POSITION LOCATION SYSTEM USING MULTIPLE POSITION LOCATION TECHNIQUES

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Appl. No.: 12/142,702
Filed: Jun. 19, 2008

Related U.S. Application Data
Provisional application No. 60/936,724, filed on Jun. 22, 2007.

Publication Classification
Int. Cl. H04Q 7/20 (2006.01) A63F 9/24 (2006.01)
U.S. Cl. ......................... 455/456.1; 463/39

ABSTRACT
A position location system includes a first position location sub-system, a second position location sub-system, and processing circuitry. The first position location sub-system determines first position location information regarding an object using a first position location technique. The second position location sub-system determines second position location information regarding the object, the second position location sub-system using a second position location technique that differs from the first position location technique. The processing circuitry processes the first position location information and the second position location information to determine position of the object within a coordinate system.
FIG. 33

240 start

242 receive image intensity signal(s) for a BF signal

244 determine distance to object based on received image intensity signal

246 determine likely material based on received image intensity signal

252 identify player or players in the physical environment based on materials

254 determine player or players' initial position based on the corresponding distances

258 all BF signals processed?

250 compile materials and distances to establish an initial model of the physical environment
FIG. 49

start

350 evaluate physical environment

352 select one or more of a plurality of positioning techniques for determining position of player and/or gaming object based on environment

354 determine position of player and/or gaming object using the selected positioning technique(s)

356 select one or more of a plurality of motion tracking techniques for determining motion of player and/or gaming object based on environment and/or position

358 determine motion of player and/or gaming object using the selected motion tracking technique(s)

360 update position?

no

yes
FIG. 53

protocol processing module 380

RFID reader 370

RFID tag 372

gaming object 14

DAC 384

digitization module 388

pre-decoding module 390

decoding module 392

encoding module 392

Vox

power generating circuit 394

envelope detection module 396

oscillation module 398

oscillation calibration module 400

comparator 402

protocol processing module 380
start

reader sends power up signal to tags (active or passive)

410

receive a powered up ACK from tags

412

at (t), send command for a response to be sent at a specific time after receipt of the command

414

at some later time, receive the response from one of the tags

416

record time and tag ID

418

compute distance for tag based on t, the stored response time, and the specific delay time

420

receive response from all tags

422

determine general position of each tag based on its corresponding distance

424

(translate)

determine general position of player or gaming object based on distances of tags to RFID readers

426
start

evaluate physical environment

first position location sub-system captures first position location information regarding object using first position location technique

second position location sub-system captures second position location information regarding object using second position location technique

Process first position location information and second position location information to determine position of object within coordinate system

Integrate position of object within coordinate system into video game function

FIG. 67
start 710
evaluate physical environment

712
first position location sub-system captures first position location information regarding first object using first position location technique

714
second position location sub-system captures second position location information regarding second object using second position location technique

716
Process first position location information to determine position of first object within coordinate system

718
Process second position location information to determine position of second object within coordinate system

719
Integrate positions of first and second objects within coordinate system into video game function

FIG. 71
start 730

Evaluate physical environment 731

First position location sub-system captures first position location information regarding first object using first position location technique 732

Second position location sub-system captures second position location information regarding second object using second position location technique after first position location 733

Process first position location information to determine position of first object within coordinate system 734

Determine motion of second object using second position location information 735

Determine motion of first object using second position location information 736

End 737

FIG.73
POSITION LOCATION SYSTEM USING MULTIPLE POSITION LOCATION TECHNIQUES

[0001] This patent application claims priority under 35 USC § 119 to a provisionally filed patent application entitled POSITION AND MOTION TRACKING OF AN OBJECT, having a provisional filing date of Jun. 2, 2007, and a provisional Ser. No. of 60/936,724 (BP6471).

CROSS REFERENCE TO RELATED PATENTS

[0002] NOT APPLICABLE

[0003] The following U.S. Utility Applications are related to the present application and are incorporated herein by reference in their entirety:


[0005] 2. The U.S. Utility application Ser. No. 12/128,810, filed May 29, 2008, entitled APPARATUS FOR POSITION DETECTION USING MULTIPLE ANTENNAS, (BP7147);

[0006] 3. The U.S. Application Ser. No. 12/128,785, filed May 29, 2008, entitled APPARATUS FOR POSITION DETECTION USING MULTIPLE HCF TRANSMISSIONS, (BP7143);


STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0011] NOT APPLICABLE

INCORPORATION-BY-REFERENCE OF MATERIAL SUBMITTED ON A COMPACT DISC

[0012] NOT APPLICABLE

BACKGROUND OF THE INVENTION

[0013] 1. Technical Field of the Invention

[0014] This invention relates generally to position location systems and more particularly to determining position of one or more objects within a position location system.

[0015] 2. Description of Related Art

[0016] Communication systems are known to support wireless and wire lined communications between wireless and/or wire lined communication devices. Such communication systems range from national and/or international cellular telephone systems to the Internet to point-to-point in-home wireless networks to radio frequency identification (RFID) systems. Each type of communication system is constructed, and hence operates, in accordance with one or more communication standards. For instance, radio frequency (RF) wireless communication systems may operate in accordance with one or more standards including, but not limited to, RFID, IEEE 802.11, Bluetooth, advanced mobile phone services (AMPS), digital AMPS, global system for mobile communications (GSM), code division multiple access (CDMA), local multi-point distribution systems (LMDS), multi-channel multi-point distribution systems (MMDS), and/or variations thereof. As another example, infrared (IR) communication systems may operate in accordance with one or more standards including, but not limited to, IrDA (Infrared Data Association).

[0017] Depending on the type of RF wireless communication system, a wireless communication device, such as a cellular telephone, two-way radio, personal digital assistant (PDA), personal computer (PC), laptop computer, home entertainment equipment, RFID reader, RFID tag, etc., communicates directly or indirectly with other wireless communication devices. For direct communications (also known as point-to-point communications), the participating wireless communication devices tune their receivers and transmitters to the same channel or channels (e.g., one of the plurality of radio frequency (RF) carriers of the wireless communication system) and communicate over that channel(s). For indirect wireless communications, such wireless communication device communicates directly with an associated base station (e.g., for cellular services) and/or an associated access point (e.g., for an in-home or in-building wireless network) via an assigned channel. To complete a communication connection between the wireless communication devices, the associated base stations and/or associated access points communicate with each other directly, via a system controller, via the public switch telephone network, via the Internet, and/or via some other wide area network.

[0018] For each RF wireless communication device to participate in wireless communications, it includes a built-in radio transceiver (i.e., receiver and transmitter) or is coupled to an associated radio transceiver (e.g., a station for in-home and/or in-building wireless communication networks, RF modem, etc.). As is known, the receiver is coupled to the antenna and includes a low noise amplifier, one or more intermediate frequency stages, a filtering stage, and a data recovery stage. The low noise amplifier receives inbound RF signals via the antenna and amplifies them. The one or more intermediate frequency stages mix the amplified RF signals with one or more local oscillations to convert the amplified RF signal into baseband signals or intermediate frequency (IF) signals. The filtering stage filters the baseband signals or the IF signals to attenuate unwanted out of bandwidth signals to produce filtered signals. The data recovery stage recovers raw data from the filtered signals in accordance with the particular wireless communication standard.

[0019] As is also known, the transmitter includes a data modulation stage, one or more intermediate frequency stages, and a power amplifier. The data modulation stage converts raw data into baseband signals in accordance with a particular wireless communication standard. The one or more intermediate frequency stages mix the baseband signals with one or more local oscillations to produce RF signals. The power amplifier amplifies the RF signals prior to transmission via an antenna.

[0020] In most applications, radio transceivers are implemented in one or more integrated circuits (ICs), which are
inter-coupled via traces on a printed circuit board (PCB). The radio transceivers operate within licensed or unlicensed frequency spectrums. For example, wireless local area network (WLAN) transceivers communicate data within the unlicensed Industrial, Scientific, and Medical (ISM) frequency spectrum of 900 MHz, 2.4 GHz, and 5 GHz. While the ISM frequency spectrum is unlicensed there are restrictions on power, modulation techniques, and antenna gain.

In IR communication systems, an IR device includes a transmitter, a light emitting diode, a receiver, and a silicon photo diode. In operation, the transmitter modulates a signal, which drives the LED to emit infrared radiation which is focused by a lens into a narrow beam. The receiver, via the silicon photo diode, receives the narrow beam infrared radiation and converts it into an electric signal.

IR communications are used in video games to detect the direction in which a game controller is pointed. As an example, an IR sensor is placed near the game display, where the IR sensor detects the IR signal transmitted by the game controller. If the game controller is too far away, too close, or angled away from the IR sensor, the IR communication will fail.

Further advances in video gaming include three accelerometers in the game controller to detect motion by way of acceleration. The motion data is transmitted to the game console via a Bluetooth wireless link. The Bluetooth wireless link may also transmit the IR direction data to the game console and/or convey other data between the game controller and the game console.

While the above technologies allow video gaming to include motion sensing, it does so with limitations. As mentioned, the IR communication has a limited area in which a player can be for the IR communication to work properly. Further, the accelerometer only measures acceleration such that true one-to-one detection of motion is not achieved. Thus, the gaming motion is limited to a handful of directions (e.g., horizontal, vertical, and a few diagonal directions).

Therefore, a need exists for improved motion tracking and positioning determination for video gaming and other applications.

BRIEF SUMMARY OF THE INVENTION

The present invention is directed to apparatus and methods of operation that are further described in the following Brief Description of the Drawings, the Detailed Description of the Invention, and the claims. Other features and advantages of the present invention will become apparent from the following detailed description of the invention made with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

FIG. 1 is a schematic block diagram of an overhead view of an embodiment of a gaming system in accordance with the present invention;

FIG. 2 is a schematic block diagram of a side view of an embodiment of a gaming system in accordance with the present invention;

FIG. 3 is a schematic block diagram of an overhead view of another embodiment of a gaming system in accordance with the present invention;

FIG. 4 is a schematic block diagram of a side view of another embodiment of a gaming system in accordance with the present invention;

FIG. 5 is a schematic block diagram of an overhead view of another embodiment of a gaming system in accordance with the present invention;

FIG. 6 is a schematic block diagram of another embodiment of a gaming system in accordance with the present invention;

FIG. 7 is a schematic block diagram of another embodiment of a gaming system in accordance with the present invention;

FIGS. 8-10 are diagrams of an embodiment of a coordinate system of a gaming system in accordance with the present invention;

FIGS. 11-13 are diagrams of another embodiment of a coordinate system of a gaming system in accordance with the present invention;

FIG. 14 is a diagram of a method for determining position and/or motion tracking in accordance with the present invention;

FIGS. 15A and 15B are diagrams of other methods for determining position and/or motion tracking in accordance with the present invention;

FIGS. 16-18 are diagrams of another embodiment of a coordinate system of a gaming system in accordance with the present invention;

FIGS. 19-21 are diagrams of another embodiment of a coordinate system of a gaming system in accordance with the present invention;

FIG. 22 is a diagram of another method for determining position and/or motion tracking in accordance with the present invention;

FIG. 23 is a diagram of another method for determining position and/or motion tracking in accordance with the present invention;

FIG. 24 is a diagram of another method for determining position and/or motion tracking in accordance with the present invention;

FIG. 25 is a diagram of another method for determining position and/or motion tracking in accordance with the present invention;

FIG. 26 is a diagram of another embodiment of a coordinate system of a gaming system in accordance with the present invention;

FIG. 27 is a schematic block diagram of an embodiment of a wireless communication system in accordance with the present invention;

FIG. 28 is a schematic block diagram of another embodiment of a wireless communication system in accordance with the present invention;

FIG. 29 is a schematic block diagram of another embodiment of a wireless communication system in accordance with the present invention;

FIG. 30 is a schematic block diagram of an overhead view of an embodiment of determining position and/or motion tracking in accordance with the present invention;

FIG. 31 is a schematic block diagram of a side view of an embodiment of determining position and/or motion tracking in accordance with the present invention;

FIG. 32 is a schematic block diagram of an embodiment of transceiver in accordance with the present invention;
FIG. 33 is a diagram of another method for determining position and/or motion tracking in accordance with the present invention;

FIG. 34 is a diagram of another method for determining position and/or motion tracking in accordance with the present invention;

FIG. 35 is a schematic block diagram of an embodiment of a wireless communication in accordance with the present invention;

FIG. 36 is a diagram of an embodiment of an antenna pattern in accordance with the present invention;

FIG. 37 is a diagram of another embodiment of an antenna pattern in accordance with the present invention;

FIG. 38 is a diagram of an example of receiving an Rf signal in accordance with the present invention;

FIG. 39 is a diagram of an example of frequency dependent in-air attenuation in accordance with the present invention;

FIGS. 40 and 41 are diagrams of an example of frequency dependent distance calculation in accordance with the present invention;

FIG. 42 is a diagram of an example of constructive and destructive signaling in accordance with the present invention;

FIG. 43 is a diagram of another example of constructive and destructive signaling in accordance with the present invention;

FIG. 44 is a schematic block diagram of an overhead view of another embodiment of a gaming system in accordance with the present invention;

FIG. 45 is a schematic block diagram of an overhead view of another embodiment of a gaming system in accordance with the present invention;

FIG. 46 is a schematic block diagram of an overhead view of another embodiment of a gaming system in accordance with the present invention;

FIG. 47 is a schematic block diagram of an overhead view of another embodiment of a gaming system in accordance with the present invention;

FIG. 48 is a diagram of another method for determining position and/or motion tracking in accordance with the present invention;

FIG. 49 is a diagram of another method for determining position and/or motion tracking in accordance with the present invention;

FIG. 50 is a schematic block diagram of an overhead view of another embodiment of a gaming system in accordance with the present invention;

FIG. 51 is a schematic block diagram of an overhead view of another embodiment of a gaming system in accordance with the present invention;

FIG. 52 is a schematic block diagram of a side view of another embodiment of a gaming system in accordance with the present invention;

FIG. 53 is a schematic block diagram of an embodiment of an RFID reader and an RFID tag in accordance with the present invention;

FIG. 54 is a diagram of a method for determining position in accordance with the present invention;

FIG. 55 is a schematic block diagram of an embodiment of a gaming object in accordance with the present invention;

FIG. 56 is a schematic block diagram of an embodiment of a three-dimensional antenna structure in accordance with the present invention;

FIG. 57 is a diagram of an example of an antenna radiation pattern in accordance with the present invention;

FIGS. 58 and 59 are diagrams of an example of frequency dependent motion calculation in accordance with the present invention;

FIG. 60 is a diagram of a method for determining motion in accordance with the present invention;

FIG. 61 is a diagram of an example of determining a motion vector in accordance with the present invention;

FIG. 62 is a schematic block diagram of an overhead view of another embodiment of a gaming system in accordance with the present invention;

FIG. 63 is a diagram of an example of audio and near audio frequency bands in accordance with the present invention;

FIG. 64 is a schematic block diagram of an overhead view of another embodiment of a gaming system in accordance with the present invention.

FIG. 65 is a schematic block diagram of an overhead view of another embodiment of a gaming system in accordance with the present invention.

FIG. 66 is a schematic block diagram of an overhead view of yet another embodiment of a position location system in accordance with the present invention.

FIG. 67 is a flow chart illustrating operations of a position location system employing multiple position location techniques.

FIG. 68 is a flow chart illustrating usage of multiple position location techniques for locating an object.

FIG. 69 is a flow chart illustrating usage of multiple position location techniques for determining position and motion of an object.

FIG. 70 is a flow chart illustrating operation for using multiple position location techniques to determine position and orientation of an object.

FIG. 71 is a flow chart illustrating operation for using multiple position location techniques to determine positions of multiple objects.

FIG. 72 is a flow chart illustrating operation for using multiple position location techniques to determine position and motion of multiple objects.

