May 2003) ("Cheok")
1007	Japanese Patent Application Publication No. JP2001070658A to Nakamura ("Nakamura")
1008	U.S. Patent No. 5,645,077 to Foxlin ("Foxlin077")
1009	Benini, L. et al., *Palmtop Computer for managing Interaction with Immersive Virtual Heritage* (2002) ("Benini")
1010	RESERVED
1011	Darken, R. & Cevik, H., *Map Usage in Virtual Environments: Orientation Issues* (1999)
1012	Lehikoinen, J. & Suomela, R., *WalkMap: Developing an Augmented Reality Map Application for Wearable Computers* (2002)
1013	InterSense Inc, *Inertia Cube2 Bringing 3D To Life – Manual for Serial Port Model* (2001)
1014	U.S. Patent No. 5,991,085 to Rallison ("Rallison")
1015	Sutherland, I., *A Head-Mounted Three Dimensional Display* (1968)

Exhibit No.	Description
1016	Fitzmaurice, G., et al., *Virtual Reality for Palmtop Computers* (1993) ("Fitzmaurice")
1017	Fitzmaurice, G., *Situated Information Spaces and Spatially Aware Palmtop Computers* (1993) ("FitzmauriceB")
1018	Schilit, B. and Theimer, M., *Disseminating Active Map Information to Mobile Hosts* (1994)
1019	Björk, S. et al., *Pirates! Using the Physical World as a Game Board*, (2001)
1020	Falk, J. et al., *Pirates!: Proximity-Triggered Interaction in a Multi-Player Game* (2001)
1021	Thomas, B. et al., *First Person Indoor/Outdoor Augmented Reality Application: ARQuake* (2002)
1022	Azuma, R., *A Survey of Augmented Reality* (1997)
1023	Young, W.R., *Advanced Mobile Phone Service: Introduction, Background, and Objectives* (1979)
1024	Gratschew, S. et al., *A Multimedia Messaging Platform for Content Delivering* (2003)
1025	Kamerman, A. and Monteban, L., *WaveLAN®-II: A High-Performance Wireless LAN for the Unlicensed Band* (1997)
1026	Ramanujan, R. et al., *Active Network Services for Mobile Wireless Environments* (2000)
1027	Hewlett-Packard Singapore (Pte) Ltd., *HP Jornada 600 Series Handheld PC User's Guide* (2000)

Exhibit No.	Description
1028	Welch, G., *Motion Tracking: No Silver Bullet, but a Respectable Arsenal* (2002)
1029	Ware, C. and Osborne, S., *Exploration and Virtual Camera Control in Virtual Three Dimensional Environments* (1990)
1030	Bowman, D., *Interaction Techniques for Common Tasks in Immersive Virtual Environments Design, Evaluation, and Application* (1999)
1031	Arns, L., *A new taxonomy for locomotion in virtual environments* (2002)
1032	Razzaque, S. et al., *Redirected Walking* (2001)
1033	Cheok, A. et al., *Touch-Space: Mixed Reality Game Space Based on Ubiquitous, Tangible, and Social Computing* (2002)
1034	Declaration of Mark Claypool ("Claypool")
1035	Declaration of Philippe Geril ("Geril")
1036	U.S. Provisional Application No. 60/499,810 ("the '810 provisional")
1037	RESERVED
1038	Declaration of Ayman K JP2001070658A Translation
1039	Transmeta Corporation, *Transmeta™ Crusoe™ TM5900 System Development Kit Product Sheet* (2003)