FIG. 73 is a flow chart illustrating operation for using multiple position location techniques to determine position and motion of multiple objects.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 is a schematic block diagram of an overhead view of an embodiment of a video gaming system 10 that includes a game console device 12 and a gaming object 14 associated with a player 16. The video gaming system 10 is within a gaming environment 22, which may be a room, portion of a room, and/or any other space where the gaming object 14 and the game console device 12 can be proximally co-located (e.g., airport terminal, on a bus, on an airplane, etc.).

In operation, the game console device 12 (embodiments of which will be described in greater detail with reference to FIGS. 2-7, 14-25, and 27-XX) determines the gaming environment 22. This may be done by sweeping the area with one or more signals within one or more frequency bands. For example, the one or more signals may be in the ultrasound
frequency band of 20 KHz to 200 MHz, the radio frequency band of 30 Hz to 3 GHz, the microwave frequency band of 3 GHz to 300 GHz, the infrared (IR) frequency band of 300 GHz to 428 THz, the visible light frequency band of 428 THz to 750 THz (×10⁻³), the ultraviolet radiation frequency band of 750 THz to 30 PFz (×10⁻⁴), and/or the X-Ray frequency band of 30 PFz to 30 EH (×10⁻⁵).

[0092] The determination of the gaming environment 22 continues with the game console device 12 measuring at least one of: reflection of the one or more signals, absorption of the one or more signals, refraction of the one or more signals, pass through of the one or more signals, angle of incidence of the one or more signals, backscattering of the one or more signals, and magnetization induced by the one or more signals to produce measured signal effects. The game console device 12 then identifies different objects based on the measured signal effects (e.g., inanimate objects have different reflective, absorption, pass through, and/or refractive properties of the one or more signals than animate beings).

[0093] The game console device 12 then determines distance of the different objects with respect to itself. From this data, the game console device 12 generates a three-dimensional topographic map of the area in which the video gaming system 10 resides to produce the gaming environment 22. In this example, the gaming environment 22 includes the player 16, the gaming object 14, a couch, a chair, a desk, the four encircling walls, the floor, and the ceiling.

[0094] Having determined the gaming environment, the game console device 12 maps the gaming environment 22 to a coordinate system (e.g., a three-dimensional Cartesian coordinate system [x, y, z], a spherical coordinate system [r, θ, φ], etc.). The game console device 12 then determines the position 18 of the player 16 and/or the gaming object 14 within the gaming environment in accordance with the coordinate system.

[0095] Once the gaming object’s position is determined, the game console device 12 tracks the motion 20 of the player 16 and/or the gaming object 14. For example, the game console device 12 may determine the position 18 of the gaming object 14 and/or the player 16 within a positioning tolerance (e.g., within a meter) at a positioning update rate (e.g., once every second or once every few seconds) and tracks the motion 20 within a motion tracking tolerance (e.g., within a few millimeters) at a motion tracking update rate (e.g., once every 10-100 milliseconds).

[0096] During play of a video game, the game console device 12 receives a gaming object response regarding a video game function from the gaming object 14. The gaming object 14 may be a wireless game controller and/or any object used or worn by the player to facilitate play of a video game. For example, the gaming object 14 may be a simulated sword, a simulated gun, a helmet, a vest, a hat, shoes, socks, pants, shorts, gloves, etc.

[0097] The game console device 12 integrates the gaming object response and the motion 20 of the player and/or the gaming object 14 with the video game function. For example, if the video game function corresponds to a video tennis lesson (e.g., a ball machine feeding balls), the game console device 12 tracks the motion of the player 16 and the associated gaming object 14 (e.g., a simulated tennis racket) and maps the motion 20 with the feeding balls to emulate a real tennis lesson. The motion 20, which includes direction and velocity, enables the game console device 12 to determine how the tennis ball is being struck. Based on how it is being struck, the game console device 12 determines the ball’s path and provides a video representation thereof.

[0098] FIG. 2 is a schematic block diagram of a side view of an embodiment of a gaming system 10 of FIG. 1 to illustrate that the position 18 and motion tracking 20 are done in three-dimensional space. Since the game console device 12 does three-dimensional positioning 18 and motion tracking 20, the distance and/or angle of the gaming object 14 and/or player 16 to the game console device 12 is a negligible factor. As such, the gaming system 10 provides accurate motion tracking of the gaming object 14 and/or player 16, which may be used to map the player’s movements to a graphics image for true interactive video game play.

[0099] FIG. 3 is a schematic block diagram of an overhead view of another embodiment of a gaming system 10 that includes the game console device 12, the gaming objects 14-15, and one or more peripheral sensors 36-40. The game console device 12 includes a video display interface 34 (e.g., a video display driver, a video graphics acceleration, a video graphics engine, a video graphics array (VGA) card, etc.), a transceiver 32 (which may include a peripheral sensor), and a processing module 30. The processing module 30 may be a single processing device or a plurality of processing devices. Such a processing device may be a microprocessor, microcontroller, digital signal processor, microcomputer, central processing unit, field programmable gate array, programmable logic device, state machine, logic circuitry, analog circuitry, digital circuitry, and/or any device that manipulates signals (analog and/or digital) based on hard coding of the circuitry and/or operational instructions. The processing module 30 may have an associated memory and/or memory element (not shown), which may be a single memory device, a plurality of memory devices, and/or embedded circuitry of the processing module. Such a memory device may be a read-only memory, random access memory, volatile memory, non-volatile memory, static memory, dynamic memory, flash memory, cache memory, and/or any device that stores digital information. Note that when the processing module 30 implements one or more of its functions via a state machine, analog circuitry, digital circuitry, and/or logic circuitry, the memory and/or memory element storing the corresponding operational instructions may be embedded within, or external to, the circuitry comprising the state machine, analog circuitry, digital circuitry, and/or logic circuitry. Further note that, the memory element stores, and the processing module executes, hard coded and/or operational instructions corresponding to at least one of the steps and/or functions illustrated in FIGS. 1-64.

[0100] In operation, the transceiver 32 generates the one or more signals within one or more frequency bands for sweeping the area to facilitate the determination of the gaming environment. In addition, the transceiver 32 generates signals during video game play to facilitate the determination of the gaming objects’ and/or the player’s position 18 and generates signals to facilitate the determination of the gaming object’s and/or the player’s motion 20. For example, the transceiver 32 may utilize a first technique, which provides a first tolerance, (e.g., accuracy within a meter as may be obtained by a 2.4 GHz or 5 GHz localized positioning system as will be discussed with reference to FIGS. 6, 7, 27-29) to determine the position 18 of the player 16 and/or the gaming objects 14-15 and a second technique, which provides a second tolerance (e.g., accuracy within a few millimeters as may be obtained by a 60 GHz localized positioning system as will be discussed
with reference to FIGS. 6, 7, 27-29 or a 60 GHz millimeter wave (MMW) radar system as will be discussed with reference to FIGS. 30-34).

[0101] The transceiver 32 receives responses (e.g., reflection of the one or more signals, absorption of the one or more signals, refraction of the one or more signals, pass through of the one or more signals, angle of incident of the one or more signals, backscattering of the one or more signals, a response to the one or more signals, and magnetization induced by the one or more signals to produce measured signal effects), converts the responses to one or more digital signals, and provides the one or more digital signals to the processing module 30.

[0102] In an embodiment, the transceiver 32 may be an ultrasound transceiver that transmits one or more ultrasound signals within an ultrasound frequency band. The ultrasound transceiver receives at least one inbound ultrasound signal (e.g., reflection, refraction, echo, etc.) that facilitates the measuring of the at least one of: the reflection of the one or more signals, the absorption of the one or more signals, refraction of the one or more signals, the pass through of the one or more signals, the angle of incident of the one or more signals, the backscattering of the one or more signals, and the magnetization induced by the one or more signals to produce measured signal effects.

[0103] In an embodiment, the transceiver 32 may be a radio frequency (RF) transceiver that transmits one or more signals within a radio frequency band. The RF transceiver receives at least one inbound RF signal (e.g., reflection, refraction, response, backscatter, etc.) that facilitates the measuring of the at least one of: the reflection of the one or more signals, the absorption of the one or more signals, refraction of the one or more signals, the pass through of the one or more signals, the angle of incident of the one or more signals, the backscattering of the one or more signals, and the magnetization induced by the one or more signals to produce measured signal effects.

[0104] In an embodiment, the transceiver 32 is a microwave transceiver that transmits the one or more signals within a microwave frequency band. The microwave transceiver receives at least one inbound microwave signal (e.g., reflection, refraction, response, backscatter, etc.) that facilitates the measuring of the at least one of: the reflection of the one or more signals, the absorption of the one or more signals, refraction of the one or more signals, the pass through of the one or more signals, the angle of incident of the one or more signals, the backscattering of the one or more signals, and the magnetization induced by the one or more signals to produce measured signal effects.

[0105] In an embodiment, the transceiver 32 is an infrared transceiver that transmits the one or more signals within an infrared frequency band. The infrared transceiver receives at least one inbound infrared signal (e.g., reflection, refraction, angle of incidence, response, backscatter, etc.) that facilitates the measuring of the at least one of: the reflection of the one or more signals, the absorption of the one or more signals, refraction of the one or more signals, the pass through of the one or more signals, the angle of incident of the one or more signals, the backscattering of the one or more signals, and the magnetization induced by the one or more signals to produce measured signal effects.

[0106] In an embodiment, the transceiver 32 is a laser transceiver that transmits the one or more signals within a visible light frequency band. The laser transceiver, which may use fiber optics, receives at least one inbound visible light signal (e.g., reflection, refraction, response, backscatter, etc.) that facilitates the measuring of the at least one of: the reflection of the one or more signals, the absorption of the one or more signals, refraction of the one or more signals, the pass through of the one or more signals, the angle of incident of the one or more signals, the backscattering of the one or more signals, and the magnetization induced by the one or more signals to produce measured signal effects.

[0107] In an embodiment, the transceiver 32 is a digital camera that utilizes ambient light as the one or more signals within the visible light frequency band. The digital camera receives the at least one inbound visible light signal (e.g., reflection and/or refraction of light off the gaming environment, the player, and the gaming object) that facilitates the measuring of the at least one of: the reflection of the one or more signals, the absorption of the one or more signals, refraction of the one or more signals, the pass through of the one or more signals, the angle of incident of the one or more signals, the backscattering of the one or more signals, and the magnetization induced by the one or more signals to produce measured signal effects.

[0108] In an embodiment, the transceiver 32 is an ultraviolet transceiver that transmits the one or more signals within an ultraviolet radiation frequency band. The ultraviolet transceiver receives at least one inbound ultraviolet radiation signal (e.g., reflection, absorption, and/or refraction of UV light off the gaming environment, the player, and the gaming object) that facilitates the measuring of the at least one of: the reflection of the one or more signals, the absorption of the one or more signals, refraction of the one or more signals, the pass through of the one or more signals, the angle of incident of the one or more signals, the backscattering of the one or more signals, and the magnetization induced by the one or more signals to produce measured signal effects.

[0109] In an embodiment, the transceiver 32 is an X-ray transceiver that transmits the one or more signals within an X-ray frequency band. The X-ray transceiver receives at least one inbound X-ray signal (e.g., reflection, absorption, and/or refraction of UV light off the player and/or the gaming object) that facilitates the measuring of the at least one of: the reflection of the one or more signals, the absorption of the one or more signals, refraction of the one or more signals, the pass through of the one or more signals, the angle of incident of the one or more signals, the backscattering of the one or more signals, and the magnetization induced by the one or more signals to produce measured signal effects.

[0110] In an embodiment, the transceiver 32 is a magnetic source that transmits the one or more signals as one or more magnetic signals. The magnetic source receives at least one inbound magnetic field that facilitates the measuring of the at least one of: the reflection of the one or more signals, the absorption of the one or more signals, refraction of the one or more signals, the pass through of the one or more signals, the angle of incident of the one or more signals, the backscattering of the one or more signals, and the magnetization induced by the one or more signals to produce measured signal effects. For instance, the magnetic source may include three coils to generate magnetic gradients in the x, y and z directions of the magnetic source. The coils may be powered by amplifiers that enable rapid and precise adjustments of the coil’s field strength and direction.

[0111] In an embodiment, the transceiver 32 may include one or more of the ultrasound transceiver, the RF transceiver, the microwave transceiver, the infrared transceiver, the laser
transceiver, the digital camera, the ultraviolet transceiver, the X-ray transceiver, and the magnetic source transceiver.

[0112] The processing module 30 receives the one or more digital signals from the transceiver 32 and processes them to determine the gaming environment 22, the position 18 of the player 16 and/or the gaming objects 14-15, and the motion 20 of the player 16 and/or the gaming object 14. Such processing includes one or more of determining reflection of the one or more signals, determining the absorption of the one or more signals, determining refraction of the one or more signals, determining the pass through of the one or more signals, determining the angle of incident of the one or more signals, interpreting the backscattering of the one or more signals, interpreting a signal response, and determining the magnetization induced by the one or more signals. The process further includes identifying objects, players, and gaming objects based on the preceding determinations and/or interpretations.

[0113] The one or more peripheral sensors 36-40, which may be a ultrasound transceiver, the RF transceiver, the microwave transceiver, the infrared transceiver, the laser transceiver, the digital camera, the ultraviolet transceiver, the X-ray transceiver, the magnetic source transceiver, an access point, a local positioning system transmitter, a local positioning system receiver, etc., transmits one or more signals and receives responses thereto that facilitate the determination of the player’s and/or gaming object’s position 18 and/or motion 20. The peripheral sensors 36-40 may be enabled at the same time using different frequencies, different time slots, time-space encoding, frequency-space encoding, or may be enabled at different times in a round robin, polling, or token passing manner.

[0114] In the example of FIG. 3, the player 16 is using two or more video gaming objects 14-15 to play the video game. In this instance, the game console device 12, alone or with data provided by one or more of the peripheral sensors 36-40, determines position of the player 16, a first associated gaming object 14, and a second associated gaming object 15 within the gaming environment 22 in accordance with the coordinate system. The game console device 12 tracks the motion of the player 16, the motion of the first associated gaming object 14, and the motion of the second associated gaming object 15.

[0115] The game console device 12 receives a first gaming object response regarding the video game function from the first associated gaming object 14 and a second gaming object response regarding the video game function from the second associated gaming object 15. The game console device 12 integrates the first gaming object response, the second gaming object response, the motion of the first player, the motion of the second player, the motion of the first associated gaming object, and the motion of the second associated gaming object with the video game function.

[0116] While the preceding discussion has focused on a video game system, the concepts of position and motion tracking are applicable for a wide variety of applications. For example, the position and motion tracking apparatus may be used for home security, baby monitoring, store security, shoplifting detection, concealed weapon detection, etc. Such an apparatus includes a transceiver section and a processing module. The transceiver section transmits one or more signals within one or more frequency bands in a given area. The one or more signals may be in the ultrasound frequency band of 20 KHz to 200 MHz, the radio frequency band of 30 THz to 3 GHz, the microwave frequency band of 3 GHz to 300 GHz, the infrared (IR) frequency band of 300 GHz to 428 THz, the visible light frequency band of 428 THz to 750 THz (n≈10^12), the ultraviolet radiation frequency band of 750 THz to 30 PHz (n≈10^15), and/or the X-Ray frequency band of 30 PHz to 30 EHHz (n≈10^18).

[0117] The transceiver section determines a response to the one or more signals (e.g., an inbound ultrasound signal, an inbound RF signal, an inbound microwave signal, an inbound IR signal, an inbound visible light signal, an inbound ultraviolet light signal, an inbound X-ray signal, and/or an inbound magnetic field). The transceiver section converts the response into a digital response signal.

[0118] The processing module processes the digital response signal to determine a measure of at least one of: reflection of the one or more signals, absorption of the one or more signals, refraction of the one or more signals, pass through of the one or more signals, angle of incident of the one or more signals, backscattering of the one or more signals, and magnetization induced by the one or more signals to produce measured signal effects. The apparatus then identifies different objects based on the measured signal effects (e.g., inanimate objects have different reflective, absorption, pass through, and/or refractive properties of the one or more signals than animate beings).

[0119] The processing module then determines distance of the different objects with respect to itself. From this data, the apparatus generates a three-dimensional topographic map of the area to produce a digital representation of the environment. The apparatus then maps the environment to a coordinate system (e.g., a three-dimensional Cartesian coordinate system [x, y, z], a spherical coordinate system [ρ, φ, θ], etc.) and determines the position of an object or person within the environment in accordance with the coordinate system.

[0120] Once the position is determined, the processing module tracks the motion of the object or person. For motion tracking, the transceiver section receives responses that provide millimeter accuracy of the object and person (e.g., 60 GHz signals, light, etc.) and converts the responses to digital signals. The processing module processes the digital signals with respect to the environment and the object or person to track motion.

[0121] FIG. 4 is a schematic block diagram of a side view of another embodiment of a gaming system 10 that includes one or more gaming objects 14-15, the player 16, the game console device 12, and one or more sensing tags 44 proximal to the player 16 and/or the game object 14-15. The one or more sensing tags 44 may be a metal patch, an RFID tag, a light reflective material, a light absorbent material, a specific RGB [red, green, blue] color, a 60 GHz transceiver, and/or any other component, material, and/or texture that assists the game console device 12 in determining the position and/or motion of the player 16 and/or the gaming object 14-15. For example, the metal patch will reflect RF and/or microwave signals at various angles depending on the position of the metal patch with respect to the game console device 12. The game console device 12 utilizes the various angles to determine the position and/or motion of the player 16 and/or the gaming object 14-15.

[0122] As another example, the gaming objects 14-15 may include a game controller that is held by the player and may further include a helmet, a shirt, pants, gloves, and/or socks, which are worn by the player. Each of the gaming objects 14-15 includes one or more sensing tags 44, which facilitate the determining of the position 18 and/or motion 20. An
example of a gaming system 10 using RFID tags will be discussed with reference to FIGS. 51-54.

[0123] FIG. 5 is a schematic block diagram of an overhead view of another embodiment of a gaming system 10 that includes a game console device 12, a plurality of players 16, 50 and a plurality of gaming objects 14, 52. In this system, the game console device 12 determines the position 18 of the first player 16 and/or the associated gaming object 14 within the gaming environment 22 in accordance with the coordinate system. The game console device 12 also determines the position 54 of the second player 50 and/or the associated gaming object 52 within the gaming environment in accordance with the coordinate system.

[0124] The game console device 12 separately tracks the motion 20 of the first player 16, the motion 20 of the first associated gaming object 14, the motion 56 of the second player 50, and the motion 56 of the second associated gaming object 52. While tracking the motion of the players and/or gaming objects, the game console may receive a gaming object response regarding the video game function from the first and/or the second associated gaming object 14, 52.

[0125] The game console device 12 integrates the first and/or second gaming object response, the motion of the first player, the motion of the second player, the motion of the first associated gaming object, and the motion of the second associated gaming object with the video game function. While the present example shows two players and associated gaming objects, more than two players and associated gaming objects could be in the gaming environment. In this instance, the game console device 12 separately determines the position and the motion of the players and the associated gaming objects as previously discussed and integrates their play in the video gaming graphics being displayed.

[0126] FIG. 6 is a schematic block diagram of another embodiment of a gaming system 10 that includes a game console device 12, a plurality of localized position system (LPS) transmitters 60-64, at least one gaming object 14, and an LPS receiver 66 associated with the gaming object 14. The LPS receiver 66 and the gaming object 14 may be separate devices or an integrated device. For example, the LPS receiver 66 may be a packaged printed circuit board (PCB) that includes an integrated circuit (IC) LPS receiver and the gaming object 14 is a game controller, where the packaged PCB is attachable to the game controller. As another example, the gaming object 14 and the LPS receiver 66 may be integrated in a device, such as a cell phone, a game controller, a personal digital assistant, a handheld computing unit, etc.

[0127] Each LPS transmitter 60-64 includes an accurate clock (e.g., an atomic clock) or is coupled to an accurate clock source (e.g., has a global positioning system (GPS) receiver) to provide an accurate time standard available for synchronization at any point in the physical area. Each LPS transmitter 60-64 transmits a spread spectrum signal containing a BPSK (Bi-Phase Switched Keyed) signal in which 1’s & 0’s are represented by reversal of the phase of the carrier. This message is transmitted at a specific frequency and a “chipping rate” of x bits per second (e.g., 50 bits per millisecond). The message may repeat every 30 milliseconds (or more frequently) and may be referred as a local C/A signal (Coarse Acquisition signal). This message contains information regarding the entire LPS and information regarding the LPS transmitter sending the local C/A signal.

[0128] The LPS receiver 66 utilizes the local C/A signals to determine its position within a given coordinate system (See FIGS. 8-14, 16-21). In particular, the LPS receiver 66 determines a time delay for at least some of the plurality of local C/A signals in accordance with the at least one clock signal. The LPS receiver 66 calculates distances (e.g., d1, d2, and d3) to the LPS transmitters 60-64 based on the time delays for at least some of the plurality of C/A signals. In other words, for each LPS RF signal received, which is received from different LPS transmitters 60-64, the LPS receiver 66 calculates a time delay with respect to the corresponding LPS transmitter. For instance, the LPS receiver 66 identifies each LPS transmitter’s 60-64 signals by their distinct C/A code pattern, and then measures the time delay for each LPS transmitter. To do this, the receiver 66 produces an identical C/A sequence using the same seed number as the LPS transmitter. By lining up the two sequences, the receiver can measure the delay and calculate the distance to the LPS transmitter 60-64.

[0129] The LPS receiver 66 then calculates the position of the corresponding plurality of LPS transmitters based on the local C/A signals. For example, the LPS receiver 66 uses the position data of the local C/A signals to calculate the LPS transmitter’s position. The LPS receiver then determines its location based on the distance of the corresponding plurality of LPS transmitters and the position of the corresponding plurality of LPS transmitters 60-64. For instance, by knowing the position and the distance of an LPS transmitter, the LPS receiver can determine its location to be somewhere on the surface of an imaginary sphere centered on that LPS transmitter and whose radius is the distance to it. When four LPS transmitters 60-64 are measured simultaneously, the intersection of the four imaginary spheres reveals the location of the receiver. Often, these spheres will overlap slightly instead of meeting at one point, so the receiver will yield a mathematically most-probable position (and often indicate the uncertainty).

[0130] The LPS receiver 66, via the gaming object 14, transmits its position within the coordinate system to the game console device 12. Alternatively, the LPS receiver 66, via the gaming object 14, may provide the LPS transmitter distances (e.g., d1, d2, and d3) to the game console device 12 such that the game console device 12 can determine the position of the gaming object within the gaming environment. Depending on the frequency of transmitting the C/A signals, the accuracy of the clocks, and carrier frequency of the signals, the accuracy of the gaming object’s position may be within a few millimeters to about a meter. If the accuracy is the former, then this arrangement may also be used to track the motion of the player and/or gaming object. If the accuracy is the latter, then this arrangement may be used to determine the player’s and/or gaming object’s position and another scheme would be used to track their motion.

[0131] FIG. 7 is a schematic block diagram of another embodiment of a gaming system 10 that includes a game console device 12, at least one gaming object 14, a player 16, a local positioning system (LPS) transmitter 74, and a plurality of LPS receivers 68-72. The LPS transmitter 74 and the gaming object 14 may be separate devices or an integrated device. For example, the LPS transmitter 74 may be a packaged printed circuit board (PCB) that includes an integrated circuit (IC) LPS transmitter and the gaming object 14 is a game controller, where the packaged PCB is attachable to the game controller. As another example, the gaming object 14 and the LPS transmitter 74 may be integrated in a device, such as a cell phone, a game controller, a personal digital assistant, a handheld computing unit, etc.
[0132] The LPS transmitter 74 includes an accurate clock and transmits a narrow pulse (e.g., pulse width less than 1 nanosecond) at a desired rate (e.g., once every millisecond to once every few seconds). The narrow pulse signal includes a time stamp of when it is transmitted.

[0133] The LPS receivers 68-72 receive the narrow pulse signal and determine their respective distances (e.g., d1, d2, and d3) to the LPS transmitter 74. In particular, an LPS receiver 68-72 determines the distance to the LPS transmitter 74 based on the time stamp and the time at which the LPS receiver received the signal. Since the narrow pulse travels at the speed of light, the distance can be readily determined.

[0134] The plurality of distances between the LPS receivers 68-72 and the LPS transmitter 74 are then processed (e.g., by the game console device 12 or by a master LOS receiver) to determine the position of the LPS transmitter 74 within the local physical area in accordance with the known positioning of the LPS receivers 68-72. For instance, with the known position of an LPS receiver and its distance to the LPS transmitter 74, the LPS receiver (the game console device or a master LPS receiver) can determine the LPS transmitter’s location to be somewhere on the surface of an imaginary sphere centered on the LPS receiver and whose radius is the distance to it. When the distance to four LPS receivers is known, the intersection of the four imaginary spheres reveals the location of the LPS transmitter 74.

[0135] The processing of the LPS receiver to transmit distances may be performed by a master LPS receiver, by the game console device 12, by a motion tracking processing module, and/or by an LPS computer coupled to the plurality of LPS receivers. The motion tracking processing module may be a single processing device or a plurality of processing devices. Such a processing device may be a microprocessor, micro-controller, digital signal processor, microcomputer, central processing unit, field programmable gate array, programmable logic device, state machine, logic circuitry, analog circuitry, digital circuitry, and/or any device that manipulates signals (analog and/or digital) based on hard coding of the circuitry and/or operational instructions. The processing module may have an associated memory and/or memory element, which may be a single memory device, a plurality of memory devices, and/or embedded circuitry of the processing module. Such a memory device may be a read-only memory, random access memory, volatile memory, non-volatile memory, static memory, dynamic memory, flash memory, cache memory, and/or any device that stores digital information. Note that when the processing module implements one or more of its functions via a state machine, analog circuitry, digital circuitry, and/or logic circuitry, the memory and/or memory element storing the corresponding operational instructions may be embedded within, or external to, the circuitry comprising the state machine, analog circuitry, digital circuitry, and/or logic circuitry. Further note that, the memory element stores, and the processing module executes, hard coded and/or operational instructions corresponding to at least some of the steps and/or functions illustrated in FIGS. 1-64.

[0136] Depending on the frequency of transmitting the pulse signals, the accuracy of the clocks, and carrier frequency of the signals, the accuracy of the gaming object’s position may be within a few millimeters to about a meter. If the accuracy is the former, then this arrangement may also be used to track the motion of the player and/or gaming object. If the accuracy is the latter, then this arrangement may be used to determine the player’s and/or gaming object’s position and another scheme would be used to track their motion.

[0137] With respect to FIGS. 6 and 7, an LPS system may include both a plurality of LPS transmitters as in FIG. 6 and a plurality of LPS receivers as in FIG. 7, where the LPS device on the person includes both the LPS receiver of FIG. 6 and the LPS transmitter of FIG. 7. Note the LPS transmitters of the FIG. 6 and the LPS transmitters of FIG. 7 may be stand-alone devices positioned through a localized physical area (e.g., a home, an office, a building, etc.) or may be included within a device that positioned through the localized physical area. For example, the LPS transmitters of FIG. 6 and the LPS receivers of FIG. 7 may be included in access points of a WLAN, may be included in smoke detectors, motion detectors of a security system, speakers of an intercom system, light fixtures, light bulbs, electronic equipment (e.g., computers, TVs, radios, clocks, etc.), and/or any device or object found or used in a localized physical area.

[0138] FIGS. 8-10 are diagrams of an embodiment of a three-dimensional Cartesian coordinate system of a localized physical area that may be used for a gaming system 10. In these figures an x-y-z origin is selected to be somewhere in the localized physical area and the position and motion of the player 16 and/or the gaming object 14 is determined with respect to the origin (e.g., 0, 0, 0). For example, a point (e.g., x1, y1, z1) on the player is used to identify its position in the gaming environment and a point (e.g., x2, y2, z2) on the gaming object 14 is used to identify its position in the gaming environment.

[0139] As the player and/or gaming object move, its new position is identified within the gaming 25 environment and the relation between the old point and the new point is used to determine three-dimensional motion.

[0140] FIGS. 11-13 are diagrams of an embodiment of a spherical coordinate system of a localized physical area that may be used for a gaming system 10. In these figures an x-y-z origin is selected to be somewhere in the localized physical area and the position and motion of the player 16 and/or the gaming object 14 is determined with respect to the origin. For example, the position of the player may be represented as vector, or spherical coordinates, (ρ, φ, θ), where ρ≥0 and is the distance from the origin to a given point P; 0 ≤φ≤180° and is the angle between the positive z-axis and the line formed from the origin and P; and 0≤θ≤360° and is the angle between the positive x-axis and the line from the origin to P projected onto the xy-plane. In general, ρ is referred to as the radius, φ is the polar angle, θ is referred to as the azimuth, the angle from the origin along the positive z-axis, rotate φ about the y-axis in the direction of the positive x-axis and rotate θ about the z-axis in the direction of the positive y-axis.

[0141] For example, a point (e.g., ρ1, φ1, θ1) on the player is used to identify its position in the gaming environment and a point (e.g., ρ2, φ2, θ2) on the gaming object 14 is used to identify its position in the gaming environment. As the player and/or gaming object move, its new position is identified within the gaming environment and the relation between the old point and the new point is used to determine three-dimensional motion. While FIGS. 8-13 illustrate two types of coordinate system, any three-dimensional coordinate system may be used for tracking motion and/or establishing position within a gaming system.
FIG. 14 is a diagram of a method for determining position and/or motion tracking that begins at step 80 where the game console device determines the gaming environment 22 (e.g., determining the properties of the localized physical area such as height, width, depth, objects in the physical area, etc.). The method then continues at step 82 where the game console device maps the gaming environment to a coordinate system (e.g., Cartesian coordinate system of FIGS. 8-10 or spherical system of FIGS. 11-13). The method continues at step 84 where the game console device determines position of the player and/or the gaming object within the gaming environment in accordance with the coordinate system.

The method continues at step 86 where the game console device tracks the motion of the player and/or the gaming object. In a system that includes two or more players, the game console device separately determines the players’ position and separately tracks their motion. In a system where a player has two or more gaming objects, the game console device separately determines the gaming objects’ position and separately tracks their motion. In a system that includes multiple players and at least one player has multiple gaming objects, the game console device separately determines the gaming objects’ position and separately tracks the gaming objects’ motion. With respect to motion tracking, an object moving at 200 miles per hour (mph) moves 0.1 millimeters per millisecond; thus determining a new position every 10 milliseconds (ms) provides about 1 millimeter accuracy for objects moving at 200 mph. As such, the game console device may determine the new position of the player and/or gaming object every 10 ms and use the old and new positions to determine the motion of the player and/or gaming object.

The method continues at step 88 where the game console device receives a gaming object response regarding a video game function from a gaming object. The method continues at step 90 where the game console device integrates the gaming object response and the motion of the at least one of the player and the gaming object with the video game function. If the system includes multiple players and/or multiple gaming objects, the game console device 12 integrates their motion into the video game graphics being displayed. If the game console device receives multiple gaming object responses, the game console device integrates them into the video game graphics being displayed.

FIG. 15A is a diagram of another method for determining position and/or motion tracking that begins at step 100 where an origin of a Cartesian coordinate system (e.g., the coordinate system of FIGS. 8-10) is determined. The origin may be any other point within the localized physical area of the gaming environment (e.g., a point on the game console device). The method continues in one or more branches. At step 106, the initial coordinates of the player are determined using one or more of a plurality of position determining techniques as described herein. This branch continues at step 108 by updating the player’s position to track the player’s motion using one or more of a plurality of motion tracking techniques as described herein. Note that the rate of tracking the motion of the player and/or gaming object may be done at a rate based on the video gaming being played and the expected speed of motion. Further note that a tracking rate of 1 millisecond provides 0.1 mm accuracy in motion tracking.

FIG. 15B is a diagram of another method for determining position and/or motion tracking that begins at step 110 by determining a reference point within a coordinate system (e.g., the vector coordinate system of FIGS. 11-13). The reference point may be the origin or any other point within the localized physical area. The method continues in one or more branches. At step 116, a vector with respect to the reference point is determined to indicate the player’s initial position, which may be done by using one or more of a plurality of position determining techniques as described herein. This branch continues at step 118 by updating the player’s position to track the player’s motion using one or more of a plurality of motion tracking techniques as described herein.

The other branch begins at step 112 by determining a vector with respect to the reference point for the gaming object to establish its initial position, which may be done by using one or more of a plurality of position determining techniques as described herein. This branch continues at step 114 by updating the gaming object’s position to track the gaming object’s motion using one or more of a plurality of motion tracking techniques as described herein. Note that the rate of tracking the motion of the player and/or gaming object may be done at a rate based on the video gaming being played and the expected speed of motion. Further note that a tracking rate of 1 millisecond provides 0.1 mm accuracy in motion tracking.

FIGS. 16-18 are diagrams of another embodiment of a coordinate system of a localized physical area that may be used for a gaming system 10. In these figures an xycz origin is selected to be somewhere in the localized physical area and the initial position of a point being tracked on the player and/or gaming object is determined based on its Cartesian coordinates with respect to the origin. As a point moves from one position (e.g., x0, y0, z0) to a new position (e.g., x1, y1, z1), the movement is tracked based on the two positions (e.g., Δx=x1-x0, Δy=y1-y0, Δz=z1-z0). Note that the player and the gaming object may each have several points that are tracked and used to determine position and motion.

The positioning and motion tracking of the player (i.e., one or more points on the player) and/or gaming object (i.e., one or more points on the gaming object) may be done with respect to the origin or with respect to each other. For instance, the gaming object’s position and motion may be determined with reference to the origin and the position and motion of the player may be determined with reference to the position and motion of the gaming object. Alternatively, the player’s position and motion may be determined with reference to the origin and the position motion of the gaming object may be determined with reference to the player’s position and motion.

FIGS. 19-21 are diagrams of an embodiment of a spherical coordinate system of a localized physical area that may be used for a gaming system 10. In these figures an origin or reference point, is selected to be somewhere in the localized physical area and the initial position of a point being tracked on the player and/or gaming object is determined based on its spherical coordinates with respect to the origin. As a point moves from one position (e.g., p0, q0, r0) to a new
position (e.g., $p1, p1, 01$), the movement is tracked based on the two positions (e.g., $\Delta V= V0-V1$ or $\Delta p=p0-p1, \Delta \phi=\phi0-\phi1, \Delta \theta=\theta0-\theta1$). Note that the player and the gaming object may each have several points that are tracked and used to determine position and motion.

[0152] The positioning and motion tracking of the player (i.e., one or more points on the player) and/or gaming object (i.e., one or more points on the gaming object) may be done with respect to the origin of the spherical coordinate system or with respect to each other. For instance, the gaming object’s position and motion may be determined with reference to the origin and the position and motion of the player may be determined with reference to the position and motion of the gaming object. Alternatively, the player’s position and motion may be determined with reference to the origin and the position motion of the gaming object may be determined with reference to the player’s position and motion.

[0153] FIG. 22 is a diagram of another method for determining position and/or motion tracking that begins at step 120 by determining environment parameters (e.g., the gaming environment) of the physical area in which the gaming object resides and/or in which the game system resides. The environmental parameters include, but are not limited to, height, width, and depth of the localized physical area, objects in the physical area, differing materials in the physical area, multiple path effects, interferers, etc.

[0154] The method continues at step 122 by mapping the environment parameters to a coordinate system (e.g., one of the systems shown in FIGS. 9-13). As an example, if the physical area is a room, a point in the room is selected as the origin and the coordinate system is applied to at least some of the room. In addition, inanimate objects in the room (e.g., a couch, a chair, etc.) are mapped to the coordinate system based on their physical location in the room.

[0155] The method continues at step 124 by determining the coordinates of the player’s, or players’, position in the physical area. The method continues at step 126 by determining the coordinates of a gaming object’s initial position. Note that the positioning of the gaming object may be used to determine the position of the player(s) if the gaming object is something worn by the player or is in close proximity to the player. Alternatively, the initial position of the player may be used to determine the initial position of the gaming object. Note that one or more of the plurality of positioning techniques described herein may be used to determine the position of the player and/or of the gaming object.

[0156] The method continues at step 128 by updating the coordinates of the player’s, or players’, position in the physical area to track the player’s, or players’, motion. The method continues at step 130 by updating the coordinates of a gaming object’s position to track its motion. Note that the motion of the gaming object may be used to determine the motion of the player(s) if the gaming object is something worn by the player or is in close proximity to the player. Alternatively, the motion of the player may be used to determine the motion of the gaming object. Note that one or more of the plurality of motion techniques described herein may be used to determine the position of the player and/or of the gaming object.

[0157] In another embodiment, the method of FIG. 22 may be performed by the game console device that begins with determining at least one positioning coordinate for the player with respect to an origin of the coordinate system and determining at least one positioning coordinate for the gaming object with respect to the at least one positioning coordinate for the player. The method continues with the game console device determining at least one next positioning coordinate for the player with respect to the origin and determining at least one next positioning coordinate for the gaming object with respect to the at least one next positioning coordinate for the player. The method continues with the game console device determining the motion of the player, with respect to the origin, based on the at least one positioning coordinate for the player and the at the least one next positioning coordinate for the player. The method also includes the game console device determining the motion of the gaming object, with respect to the player, based on the at least one positioning coordinate for the gaming object and the at the least one next positioning coordinate for the gaming object.

[0158] FIG. 23 is a diagram of another method for determining position and/or motion tracking that begins at step 140 by determining a reference point within the physical area in which the gaming object lays and/or in which the game system lays. The method then continues at step 142 by determining a vector for a player’s initial position with respect to a reference point of a coordinate system (e.g., one of the systems shown in FIGS. 11-13). As an example, if the physical area is a room, a point in the room is selected as the origin and the coordinate system is applied to at least some of the room.

[0159] The method continues at step 144 by determining a vector of a gaming object’s initial position. Note that the positioning of the gaming object may be used to determine the position of the player(s) if the gaming object is something worn by the player or is close proximity to the player. Alternatively, the initial position of the player may be used to determine the initial position of the gaming object. Note that one or more of the plurality of positioning techniques described herein may be used to determine the position of the player and/or of the gaming object.

[0160] The method continues at step 146 by updating the vector of the player’s, or players’, position in the physical area to track the player’s motion. The method continues at step 148 by updating the vector of the gaming object’s position to track its motion. Note that the motion of the gaming object may be used to determine the motion of the player(s) if the gaming object is something worn by the player or is close proximity to the player. Alternatively, the motion of the player may be used to determine the motion of the gaming object. Note that one or more of the plurality of motion techniques described herein may be used to determine the position of the player and/or of the gaming object.

[0161] FIG. 24 is a diagram of another method for determining position and/or motion tracking that begins at step 150 by determining environment parameters of the physical area in which the gaming object lays and/or in which the game system lays. The environmental parameters include, but are not limited to, height, width, and depth of the localized physical area, objects in the physical area, differing materials in the physical area, multiple path effects, interferers, etc.

[0162] The method continues at step 152 by mapping the environment parameters to a coordinate system (e.g., one of the systems shown in FIGS. 16-18). As an example, if the physical area is a room, a point in the room is selected as the origin and the coordinate system is applied to at least some of the room. In addition, objects in the room (e.g., a couch, a chair, etc.) are mapped to the coordinate system based on their physical location in the room.

[0163] The method continues at step 154 by determining the coordinates of the gaming object’s initial position in the
physical area. The method continues at step 156 by determining the coordinates of the player’s initial position with respect to the gaming object’s initial position. Note that one or more of the plurality of positioning techniques described herein may be used to determine the position of the player and/or of the gaming object.

[0164] The method continues at step 156 by updating the coordinates of the gaming object’s position in the physical area to track its motion. The method continues at step 158 by updating the coordinates of the player’s position to track the player’s motion with respect to the gaming object. Note that one or more of the plurality of motion techniques described herein may be used to determine the position of the player and/or of the gaming object.

[0165] In another embodiment, the method of FIG. 24 may be performed by the game console device that begins with determining at least one positioning coordinate for the gaming object with respect to an origin of the coordinate system and determining at least one positioning coordinate for the player with respect to the at least one positioning coordinate for the gaming object. The method continues with the game console device determining at least one next positioning coordinate for the gaming object with respect to the origin and determining at least one next positioning coordinate for the player with respect to the at least one next positioning coordinate for the gaming object.

[0166] The method continues with the game console device determining the motion of the gaming object, with respect to the origin, based on at least one positioning coordinate for the gaming object and the at least one next positioning coordinate for the gaming object. The method continues with the game console device determining the motion of the player, with respect to the gaming object, based on the at least one positioning coordinate for the player and the at least one next positioning coordinate for the player.

[0167] FIG. 25 is a diagram of another method for determining position and/or motion tracking that begins at step 162 by determining a reference point within the physical area in which the gaming object lays and/or in which the game system lies. The method continues at step 164 by determining a vector for a gaming object’s initial position with respect to a reference point of a coordinate system (e.g., one of the systems shown in FIGS. 19-21). As an example, if the physical area is a room in a house and a gaming object is selected as the origin and the coordinate system is applied to at least some of the room.

[0168] The method continues at step 166 by determining a vector of the player’s initial position with respect to the gaming object’s initial position. Note that one or more of the plurality of positioning techniques described herein may be used to determine the position of the player and/or of the gaming object.

[0169] The method continues at step 168 by updating the vector of the gaming object’s position in the physical area to track its motion. The method continues at step 70 by updating the vector of the player’s position with respect to the gaming object’s motion to track the player’s motion. Note that one or more of the plurality of motion techniques described herein may be used to determine the position of the player and/or of the gaming object.

[0170] FIG. 26 is a diagram of another embodiment of a coordinate system of a gaming system that is an extension of the coordinate systems discussed above. In this embodiment, the coordinate system includes a positioning coordinate grid 172 and a motion tracking grid 174, where the motion tracking grid 174 has a finer resolution than the positioning coordinate grid 172. For example, the player and/or gaming object may be positioned anywhere within the gaming environment at a given time, but, for a given time interval (e.g., 1 second), the player’s and/or gaming object’s position will be relatively fixed. However, within this relative stationary position, the player and/or gaming object may move (e.g., a head bob, slash of the gaming object, turn sideways, etc.) during the given time interval. Thus, the low resolution (e.g., within a meter) of the positioning coordinate grid 172 can be adequately used to establish the player’s and/or gaming object’s relatively stationary positions for the given time interval. Within the given time interval, the finer resolution (e.g., within a few millimeters) of the motion tracking grid 174 of is used at a higher interval rate (e.g., once every 10 ms) to accurately track the motion of the player and/or game object. Note that, once the relatively stationary position of the player and/or gaming object for the given time period is established, the motion tracking can be focused to the immediate area of the relatively stationary position.

[0171] FIG. 27 is a schematic block diagram of an embodiment of a wireless communication system that includes a plurality of access points 180-184, a gaming console device 12, a gaming object 14, a device 186, and a local positioning system (LPS) receiver 66. The LPS receiver 66 is associated with the gaming object 14 and/or with the player 16. The gaming console device 12 is coupled to the plurality of access points (AP) 180-184 and to at least one wide area network (WAN) connection (e.g., digital subscriber loop (DSL) connection, cable modem, satellite connection, etc.). In this manner, the game console device 12 may function as the bridge, or hub, for the WLAN to the outside world.

[0172] The access points 180-184 are positioned throughout a given area to provide a seamless WLAN for the given area (e.g., a house, an apartment building, an office building, etc.). The device 186 may be any wireless communication device that includes circuitry to communicate with a WLAN. For example, the device may be a cell phone, a computer, a laptop, a PDA, a cordless phone, etc.

[0173] In addition, each access point 180-184 includes an accurate clock (e.g., an atomic clock) or is coupled to an accurate clock source to provide an accurate time standard for synchronization at any point in the physical area. Each AP transmits a spread spectrum signal (s1) containing a BPSK (Bi-Phase Switched keyed) signal in which 1’s & 0’s are represented by reversal of the phase of the carrier or a signal having some other format (e.g., FM, AM, QAM, QPSK, ASK, FSK, MSK). This message is transmitted at a specific frequency at a “chipping rate” of x bits per second (e.g., 50 bits per second). The signal may repeat every 10-30 milliseconds (or longer duration) and it contains information regarding the entire LPS and information regarding the AP transmitting the signal. Alternatively, the signal may be a very narrow pulse (e.g., less than 1 nanosecond), repeated at a desired rate (e.g., 1-100 KHz).

[0174] The LPS receiver 66 utilizes the signals to determine its position within a given coordinate system (See FIGS. 8-14, 16-21). For instance, the LPS receiver 66 determines a time delay (e.g., t1, t2, and t3) for at least some of the plurality of signals in accordance with the at least one clock signal. The LPS receiver 66 calculates a distance to a corresponding one of the plurality of AP’s based on the time delays of the signals (s1). In other words, for each signal received, which is received from different AP’s, the LPS receiver 66 is calculat-
ing a time delay of the signal(s) received from the APs, or a subset thereof, (e.g., at a minimum three and preferably four) to triangulate its position in three-dimensional space. For instance, the LPS receiver 66 identifies each AP signal by its distinct code pattern, and then measures the time delay for each AP. To do this, the receiver 66 produces an identical signal sequence using the same seed number as the AP. By lining up the two sequences, the receiver 66 can measure the delay and calculate the distance to the AP.

[0175] The LPS receiver 66 then determines the position of the corresponding plurality of APs based on the signals. For example, the LPS receiver 66 uses the position data of the signals to determine the APs' position. The LPS receiver 66 then determines its location based on the distance to the APs and the position of the APs. For instance, by knowing the position and the distance of an AP, the LPS receiver 66 can determine its location to be somewhere on the surface of an imaginary sphere centered on that AP and whose radius is the distance to it. When four APs are measured simultaneously, the intersection of the four imaginary spheres reveals the location of the receiver. Often, these spheres will overlap slightly instead of meeting at one point, so the receiver will yield a mathematically most-probable position (and often indicate the uncertainty).

[0176] Depending on the frequency of transmitting the signal(s), the accuracy of the APs' clocks, and the carrier frequency of the signal, the accuracy of the gaming object's position may be within a few millimeters to about a meter. If the accuracy is the former, then this arrangement may be used to determine the relative position and to track the motion of the player and/or gaming object. If the accuracy is the latter, then this arrangement may be used to determine the player's and/or gaming object's position and another scheme would be used to track their motion.

[0177] FIG. 28 is a schematic block diagram of another embodiment of a wireless communication system that includes a plurality of access points 180-184, a gaming console device 12, a gaming object 14, and the device 186. The gaming object 14 and/or the player 16 may have associated therewith a local positioning system (LPS) transmitter 74. The game console device 12 is coupled to the plurality of access points (AP) 180-184, which are positioned throughout a given area to provide a seamless WLAN for the given area (e.g., a house, an apartment building, an office building, etc.). In addition, the game console device 12 is coupled to at least one wide area network (WAN) connection (e.g., DSL connection, cable modem, satellite connection, etc.). In this manner, the game console device may function as the bridge, or hub, for the WLAN to the outside world.

[0178] The LPS transmitter 74 includes an accurate clock and transmits a narrow pulse (e.g., pulse width less than 1 nano second) at a desired rate (e.g., once every milli second to once every few seconds). The narrow pulse signal includes a time stamp of when it is transmitted.

[0179] The APs 180-184 receive the narrow pulse signal and determine their respective distances to the LPS transmitter 74. In particular, an AP determines the distance to the LPS transmitter 74 based on the time stamp and the time at which the AP received the signal. Since the narrow pulse travels at the speed of light, the distance can be readily determined.

[0180] The plurality of distances between the APs 180-184 and the LPS transmitter 74 are then processed to determine the position of the LPS transmitter 74 within the local physical area in accordance with the known positioning of the APs. For instance, with the known position and the distance of an AP to the LPS transmitter 74, an AP can determine the LPS transmitter's location to be somewhere on the surface of an imaginary sphere centered on that AP and whose radius is the distance to it. When the distance to four APs is known, the intersection of the four imaginary spheres reveals the location of the LPS transmitter.

[0181] The processing of the AP to transmitter 74 distances may be performed by a master AP by the game console device 12, by a motion tracking processing module, and/or by an LPS computer coupled to the plurality of APs 180-184. The motion tracking processing module may be a single processing device or a plurality of processing devices. Such a processing device may be a microprocessor, micro-controller, digital signal processor, microcomputer, central processing unit, field programmable gate array, programmable logic device, state machine, logic circuitry, analog circuitry, digital circuitry, and/or any device that manipulates signals (analog and/or digital) based on hard coding of the circuitry and/or operational instructions. The processing module may have an associated memory and/or memory element, which may be a single memory device, a plurality of memory devices, and/or embedded circuitry of the processing module. Such a memory device may be a read-only memory, random access memory, volatile memory, non-volatile memory, static memory, dynamic memory, flash memory, cache memory, and/or any device that stores digital information. Note that when the processing module implements one or more of its functions via a state machine, analog circuitry, digital circuitry, and/or logic circuitry, the memory and/or memory element storing the corresponding operational instructions may be embedded within, or external to, the circuitry comprising the state machine, analog circuitry, digital circuitry, and/or logic circuitry. Further note that, the memory element stores, and the processing module executes, hard coded and/or operational instructions corresponding to at least some of the steps and/or functions illustrated in FIGS. 1-64.

[0182] Depending on the frequency of transmitting the signal(s), the accuracy of the APs' clocks, and the carrier frequency of the signal, the accuracy of the gaming object's position may be within a few millimeters to about a meter. If the accuracy is the former, then this arrangement may be used to determine the relative position and to track the motion of the player and/or gaming object. If the accuracy is the latter, then this arrangement may be used to determine the player's and/or gaming object's position and another scheme would be used to track their motion.

[0183] FIG. 29 is a schematic block diagram of another embodiment of a wireless communication system that includes a plurality of LAN devices 912-196, a WAN coupling device 190, a game console device 12, a gaming object 14, and a player 16. Each of the LAN devices 192-196, which may be a wired device (e.g., includes an Ethernet network card, a fire wire interface, etc.) or a wireless device, includes an LPS module 198-202 and the gaming object 14 and/or the player 16 has associated therewith an LPS personal module 205. In one embodiment, the LPS modules 198-202 include an LPS transmitter 60-64 and the LPS personal module 205 includes an LPS receiver 66 as described with reference to FIG. 6.

[0184] In another embodiment, the LPS modules 198-202 include an LPS receiver 68-72 and the LPS personal module 205 includes an LPS transmitter 74. Note that the WAN coupling device 190 may be a cable modem, a DSL modem,
a satellite receiver, a cable receiver, and/or any other device that provides a WAN connection to a WAN network (e.g., the internet, a public phone system, a private network, etc.).

Figs. 30 and 31 are top and side view diagrams of an embodiment of determining position and/or motion tracking using RF and/or microwave signaling. In this embodiment, the transceiver 32 (which may be included in the game console device, coupled to a game console, coupled to a remote game console, or coupled to a server via an WAN connection) transmits a plurality of beamformed signals at one or more frequencies (e.g., frequencies in the ISM band, 29 MHz, 60 MHz, above 60 GHz, and/or other millimeter wavelengths (MMW)) to sweep the physical area. For each signal transmitted, the transceiver 32 determines the reflected signal energy and may also determine the refracted signal energy. The transceiver 32 may also determine the pass through signal component. Since different objects reflect, refract, and/or pass through RF to MMW signals in different ways, the game console device 12 can identify an object based on the reflected, refracted, and/or pass through signal energies. For example, human beings reflect, refract, and/or pass through RF and MMW signals in a different way than inanimate objects such as furniture, walls, plastics, metals, clothing, etc.

In this manner, a three dimension image of the physical area is obtained. Further analysis of the reflected, pass through, and/or refracted signals yields the distance to the transceiver 32. From the distance for a plurality of beamformed signals, the position of the objects (including the player and the gaming object) may be determined. Note that more than one transceiver may be used to determine the three-dimensional image of the physical area and/or to determine positioning and/or motion tracking within the physical area. A paper entitled, "Public Security Screening for Metallic Objects with Millimeter Wave Images", Imaging for Crime Detection and Prevention, 2005. ICDP 2005. The IEE International Symposium on Page(s): 1-4, 7-8 June 2005, discusses basic elements of MMW imaging, which is incorporated herein by reference. Beamforming is discussed in a patent application entitled, "BEAMFORMING AND/OR MIMO RF FRONT-END AND APPLICATIONS THEREOF", having a Ser. No. of 11/527,961, and a filing date of Sep. 27, 2006, which is incorporated herein by reference.

In addition to determining position of objects, the transceiver 32 using MMW signaling can track the motion of the player and/or gaming object. With WWM signaling, the wavelength of a 60 GHz signal is approximately 5 millimeters. Thus, a ninety degree phase shift of the signal corresponds to a 1.25 millimeter movement. Accordingly, by transmitting the signals at a motion tracking rate (e.g., once every 10-30 ms), the motion of the player and/or gaming object can be tracked with millimeter accuracy.

FIG. 32 is a schematic block diagram of an embodiment of a transceiver 32 that includes a processing module 220, one or more image intensity sensors 222, and an RF transmitter 224. The RF transmitter 224 includes an oscillator 228, a plurality of power amplifiers (PA) 230-232, and a beamforming module 226 coupled to a plurality of antenna structures. The plurality of antenna structures may be configurable antenna structures as discussed in patent application entitled, "INTEGRATED CIRCUIT ANTENNA STRUCTURE", having a Ser. No. of 11/648,826, and a filing date of Dec. 29, 2006, patent application entitled, "MULTIPLE BAND ANTENNA STRUCTURE", having a Ser. No. of 11/527,959, and a filing date of Sep. 27, 2006, and/or patent application entitled, "MULTIPLE FREQUENCY ANTENNA ARRAY FOR USE WITH AN RF TRANSMITTER OR TRANSCEIVER", having a Ser. No. of 11/529,058, and a filing date of Sep. 28, 2006, all of which are incorporated herein by reference.

The processing module 220 may be a single processing device or a plurality of processing devices. Such a processing device may be a microprocessor, microcontroller, digital signal processor, microcomputer, central processing unit, field programmable gate array, programmable logic device, state machine, logic circuitry, analog circuitry, digital circuitry, and/or any device that manipulates signals (analog and/or digital) based on hard coding of the circuitry and/or operational instructions. The processing module may have an associated memory and/or memory element, which may be a single memory device, a plurality of memory devices, and/or embedded circuitry of the processing module. Such a memory device may be a read-only memory, random access memory, volatile memory, non-volatile memory, static memory, dynamic memory, flash memory, cache memory, and/or any device that stores digital information. Note that when the processing module implements one or more of its functions via a state machine, analog circuitry, digital circuitry, and/or logic circuitry, the memory and/or memory element storing the corresponding operational instructions may be embedded within, or external to, the circuitry comprising the state machine, analog circuitry, digital circuitry, and/or logic circuitry. Further note that, the memory element stores, and the processing module executes, hard coded and/or operational instructions corresponding to at least some of the steps and/or functions illustrated in Figs. 1-64.

In operation, the oscillator 228 provides an oscillation at a desired frequency (e.g., within the ISM band, within the licensed and/or unlicensed RF communication bands of 450 MHz up to 29 GHz, 60 MHz, between microwave and IR frequency bands, etc.). The power amplifiers 230-232 amplify the oscillation to produce outbound signals. The beamforming module 226 adjusts phase and/or amplitude of at least one of the outbound signals to produce an in-air beamformed signal 212. The selection of the phase and/or amplitude focuses the energy of the beamformed signal 212 in a particular direction. As such, by adjusting the phase and/or amplitude of one or more outbound signals, a beamformed signal 212 can be directed in any two or three dimensional direction within the physical area. In addition, the desired frequency of the oscillation may be adjusted to provide a frequency spectrum sweep of the physical area.

The one or more image intensity sensors 222 measure the temperature of the objects, which is a function of the reflectivity, emissivity, and transmissivity of the surface of the physical area. Emissivity is the ratio of the radiation intensity of a nonblack body to the radiation intensity of a blackbody. This ratio, which is usually designated by the Greek letter ε, is always less than or just equal to one. The emissivity characterizes the radiation or absorption quality of nonblack bodies. Published values are available for most substances. Emissivities vary with temperature and also vary throughout the spectrum. Transmissivity is the ratio of the transmitted radiation to the radiation arriving perpendicular to the boundary between two mediums.

For a given beamformed signal, the one or more image sensors provide the temperature of the object(s) to the processing module 220. The processing module 220 accumu-
lates temperatures of the object(s) for various beamformed signals 212 and/or for various frequencies and processes the temperatures in accordance with an image intensity processing algorithm to provide a three dimensional image of the physical area and the objects in it. The image intensity processing algorithm may further include a positioning and/or motion tracking sub routine to establish the positioning and/or motion tracking of a player and/or gaming object within the physical area. Note that the gaming object may be made of one or more materials that makes it readily distinguishable from other objects that may be found in the physical area. For example, it may be made of a combination of metals and plastics in a particular shape.

[0193] FIG. 33 is a diagram of another method for determining position and/or motion tracking that begins at step 240 by transmitting one of a plurality of beamformed signals. The method continues at step 242 by receiving one or more image intensity signals (e.g., reflectivity, emissivity, and transmissivity of the surface of the physical area) for the given beamformed signal. The method then branches to step 246 and step 248. At step 246, the likely material of the object(s) is determined based on the received one or more image intensity signals. At step 248, the distance to the object(s) is determined based on the received one or more image intensity signals. The method continues at step 248 by determining whether all of the beamformed signals have been processed (e.g., different angles and/or at different frequencies). If not, the process repeats by transmitting one of the beamformed signals.

[0194] When all of the beamformed signals have been transmitted, the method continues at step 250 by compiling materials and distances to establish an initial model of the physical environment. The method continues at step 252 by identifying the player or players in the physical environment based on the materials. This step may further include identifying a gaming object. The method continues at step 254 by determining the one or more player’s position based on the corresponding distances. This step may further include determining the position of a gaming object. Note that this method may be continually performed to track motion of the player and/or gaming object.

[0195] FIG. 34 is a diagram of another method for determining position and/or motion tracking that may begin at step 260 with the optional step of adjusting frequency (e.g., in the MMW band) of the beamforming signals for optimal human imaging. The method continues at step 262 by updating the beamforming coefficients based on the player’s and/or gaming objects position. With this step, or these steps, the transceiver is focused on tracking the motion of the player and/or gaming object.

[0196] The method continues at step 264 by transmitting one of the beamforming signals and at step 266 by receiving one or more image intensity signals in response to the focused beamformed signal. The method then continues at step 268 by determining a distance to the object based on the received one or more image intensity signals. If all of the beamforming signals have not been transmitting as determined at step 270, the method repeats at step 264 by transmitting the next beamforming signal.

[0197] When all of the beamformed signals have been transmitted for this interval, the method continues at step 272 by compiling distances to establish the player’s and/or gaming objects motion. The method continues at step 274 by determine whether it is time to update the position of the player and/or gaming object. In an embodiment, the motion tracking processing may be repeated every 10-100 mSec and the positioning may be updated once every 1-10 seconds. In general, the positioning may be updated to keep the player and/or gaming object within a desired processing region. For example, with reference to FIG. 26, the motion tracking grid is moved based on the updated positioning such that the focusing of the beamforming signals is concentrated on the motion tracking grid.

[0198] Returning to the discussion of FIG. 34, when it is not time to update the positioning, the method repeats. If it is time to update the positioning, the method of FIG. 33 may be used.

[0199] FIG. 35 is a schematic block diagram of an embodiment of a wireless communication between a gaming object 14 and a game console device 12. In this embodiment, the gaming object 14 and the game console device 12 each includes a plurality of antenna structures. The antenna radiation pattern for the plurality of structures may be as shown in FIG. 36.

[0200] Returning to the discussion of FIG. 35, the gaming object 14 transmits a plurality of signals via the antenna structures, where each of the signals has a different carrier frequency (e.g., 11, 12, etc.). The antennas structures of the game console device 12 are tuned for the different carrier frequencies. For example, a first array of antennas is tuned for a first frequency and a second array of antennas is tuned for a second frequency. Note that the signals may be sinusoidal tones and/or RF communications in accordance with a wireless communication protocol. With the antenna radiation pattern as shown in FIG. 36, the antenna arrays will receive their respective signals with differing signal characteristics (signal strength, phase, beam angle, constructive and destructive interference of the signals, etc.), based on the orientation of the gaming object 14 with respect to the game console device 12. An example of this will be described with reference to FIGS. 37 and 38.

[0201] In this manner, as the characteristics of the respective signals changes, the movement of the gaming object 14 may be determined. Note that in another embodiment, the game console device 12 may transmit the signals and the gaming object 14 determines the signal characteristics.

[0202] With reference to FIGS. 34-36, both signal frequency and range between the end points of the medium affect the amount of attenuation. In general, attenuation is proportional to the square of the distance between the transmitter and receiver and is proportional to the square of the frequency of the radio signal. For instance, the attenuation increases as the frequency or range increases. Open outdoor attenuation is based on straightforward free space loss formulas, while indoor attenuation is more complex due to signals bounce off obstacles and penetrating a variety of materials that offer varying effects on attenuation. In general, an 802.11b radios operating at 11 Mbps will experience approximately 100 dB of attenuation at about 200 feet.

[0203] FIG. 37 is a diagram of another embodiment of an antenna radiation pattern for first and second antennas for first and second frequencies. The diagram further illustrates a source position of the transmitted signals. In this example, the 12 antennas are orthogonal with each other at a 45 degree relationship with the 11 antennas, which are orthogonal to each other.

[0204] FIG. 38 is a diagram of an example of receiving the RF and/or MMW signals by the various antennas of the antenna arrays. As shown, 11 antennas receive the transmitted RF and/or MMW signal [e.g., A(1) cos[(1)f(t)] with different
characteristics. The received signals of the 11 antennas are combined to produce a first resulting signal [e.g., $A_1 \cos(\omega_1(t) + \theta_1 + \phi_1)$, where $A_1$ is the received amplitude, $\theta_1$ is the beam angle, and $\phi_1$ is the phase rotation. As is shown, 12 antennas receive the transmitted RF and/or MMW signal [e.g., $A_2 \cos(\omega_2(t))$] with different characteristics. The received signals of the 12 antennas are combined to produce a second resulting signal [e.g., $A_2 \cos(\omega_2(t) + \theta_2 + \phi_2)$]. The resulting signals can be processed to determine the beam angle, phase angle, and amplitude of the transmitted signals. From this information, the position and/or motion tracking may be determined.

[0205] To enhance the positioning and/or motion tracking the attenuation curves of FIG. 39 may be used. As shown, 12 is of a higher frequency and thus attenuates in air more quickly over distance than the 11 signals. Note that more than two carrier frequencies may be used to facilitate the determination of the position and/or motion tracking.

[0206] FIGS. 40 and 41 are diagrams of an example of frequency dependent distance calculation where the phase difference at different times for different signals is determined. The positioning and/or motion tracking of an object may be done based on the phase difference, the transmission distance, and the frequency of the signals from time to time. For example, at time TX to, the transmitter transmits a signal as shown in FIG. 40. At time RX $t_3 + \Delta t_{t,1}$, the first antenna receives the signal. The phase rotation (e.g., $\Delta \theta_{t,1}$) of the received signal is determined. At time RX $t_3 + \Delta t_{t,2}$, the second antenna receives the signal. The phase rotation (e.g., $\Delta \theta_{t,2}$) of the received signal is determined. With a known distance between the first and second antennas, the different phase rotations, and the carrier frequency of the signal, the distance between the transmitter and receiver can be determined. Using the beam angle, the orientation of the distance can be determined.

[0207] FIGS. 42 and 43 are diagrams of an example of constructive and destructive signalizing to facilitate the determination of positioning and/or motion tracking. In this embodiment, at least two antennas physically separated by a known distance transmit different sinusoidal signals [e.g., $\cos(\omega_1(t))$ and $\cos(\omega_2(t))$]. In air, the signals combine in a constructive and destructive manner [e.g., $\cos(\omega_1(t)) + \cos(\omega_2(t)) = 2 \cos(\omega_1/2(t) + \cos(\omega_2(t)/2(t)) - 2 \cos(\omega_1/2(t) + \omega_2(t))/2(t) - \cos(\omega_1/2(t) - \omega_2(t)/2(t))$].

[0208] An array assembly of the gaming object and/or player receives the signals and, based on the constructive and destructive patterns, the distance may be determined. Obtaining multiple distances from multiple sources and knowing the source locations, the position and/or motion of the object can be determined. Such a process may be augmented by using the attenuation properties of a signal in air and/or by using multiple different frequency signals.

[0209] FIG. 44 is a schematic block diagram of an overhead view of another embodiment of a gaming system 10 that includes a game console device 12, a gaming object 14, and a plurality of digital image sensors 290-294 (e.g., digital cameras, digital camcorders, digital image sensor, etc.). The gaming system 10 has an associated physical area in which the gaming object 14 and player 16 are located. The physical area may be a room, a portion of a room, and/or any other space where the gaming object and game console are proximally co-located (e.g., airport terminal, on a bus, on an airplane, etc.). The game console device 12 may be in the physical area or outside of the physical area, but electronically connected to the physical area via a WLAN, WAN, telephone, DSL modem, cable modem, etc.

[0210] In this system 10, the plurality of digital imaging sensors 290-294 periodically (e.g., in the range of once every 1 millisecond to once every 10 seconds) captures an image of the player 16 and/or gaming object 14 within the physical area based on the position of the player and/or gaming object. Note that the digital imaging sensors 290-294 may be continually repositioned to determine the player's and/or gaming object's position and/or to track the motion of the gaming object and/or player.

[0211] The captured images are initially used to determine the position of the gaming object and/or the player. Once the player's and/or gaming object's position is determined, the digital image sensors may be positioned and/or adjusted to focus on the player's and/or gaming object's movement. The images captured by the digital image sensors are then processed using a two-dimension and/or three-dimension algorithm to determine the motion of the gaming object and/or the player. Note that the player 16 and/or gaming object 14 may include sensors (e.g., blue screen patches, etc.) thereon to facilitate the position and/or motion tracking processing.

[0212] FIG. 45 is a schematic block diagram of an overhead view of another embodiment of a gaming system 10 that includes a game console device 12, a gaming object 14, and a plurality of heat sensors 300-304 (e.g., infrared thermal imaging cameras, infrared radiation thermometers, thermal imagers, ratio thermometers, Optical Pyrometer, fiber-optic temperature sensor, etc.). The gaming system has an associated physical area in which the gaming object and player are located. The physical area may be a room, a portion of a room, and/or any other space where the gaming object and game console are proximally co-located (e.g., airport terminal, on a bus, on an airplane, etc.). The game console device 12 may be in the physical area or outside of the physical area, but electronically connected to the physical area via a WLAN, WAN, telephone, DSL modem, cable modem, etc.

[0213] In this system 10, the plurality of heat sensors 300-304 periodically (e.g., in the range of once every 1 millisecond to once every 10 seconds) captures a heat image of the player 16 and/or gaming object 14 within the physical area based on the position of the player and/or gaming object. Note that the heat sensors 300-304 may be continually repositioned to determine the player's and/or gaming object's position and/or to track the motion of the gaming object and/or player.

[0214] The captured heat images are initially used to determine the position of the gaming object and/or the player. Once the player's and/or gaming object's position is determined, the heat sensors may be positioned and/or adjusted to focus on the player and/or gaming object movement. The heat images captured by the heat sensors are then processed using a two-dimension and/or three-dimension algorithm to determine the motion of the gaming object and/or the player. Note that the player and/or gaming object may include sensors thereon to facilitate the position and/or motion tracking processing.

[0215] FIG. 46 is a schematic block diagram of an overhead view of another embodiment of a gaming system 10 that includes a game console device 12, a gaming object 14, and a plurality of electromagnetic sensors 310-314 (e.g., Magnetometers, gauss meters, magnetic field sensors, electromagnetic and EMC/EMI/RFI probes for measuring electromagnetic fields, etc.). The gaming system has an associated
physical area in which the game gaming object 14 and player 16 are located. The physical area may be a room, portion of a room, and/or any other space where the gaming object and game console are proximally co-located (e.g., airport terminal, on a bus, on an airplane, etc.). The game console device may be in the physical area or outside of the physical area, but electronically connected to the physical area via a WLAN, WAN, telephone, DSL modem, cable modem, etc.

[0216] In this system, the plurality of electromagnetic sensors 310-314 periodically (e.g., in the range of once every 1 millisecond to once every 10 seconds) captures an electromagnetic image of the player and/or gaming object within the physical area based on the position of the player and/or gaming object. Note that the electromagnetic sensors 310-314 may be continually repositioned to determine the player’s and/or gaming object’s position and/or to track the motion of the gaming object and/or player.

[0217] The captured electromagnetic images are initially used to determine the position of the gaming object and/or the player. Once the player’s and/or gaming object’s position is determined, the electromagnetic sensors may be positioned and/or adjusted to focus on the player and/or gaming object movement. The electromagnetic images captured by the electromagnetic sensors are then processed using a two-dimensional and/or three-dimensional algorithm to determine the motion of the gaming object and/or the player. Note that the player and/or gaming object may include sensors thereon to facilitate the position and/or motion tracking processing.

[0218] FIG. 47 is a schematic block diagram of an overview view of another embodiment of a gaming system 10 that includes a game console device 12, a gaming object 14, and a plurality of laser sensors 320-324 (e.g., Laser Distance Measurement Photoelectric Sensor, digital laser sensor, short range laser sensor, medium range laser sensor, etc.). The gaming system has an associated physical area in which the gaming object 14 and player 16 are located. The physical area may be a room, a portion of a room, and/or any other space where the gaming object 14 and the game console device 12 are proximally co-located (e.g., airport terminal, on a bus, on an airplane, etc.). The game console device 12 may be in the physical area or outside of the physical area, but electronically connected to the physical area via a WLAN, WAN, telephone, DSL modem, cable modem, etc.

[0219] In this system, the plurality of laser sensors 320-324 periodically (e.g., in the range of once every 1 millisecond to once every 10 seconds) captures laser based relative distances of the player and/or gaming object within the physical area based on the position of the player and/or gaming object. Note that the laser sensors 320-324 may be continually repositioned to determine the player’s and/or gaming object’s position and/or to track the motion of the gaming object and/or player.

[0220] The relative distances are initially used to determine the position of the gaming object 14 and/or the player 16. Once the player’s and/or gaming object’s position is determined, the laser sensors may be positioned and/or adjusted to focus on the player and/or gaming object movement. Subsequent relative distances are processed using a two-dimensional and/or three-dimensional algorithm to determine the motion of the gaming object and/or the player. Note that the player and/or gaming object may include sensors thereon to facilitate the position and/or motion tracking processing.

[0221] FIG. 48 is a diagram of another method for determining position and/or motion tracking that begins at steps 330 and 332 by determining the relative position of the player and/or gaming object using two or more positioning techniques (e.g., RF beam forming, laser sensors, etc.). The method continues at step 334 by combining the two or more positions to produce the initial position. Note that the two or more positioning techniques may be weighted based on a variety of factors including, but not limited to, accuracy, distance, interference, availability, etc. Note that one technique may be used to capture the position in one plane (e.g., x-y plane), a second technique may be used to capture the position in a second plane (e.g., x-z plane), and/or a third technique may be used to capture the position in a third plane (e.g., y-z plane).

[0222] The method continues at steps 336 and 338 by determining the motion of the player and/or gaming object using two or more motion tracking techniques. Note that in many instances the same technique may be used for positioning as for motion tracking, where the motion tracking is done with greater resolution and at a greater rate than the positioning. The method continues at step 340 by combining the two motion tracking values to produce the current motion of the player and/or gaming object. Note that the two or more motion tracking techniques may be weighted based on a variety of factors including, but not limited to, accuracy, availability, speed of movement, interference, distance, user preference, etc. Further note that the motion of a player and/or gaming object may be enhanced by including a positioning and/or motion tracking sensor on the player and/or gaming object.

[0223] The method continues at step 342 by determining whether the position needs to be updated (e.g., change focus of motion tracking processing). If yes, the method repeats at steps 330 and 332. If not, the method repeats at steps 336 and 338.

[0224] FIG. 49 is a diagram of another method for determining position and/or motion tracking that begins at step 350 by evaluating the physical environment in which the player and/or gaming object are located. The game console may also be located in the physical environment, which may be a room, a portion of a room, an office, and/or any area in which a player can play a video game. The method continues at step 352 by selecting one or more of a plurality of positioning techniques for determining the position of the player and/or gaming object based on the physical environment.

[0225] The method continues at step 354 by determining the position of the player and/or gaming object using the one or more positioning techniques. The method continues at step 356 by selecting one or more of motion tracking techniques to determine the motion of the player and/or gaming object based on the environment and/or the position of the player and/or gaming object. The method continues at step 358 by determining the motion of the player and/or gaming object using the selected motion tracking technique(s). The method continues at step 360 by determining whether the position of the player and/or gaming object needs to be updated and repeats as shown.

[0226] FIG. 50 is a schematic block diagram of an overhead view of another embodiment of a gaming system 10 that includes a game console device 12, a gaming object 14, an RFID reader 370, at least one RFID tag 372 associated with the player 16, and at least one RFID tag 372 associated with the gaming object 14. The gaming system has an associated physical area in which the gaming object and player are located. The physical area may be a room, a portion of a room,
and/or any other space where the gaming object 14 and the game console device 12 are proximally co-located (e.g., airport terminal, on a bus, on an airplane, etc.). The game console device 12 may be in the physical area or outside of the physical area, but electronically connected to the physical area via a W LAN, WAN, telephone, DSL modem, cable modem, etc.

In this system, the RFID reader 370 periodically (e.g., in the range of once every 1 millisecond to once every 10 seconds) communicates with the RFID tags 372 to determine distances of the player 16 and/or gaming object 14 within the physical area. This may be done by using the RFID system (e.g., the reader and the tags) as an RF radar system. For example, the RFID system may use a backscatter technique to determine distances between the RFID reader and the RFID tags. In another example, the RFID system may use frequency modulation to compare the frequency of two or more signals, which is generally more accurate than timing the signal. By changing the frequency of the returned signal and comparing that with the original, the difference can be easily measured.

As another example, the RFID system may use a continuous wave radar technique. In this instance, a “carrier” radar signal is frequency modulated in a predictable way, typically varying up and down with a sine wave or sawtooth pattern at audio frequencies or other desired frequency. The signal is then sent out from one antenna and received on another and the signal can be continuously compared. Since the signal frequency is changing, by the time the signal returns to the source the broadcast has shifted to some other frequency. The amount of that shift is greater over longer times, so greater frequency differences mean a longer distance. The amount of shift is therefore directly related to the distance traveled, and can be readily determined. This signal processing is similar to that used in speed detecting Doppler radar.

The distances are initially used to determine the position of the gaming object and/or the player. Once the player’s and/or gaming object’s position is determined, the RFID system may be adjusted to focus on the player and/or gaming object movement. Subsequently determined distances are processed using a two-dimension and/or three-dimension algorithm to determine the motion of the gaming object and/or of the player.

FIG. 51 is a schematic block diagram of an overhead view of another embodiment of a gaming system 10 that includes a game console device 12, a gaming object 14, a plurality of RFID readers 370, a plurality of RFID tags 372 associated with the player 16, and a plurality of RFID tags 372 associated with the gaming object 14. The gaming system 10 has an associated physical area in which the gaming object and player are located. The physical area may be a room, portion of a room, and/or any other space where the gaming object 14 and the game console device 12 are proximally co-located (e.g., airport terminal, on a bus, on an airplane, etc.). The game console device 12 may be in the physical area or outside of the physical area, but electronically connected to the physical area via a W LAN, WAN, telephone, DSL modem, cable modem, etc.

In this system, one or more of the RFID readers 370 periodically (e.g., in the range of once every 1 millisecond to once every 10 seconds) communicates with one or more of the RFID tags 372 to determine distances of the player 16 and/or gaming object 14 within the physical area. This may be done by using the RFID system (e.g., the readers and the tags) as an RF radar system. For example, the RFID system may use a backscatter technique to determine distances between the RFID reader and the RFID tags. In another example, the RFID system may use frequency modulation to compare the frequency of two or more signals, which is generally more accurate than timing the signal. By changing the frequency of the returned signal and comparing that with the original, the difference can be easily measured.

As another example, the RFID system may use a continuous wave radar technique. In this instance, a “carrier” radar signal is frequency modulated in a predictable way, typically varying up and down with a sine wave or sawtooth pattern at audio frequencies or other desired frequency. The signal is then sent out from one antenna and received on another and the signal can be continuously compared. Since the signal frequency is changing, by the time the signal returns to the source the broadcast has shifted to some other frequency. The amount of that shift is greater over longer times, so greater frequency differences mean a longer distance. The amount of shift is therefore directly related to the distance traveled, and can be readily determined. This signal processing is similar to that used in speed detecting Doppler radar.

The distances are initially used to determine the position of the gaming object and/or the player. Once the player’s and/or gaming object’s position is determined, the RFID system may be adjusted to focus on the player and/or gaming object movement. Subsequently determined distances are processed using a two-dimension and/or three-dimension algorithm to determine the motion of the gaming object and/or of the player.

FIG. 52 is a schematic block diagram of a side view of another embodiment of a gaming system 10 that includes a game console device 12, a gaming object 14, one or more RFID readers 370, a plurality of RFID tags 372 associated with the player 16, and a plurality of RFID tags 372 associated with the gaming object 14. The gaming system has an associated physical area in which the gaming object and player are located.

In this illustration, the player 16 and the gaming object 14 are within the determined relative position 378. To track the player’s and gaming object’s motion with the relative position 378, the one or more RFID readers 370 transmits an RFID reader transmission 374, which may be in accordance with an RF radar transmission as discussed above. Alternatively, the RFID reader transmission 374 may be request for at least one of the RFID tags 372 to provide a response regarding information to determine its position or distance with reference to a particular point.

The RFID tags provide an RFID tag response 376, which may be in accordance with the RF radar transmissions discussed above. Alternatively, the RFID tags may provide a response regarding information to determine its position or its distance to a reference point. The communication between the RFID reader(s) and RFID tags may be done in a variety of ways, including, but not limited to, a broadcast transmission and collision detection and avoidance response scheme, in a round robin manner, in an ad hoc manner based on a desired updating rate for a given RFID tag (e.g., a slow moving tag needs to be updated less often than a fast moving tag), etc.

FIG. 53 is a schematic block diagram of an embodiment of an RFID reader 370 in the game console device 12 and an RFID tag 372 in the gaming object 14. The RFID reader 370 includes a protocol processing module 380, an
encoding module 382, a digital to analog converter 384, an RF front-end 386, a digitization module 388, a pre-decoding module 390, and a decoding module 392. The RFID tag 372 includes a power generating circuit 394, an envelope detection module 396, an oscillation module 398, an oscillation calibration module 400, a comparator 402, and a processing module 404. The details of the RFID render 370 are disclosed in patent application entitled RFID READER ARCHITECTURE, having a Ser. No. of 11/357,812, and a filing date of Mar. 16, 2006 and the details of the RFID tag 372 are disclosed in patent application entitled POWER GENERATING CIRCUIT, having a Ser. No. of 11/394,808, and a filing date of Mar. 31, 2006. Both patent applications are incorporated herein by reference.

[0238] FIG. 54 is a diagram of a method for determining position of a player and/or gaming object that begins at step 410 with an RFID reader transmitting a power up signal to one or more RFID tags, which may be active or passive tags. The power up signal may be a tone signal such that a passive RFID tag can generate power therefrom. The power up signal may be a wake-up signal for an active RFID tag. The method continues at step 412 with the RFID tag providing an acknowledgement that it is powered up. Note that this step may be skipped.

[0239] The method continues at step 414 with the RFID reader transmitting a command at time t0, where the command requests a response to be sent at a specific time after receipt of the command. In response to the command, an RFID tag provides the response and, at step 416, the reader receives it. The method continues at step 418 with the RFID reader recording the time and the tag ID. The method continues at step 420 with the reader determining the distance to the RFID tag based on the stored time, time t0, and the specific time delay.

[0240] The method continues at step 422 by determining whether all or a desired number of tags have provided a response. If not, the method loops as shown. If yes, the method continues at step 424 by determining the general position of the player and gaming object based on the distances. As an alternative, the general position of each of the tags may be determined from the respective distances at step 426. Note that at least three, and preferably four, distances need to be accumulated from different sources (e.g., multiple RFID readers or an RFID reader with multiple physically separated transmitters) to triangulate the RFID tag's position.

[0241] FIG. 55 is a schematic block diagram of an embodiment of a gaming object 14 that includes an integrated circuit (IC) 434, a gaming object transceiver 432, and a processing module 430. The IC 434 includes one or more of an RFIC tag 446, a servo motor 448, a received signal strength indicator 444, a pressure sensor 436, an accelerometer 438, a gyrorotor 440, an LPS receiver 442, and an LPS transmitter 445. Note that if the gaming object 14 is an item worn by the player to facilitate playing a video game, the gaming object 14 may not include the processing module 430 and/or the gaming object transceiver 432.

[0242] The RFID tag is coupled to one or more antenna assemblies and the gaming object transceiver is also coupled to one or more antenna assemblies. In this instance, the RFID tag may communicate with an RFID reader using one or more carrier frequencies to facilitate positioning and/or tracking as described above. In addition to, or in the alternative, the RFID tag may provide the communication path for data generated by the RSSI module, the servo motor, the pressure sensor, the accelerometer, the gyrorotor, the LPS receiver, and/or the LPS transmitter. Details of including a gyrorotor or pressure sensor on an IC is provided in patent application entitled GAME DEVICES WITH INTEGRATED GYRATORS AND METHODS FOR USE THEREWITH, having a Ser. No. of 11/731,318, and a filing date of Mar. 29, 2007 and patent application entitled RF INTEGRATED CIRCUIT HAVING AN ON-CHIP PRESSURE SENSING CIRCUIT, having a Ser. No. of 11/805,585, and a filing date of May 23, 2007. Both patent applications are incorporated herein by reference.

[0243] The RFID tag may use a different frequency than the gaming object transceiver for RF communications or it may use the same, or nearly the same, frequency. In the latter case, the frequency spectrum may be shared using a TDMA, FDMA, or some other sharing protocol. If the RFID tag and the gaming object transceiver share the frequency spectrum, they may share the antenna structures. Note that the antenna structures may be configurable as discussed in patent application entitled, “INTEGRATED CIRCUIT ANTENNA STRUCTURE”, having a Ser. No. of 11/648,826, and a filing date of Dec. 29, 2006, patent application entitled, “MULTIPLE BAND ANTENNA STRUCTURE”, having a Ser. No. of 11/527,959, and a filing date of Sep. 27, 2006, and/or patent application entitled, “MULTIPLE FREQUENCY ANTENNA ARRAY FOR USE WITH AN RF TRANSMITTER OR TRANSCEIVER”, having a Ser. No. of 11/529,058, and a filing date of Sep. 28, 2006, all of which are incorporated herein by reference.

[0244] FIG. 56 is a schematic block diagram of an embodiment of a three-dimensional antenna structure 350 that includes at least one antenna having a radiation pattern along each of the three axes (x, y, z). Note that the 3D antenna structure 350 may include more than three antennas having radiation patterns at any angle within the three-dimensional space. Note that the antennas may be configurable antennas as previously discussed to accommodate different frequency bands. FIG. 57 is a diagram of an example of an antenna radiation pattern 352 for one of the antennas of the antenna structure 350 of FIG. 56.

[0245] FIGS. 58 and 59 are diagrams of an example of frequency dependent motion calculation where a signal (TX) is received at time tn and another signal (TX) is received at time tn+1, where n is any number. As shown in FIG. 58, the signal is received with respect to the xy plane and with respect to the xz plane by the three antennas of FIG. 56. In this configuration, each antenna will receive the signal with a different amplitude (and may be a different phase as well) due to its angle with respect to the source of the signal. From these differing received signals, the angular direction of the source with respect to the 3D antenna structure can be determined. To determine the distance between the 3D antenna structure and the source, one or more of the distance determination techniques discussed herein may be used (e.g., attenuation of the magnitude of the transmitted signal). With the distance and angle known, the position of the 3D antenna structure, which may be affiliated with a player and/or gaming object, can be determined for time tn.

[0246] FIG. 59 shows the signal being received at time tn+1, which is at a different angle than the signal transmitted at time tn. The differing received signals by the antennas are used to determine the angular position of the source and one or more of the distance determination techniques discussed herein may be used to determine the distance to the source.
From the known angular position and the known distances, the position of the 3D antenna structure may be determined for time $tn+1$. Comparing the position of the 3D antenna structure at time $tn$ with its position at time $tn+1$ yields its motion.

**[0247]** FIG. 60 is a diagram of a method for determining motion that begins at step 360 by transmitting an RF signal at time $tn$. The RF signal may be a narrow pulse, may be a sinusoidal signal, and/or may be an RF transmission in accordance with a wireless communication protocol. The method continues at step 362 with the 3D antenna structure receiving the RF signal. The method continues at step 364 by determining a 3D vector of the received RF signal. An example of this is shown in FIG. 61.

**[0248]** The method continues at step 366 by transmitting another RF signal at time $tn+1$. The method continues at step 368 with the 3D antenna structure receiving the RF signal. The method continues at step 370 by determining a 3D vector of the received RF signal. An example of this is shown in FIG. 61. The method continues at step 372 by determining the motion of the player and/or gaming object by comparing the two 3D vectors. This process continues for each successive $tn$ and $tn+1$ combination. Note that the duration between $tn$ and $tn+1$ may vary depending on one or more of the video game being played, the speed of motion, the anticipated speed of motion, the quality of the motion estimation, and/or motion prediction algorithms, etc.

**[0249]** FIG. 62 is a schematic block diagram of an overhead view of another embodiment of a gaming system 10 that includes a game console device 12, a player 16, a gaming object 14, and a plurality of directional microphones 280. The gaming system has an associated physical area in which the game gaming object and player are located. The physical area may be a room, portion of a room, and/or any other space where the gaming object 14 and game console device 12 are proximally co-located (e.g., airport terminal, on a bus, on an airplane, etc.). The game console device 12 may be in the physical area or outside of the physical area, but electronically connected to the physical area via a WLAN, WAN, telephone, DSL modem, cable modem, etc.

**[0250]** In this system, the plurality of directional microphones 380-382 periodically (e.g., in the range of once every 1 millisecond to once every 10 seconds) captures audible, near audible, and/or ultrasound signals (together, acoustic waves) of the player 16 and/or gaming object 14 within the physical area. Note that the directional microphones 380-382 may be continually repositioned to determine the player’s and/or gaming object’s position and/or to track the motion of the gaming object and/or player.

**[0251]** The captured audible, near audible, and/or ultrasound signals are used to determine the initial position of the gaming object and/or the player. Once the player’s and/or gaming object’s position is determined, the directional microphones 380-382 may be positioned and/or adjusted to focus on the player and/or gaming object movement. The captured signals are then processed using a two-dimension and/or three-dimension algorithm to determine the motion of the gaming object and/or the player. Note that the player and/or gaming object may include near audible and/or ultrasound signal generators thereon facilitating the position and/or motion tracking processing.

**[0252]** FIG. 63 is a diagram of an example of audio, near audio, and ultrasound frequency bands that may be used by the system of FIG. 63. In this example, a positioning tone (e.g., a sinusoidal signal) has a frequency just above the audible frequency range (e.g., at 25-35 KHZ) and/or in the ultrasound frequency band, which are within the bandwidth of the microphone. Thus, the microphones may serve a dual purpose: capturing audio for normal game play, game set up, game authentication, player authentication, gaming object authentication, and for position determination and motion tracking. In an embodiment, the gaming object and/or the player may transmit a near audible signal (e.g., a tone at 25 KHZ), which is above the audible frequency range, but within the bandwidth of the directional microphones 380-382. The directional microphones may adjust their position to focus in on the source of the tone. The angular positioning and the intersection thereof may be used to determine the location of the gaming object and/or the player.

**[0253]** FIG. 64 is a schematic block diagram of an overhead view of another embodiment of a gaming system 10 that includes a gaming object 14, a player 15, a directional microphone 390, and a game console device 12. In this embodiment, the game console device 12 and/or the gaming object 14 include one or more directional microphones (and may include transmitters) 390 that have their orientation adjusted based on the position and/or motion of the gaming object to better receive an audible signal from the gaming object, player, and/or the game console device. The gaming object 14 may also include a sound energy transmitter. In a first operation, based upon receipt of a sound energy signal from the gaming object by the directional microphones 390 and subsequent processing, a position of the gaming object may be determined. In a second operation, sound energy from the transmitters 390 is reflected by the user and/or the gaming object. Based upon the receipt of such sound energy, a position of the gaming object and/or the user may be determined.

**[0254]** FIG. 65 is a schematic block diagram of an overhead view of still another embodiment of a position location system in accordance with the present invention. The position location system of FIG. 65 includes first position location sub-system, second position location sub-system, and processing circuitry that is coupled to the first position location sub-system and to the second position location sub-system. The position location system illustrated in FIG. 65 is deployed within a gaming environment 6502. However, in other embodiments, the position location system of FIG. 65 may be deployed in a physical area that does not support gaming. In such case, the position location system of FIG. 65 would simply be used to locate objects other than gaming objects within the physical area.

**[0255]** With the particular embodiment of FIG. 65, the video gaming system 6500 supports video gaming within the video gaming environment 6502 of the physical area. Consistently with the previous description made herein, the video gaming system 6500 includes a game console 12, a gaming object 14, and a gaming object 15. During play, a player 16 holds one or both the gaming objects 14 and 15 and the position location system performs position 18 and motion tracking 20 of the objects 14 and 15 and/or the player 16. By performing such position 18 and motion tracking 20, the position location system supports the player 16 interacting with a gaming function supported by game console 12.

**[0256]** The position location system of FIG. 65 includes at least two position location sub-systems, at least two of which use differing position location techniques. For example, in the embodiment of FIG. 65, the position location system includes first position location sub-system having position location
sub-system components 6504A, 6504B, and 6504C. Likewise, the position location system includes a second position location sub-system having position location sub-system components 6506A, 6506B, and 6506C. As is illustrated in FIG. 65, each of these position location sub-system components couples to the game console 12 via wired and/or wireless communication links. The game console 12 includes processing circuitry that receives position location information from the at least two position location sub-systems and processes such information to locate one or more of gaming object 14, gaming object 15, and player 16 within the gaming environment 6502. In a non-gaming embodiment, processing circuitry locates one or more objects within the physical area without supporting gaming.

[0257] As is shown with the system of FIG. 65, each of the first position location sub-system and the second position location sub-system may each include a plurality of receivers that orient about the gaming environment/physical area 6502. Further, with the embodiment of FIG. 65, the first position location sub-system may include at least one transmitter. The at least one transmitter may be located in conjunction with the gaming object 14 or 15 and/or may be co-located with the various receivers of the first and second position location sub-systems that are located about the gaming area 6502. In such case, position location sub-system components are distributed about the gaming area, e.g., 6504A-6504C and may have substantially co-located receivers and transmitters.

[0258] According to one aspect of the position location system of FIG. 65, the first position location sub-system uses a first position location technique while the second position location sub-system uses a second position location technique that differs from the first position location technique. The various position location techniques that may be employed by the first and second position location sub-systems of FIG. 65 have been described previously herein with reference to FIGS. 1-64. Generally, these techniques include one or more of acoustic wave detection, RF signal detection, digital imaging, IR detection, laser distance measurement, thermal imaging, and/or multiple access accelerometer sensing.

[0259] When using acoustic wave detection technique with the system of FIG. 65, the object 14 and/or 15 may include at least one acoustic energy source, e.g., ultrasonic transmitter, and the first position location sub-system may include a plurality of sound energy receivers that are located about the gaming environment 6502.

[0260] With one example of use of RF signal detection, the object 14 or 15 includes at least one RF transmitter and one or more of the first and second position location sub-systems include a plurality of receivers. With a second example of use of RF signal detection, the object 14 or 15 includes at least one RF receiver and the first and/or the second position location sub-systems include a plurality of RF transmitters. With another example of use of RF signal detection, the first and/or second position location sub-systems include at least one RF transmitter and a plurality of RF receivers.

[0261] With a first embodiment of the use of digital imaging, one or more gaming objects 14 and/or 15 include(s) a plurality of digital cameras. This technique, as was previously described herein, uses the digital cameras of the gaming objects 14 and/or 15 to recognize reference points in the gaming environment 6502 and to determine position(s) of the object(s) 14 and/or 15 based upon these reference points. With another embodiment using digital imaging, the first and/or second position location sub-systems include a plurality of digital cameras. The first and/or second position location sub-systems identify reference points, including object reference points, captured in the digital images to locate gaming object 14 and/or 15.

[0262] With an embodiment of the system of FIG. 65 using IR detection, the object may include an IR source and the first and/or second position location sub-systems include a plurality of IR receivers. With another embodiment of using IR detection, the first and/or second position location sub-systems include at least one IR source and a plurality of IR receivers. Any of these various techniques may be employed with the position location sub-systems and illustrated further herein with reference to FIGS. 66-73.

[0263] Operations of the video gaming system 6500 of FIG. 65 will be described further herein with reference to FIGS. 67-73.

[0264] FIG. 66 is a schematic block diagram of an overhead view of yet another embodiment of a position location system in accordance with the present invention. The FIG. 66, a position location system includes a first position location sub-system, a second position location sub-system, and processing circuitry that couples to the first position location sub-system and to the second position location sub-system. The first position location sub-system includes a plurality of position location sub-system components 6604A, 6604B, and 6604C. The second position location sub-system includes a plurality of position location sub-system components 6606A, 6606B, and 6606C. The position location sub-system(s) components couple to the processing circuitry of game console 12 via a wired and/or wireless communication link.

[0265] With the embodiment of FIG. 66, the first position location sub-system is operable to determine first position location information regarding a first gaming object 14 using a first position location technique. The second position location sub-system is operable to determine second position location information regarding a second object 52. The second position location sub-system uses a second position location technique that differs from the first position location technique. As was previously described with reference to FIGS. 1-65, various position location techniques may be employed in accordance with the present invention. Generally, the first position location sub-system includes components 6604A-6604C that use a position location technique that differs from a second position location technique used by the second position location sub-system that includes component 6606A-6606C.

[0266] The game console 12 includes processing circuitry coupled to both the first position location sub-system and to the second location sub-system via wired and/or wireless couplings. The processing circuitry of gaming console 12 processes the first position location information to determine a position of the first object 14 within a coordinate system. Further, the processing circuitry processes the second position location information to determine a position of the second object 52 within the coordinate system. As was previously described herein with reference to FIGS. 1 - 64, the coordinate system is associated with the physical environment within which the position location system is deployed. When the position location system operates in conjunction with a video gaming system, the coordinate system in which objects 14 and 52 are located is related to a video gaming function. In such case, the location of gaming objects 14 and 52 are related to the gaming environment to incorporate the
gaming functions and operations as well as positions of players 16 and 50 into the video game function. Thus, with the system of FIG. 66, the first position location sub-system is used to determine position 18 and motion track 20 player 16 and/or gaming object 14. Further, the second position location sub-system is employed to determine position 54 and/or motion tracking 56 of player 50 and/or gaming object 52.

[0267] As was previously described herein, the coordinate system used with the system of FIG. 66 may include a three-dimensional Cartesian coordinate system or a spherical coordinate system. Further as was the case with the system of FIG. 65, the position location sub-systems of FIG. 66 include receivers and/or transmitters deployed about a physical area that are operable to locate players 16 and 50 and/or gaming objects 14 and/or 52 within the physical area. Further operations of the position location system of FIG. 66 will be described further herein with reference to FIGS. 71-73. Generally, the operations described herein with reference to FIGS. 67-73 may be employed with one or both of the systems of FIGS. 65 and 66.

[0268] FIG. 67 is a flow chart illustrating operations of a position location system employing multiple position location techniques. With the operation of FIG. 67, the position location system first evaluates its physical environment (Step 670). In evaluating the physical environment at Step 670, the position location sub-system may perform calibration operations. Such calibration operations may be performed according to techniques previously described herein and that will be described herein with reference to FIG. 68.

[0269] Operation proceeds with capturing first position location information regarding the object using a first position location sub-system that uses a first position location technique (Step 672). The system of FIGS. 65 and/or 66 may be employed with the operations of FIG. 67 to locate the object using first position location sub-system. Operation proceeds to capturing second position location information regarding the object by a second position location sub-system using the second position location technique (Step 674). Then, processing circuitry or another processing device processes the first position location information and the second position location information to determine a position of the object within a coordinate system (Step 676). The coordinate system may correspond to a gaming environment, a factory, an office, a shopping mall, or any other physical area where objects may be located. Then, for the embodiments of a gaming system the positions of the object within the coordinate system is integrated into a video game function (Step 678).

[0270] According to various embodiments of Step 676, the first position location information and the second position location information are used in differing manners. For example, the first position location information may be used as primary information to locate the object while the second position location information may be used as secondary information to locate the object. With this operation, the second position location information is used as a safeguard or resolution enhancement to error check or increase resolution of the first position location information. Further, the second position location information may be used to calibrate the first position location information. Such calibration may occur at startup and/or during standard intervals of operation of the position location system.

[0271] In other embodiments, the second position location information is simply used to augment the first position location information. An example of augmentation use of the second position location information occurs when the first position location information is interrupted intermittently or infrequently. In such case, the second position location information would fill-in the missing first position location information. Further, augmentation of the first position location information with the second position location information occurs at different points in the gaming operation when additional resolution, enhanced motion detection, greater location position, or another operation occurs in which a single position location technique is insufficient for the current demands.

[0272] FIG. 68 is a flow chart illustrating usage of multiple position location techniques for locating an object. As shown in FIG. 68, operation begins with evaluating the physical environment (Step 680). The first position location sub-system captures the first position location information regarding the object using a first position location technique (Step 682). Then, the second position location sub-system captures the second position location information regarding the object using the second position location technique (Step 684). The processing circuitry then calibrates the first position location system using the second position location information to produce calibration settings (Step 686). From Step 686, operation ends. Note that the operations of FIG. 68 may be employed at startup, periodically, or when a lack of acceptable calibration is detected by the position location system.

[0273] FIG. 69 is a flow chart illustrating usage of multiple position location techniques for determining position and motion of an object. The operations of FIG. 69 commence with position location systems evaluating the physical environment within which the position location system operates (Step 690). The first position location sub-system then captures the first position location information regarding the object using the first position location technique (Step 692). Operation proceeds to capturing second position location information regarding the object by the second position location sub-system using a second position location technique (Step 694). After the first and second position location is captured, the processing circuitry determines the position of the object using the first position location information (Step 696). Then, the processing circuitry determines a motion of the object using the second position location information (Step 698).

[0274] One particular alternate embodiment of the operations of FIG. 69 includes using one position location technique that is very good at determining the position of the object but not as good at determining motion. One example of such operation is using an acoustic wave detection technique to locate at an object within a gaming environment but to use multiple access accelerometers to determine motion of the object. Likewise, an RF signal detection technique could be used to locate the object while using the multiple access accelerometer to detect motion of the object. In such case, a very high quality capture of both position and motion would result.

[0275] FIG. 70 is a flow chart illustrating operation for using multiple position location techniques to determine position and orientation of an object. The operations of FIG. 70 commence with the position location system evaluating the physical environment (Step 700). Then, the first position location sub-system captures first position location information regarding the object using the first position location technique (Step 702). The second position location sub-sys-
tem then captures second position location information regarding the object using a second position location technique (Step 704). The processing circuitry then determines the position of a first reference point of the object using the first position location information (Step 706).

[0276] The processing circuitry next determines the position of a second reference point of the object using the second position location information (Step 708). Then, the processing circuitry determines a position of the object using the first and/or second position location information (Step 706). Finally, the position location system determines an orientation of the object using the first and/or second position location information (Step 708).

[0277] As was previously shown with reference to FIG. 4, the gaming object 14 may include multiple reference points and the player 16 may wear a plurality of sensing tags 44. Using the position location system illustrated in FIGS. 65 and/or 66, the various reference points, e.g., sensing tags 44 worn by player 16 and/or multiple reference points of gaming object 14 may be separately tracked using two different position location techniques. In such case, one reference point, e.g., a sensing tag 44 located on an arm or head of the player 16 may be used to locate the player while information captured regarding differing sensing tags 44 of the player 16 may be used to determine an orientation of the player within the gaming environment. Likewise, when the gaming object 14 includes multiple reference points, e.g., multiple sensing tags 44, the first position location technique may be used to determine a position of one of the sensing tags 44 and the second position location technique may be used to determine location of a second sensing tag on the gaming object 14. In combination, using the two position location techniques, both the position and orientation of gaming object 14 may be determined.

[0278] FIG. 71 is a flow chart illustrating operation for using multiple position location techniques to determine positions of multiple objects. The operation of FIG. 71 commences with the position location system evaluating a physical environment in which the position location system is deployed (Step 710). Operation continues with the first position location sub-system capturing first position location information regarding a first object using a first position location technique (Step 712). Operation continues with the second position location sub-system capturing second position location information regarding a second object using a second position location technique (Step 714). The processing circuitry of the position location system then processes the first position location information to determine a position of the first object within a coordinate system (Step 716). The coordinate system would have been established at Step 710 and may be included with a video game function as has been previously described in great detail with reference to the present invention.

[0279] Operation continues with the processing circuitry processing the second position location information to determine a position of a second object within the coordinate system (Step 718). A system in which multiple gaming object positions are tracked was previously described herein with reference to FIG. 66. Operation continues in FIG. 71 with the processing circuitry integrating the positions of the first and second objects within the coordinate system into a video game function (Step 719). The video game function operations will be employed when the position location sub-system operates in conjunction with the video game function. When the position location system is not used in conjunction with the video game function, Step 719 would not occur.

[0280] FIG. 72 is a flow chart illustrating operation for using multiple position location techniques to determine position and motion of multiple objects. The operation of FIG. 72 commences with the position location system evaluating the physical environment (Step 720). In evaluating the physical environment at Step 720, the position location system may establish coordinate system within a physical environment. Then, operation continues with the first position location sub-system capturing first position location information regarding a first object using a first position location technique (Step 722). Operation continues with the second position location sub-system capturing second position location information regarding a second object using a second position location technique (Step 723). Then, the processing circuitry or gaming console processes the first position location information to determine a position of the first object within a coordinate system (Step 724).

[0281] Operation continues with the position location system processing second position location information to determine a position of the second object within the coordinate system (Step 725). The processing circuitry then determines motion of the first object using the first position location information (Step 726). Finally, the processing circuitry determines a motion of the second object using the second position location information (Step 727). With the operations of FIG. 72, the first position location sub-system operates solely upon the first object while the second position location sub-system operates solely upon the second object. In such case, the first position location sub-system may locate multiple reference points on the object (or the player) for subsequent processing. Further, the second position location sub-system may locate multiple reference points on the second object (or player) for subsequent processing.

[0282] FIG. 73 is a flow chart illustrating operation for using multiple position location techniques to determine position and motion of multiple objects. Referring now to FIG. 73, the position location sub-system evaluates the physical environment within which the position location sub-system is deployed (Step 730). The first position location sub-system then captures first position location information regarding the first object using a first position location technique (Step 732). The second position location sub-system then captures the second position location information regarding a second object using second position location technique (Step 733). The processing circuitry of the position location sub-system then processes the first position location information to determine a position of the first object within the coordinate system (Step 734). The processing circuitry next processes the second position location information to determine a position of the second object within the coordinate system (Step 735).

[0283] Operation continues with the processing circuitry determining a motion of the second object using the first position location information (Step 736). Finally, operation concludes with the processing circuitry determining a motion of the first object using the second position location information (Step 737). In contrast to the operations of FIG. 72, the operations of FIG. 73 use a cross position location technique on common objects. In such case, a first position location technique is used to locate an object while a second position location technique is used to detect motion of the object. In such case, even though only two position location sub-sys-
tems are included with the position location system, cross technique benefits are provided for multiple gaming objects tracking purposes.

[0284] As may be used herein, the terms “substantially” and “approximately” provides an industry-accepted tolerance for its corresponding term and/or relativity between items. Such an industry-accepted tolerance ranges from less than one percent to fifty percent and corresponds to, but is not limited to, component values, integrated circuit process variations, temperature variations, rise and fall times, and/or thermal noise. Such relativity between items ranges from a difference of a few percent to magnitude differences. As may also be used herein, the term(s) “coupled to” and/or “coupling” and/or includes direct coupling between items and/or indirect coupling between items via an intervening item (e.g., an item includes, but is not limited to, a component, an element, a circuit, and/or a module) where, for indirect coupling, the intervening item does not modify the information of a signal but may adjust its current level, voltage level, and/or power level. As may further be used herein, inferred coupling (i.e., where one element is coupled to another element by inference) includes direct and indirect coupling between two items in the same manner as “coupled to.” As may even further be used herein, the term “operable to” indicates that an item includes one or more of power connections, input(s), output(s), etc., to perform one or more of its corresponding functions and may further include inferred coupling to one or more other items. As may still further be used herein, the term “associated with,” includes direct and/or indirect coupling of separate items and/or one item being embedded within another item. As may be used herein, the term “comparably favorably” indicates that a comparison between two or more items, signals, etc., provides a desired relationship. For example, when the desired relationship is that signal 1 has a greater magnitude than signal 2, a favorable comparison may be achieved when the magnitude of signal 1 is greater than that of signal 2 or when the magnitude of signal 2 is less than that of signal 1.

[0285] The present invention has also been described above with the aid of method steps illustrating the performance of specified functions and relationships thereof. The boundaries and sequence of these functional building blocks and method steps have been arbitrarily defined herein for convenience of description. Alternate boundaries and sequences can be defined so long as the specified functions and relationships are appropriately performed. Any such alternate boundaries or sequences are thus within the scope and spirit of the claimed invention.

[0286] The present invention has been described above with the aid of functional building blocks illustrating the performance of certain significant functions. The boundaries of these functional building blocks have been arbitrarily defined for convenience of description. Alternate boundaries could be defined as long as the certain significant functions are appropriately performed. Similarly, flow diagram blocks may also have been arbitrarily defined herein to illustrate certain significant functionality. To the extent used, the flow diagram block boundaries and sequence could have been defined otherwise and still perform the certain significant functionality. Such alternate definitions of both functional building blocks and flow diagram blocks and sequences are thus within the scope and spirit of the claimed invention. One of average skill in the art will also recognize that the functional building blocks, and other illustrative blocks, modules and components herein, can be implemented as illustrated or by discrete components, application specific integrated circuits, processors executing appropriate software and the like or any combination thereof.

What is claimed is:

1. A position location system comprising:
   a first position location sub-system operable to determine first position location information regarding an object using a first position location technique;
   a second position location sub-system operable to determine second position location information regarding the object, the second position location sub-system using a second position location technique that differs from the first position location technique; and
   processing circuitry coupled to the first position location sub-system and to the second position location sub-system and operable to process the first position location information and the second position location information to determine position of the object within a coordinate system.

2. The position location system of claim 1, wherein:
   the first position location sub-system includes a plurality of receivers for orientation about a physical area; and
   the second position location sub-system includes a plurality of receivers for orientation about the physical area.

3. The position location system of claim 2, wherein the first position location sub-system includes at least one transmitter.

4. The position location system of claim 2, wherein the at least one transmitter and at least one receiver of the plurality of receivers of the first position location sub-system are substantially co-located.

5. The position location system of claim 1, wherein processing circuitry is operable to:
   process the first position location information as primary information to locate the object; and
   process the second position location information as secondary information to locate the object.

6. The position location system of claim 1, wherein the processing circuitry is operable to process the second position location information to calibrate the first position location information.

7. The position location system of claim 1, wherein the processing circuitry is operable to process the second position location information to augment the first position location information.

8. The position location system of claim 1, wherein the processing circuitry is operable to:
   process the first position location information to determine a position of at least one first reference point on the object; and
   process the second position location information to determine a position of at least one second reference point on the object.

9. The position location system of claim 8, wherein the processing circuitry is operable to determine a position and orientation of the object based upon the first position location information and the second position location information.

10. The position location system of claim 1, wherein the processing circuitry is operable to:
    process the first position location information to determine the position of the object within the coordinate system; and
    process the second position location information to determine motion of the object within the coordinate system.
11. The position location system of claim 1, wherein the first position location technique and the second position location technique are selected from the group consisting of:
   acoustic wave detection, wherein the object includes at least one sound energy source and the first position location sub-system includes a plurality of sound energy receivers;
   Radio Frequency (RF) signal detection, wherein the object includes at least one RF transmitter and the first position location sub-system includes a plurality of RF receivers;
   RF signal detection, wherein the object includes at least one RF receiver and the first position location sub-system includes a plurality of RF transmitters;
   RF signal detection, wherein the first position location sub-system includes at least one RF transmitter and a plurality of RF receivers;
   digital imaging, wherein the object includes a plurality of digital cameras;
   digital imaging, wherein the first position location sub-system includes a plurality of digital cameras;
   Infrared (IR) detection wherein the object includes an IR source and the first position location sub-system includes a plurality of IR receivers;
   IR detection, wherein the first position location sub-system includes at least one IR source and a plurality of IR receivers;
   laser distance measurement;
   thermal imaging; and
   multiple axis accelerometer sensing.

12. A method for locating an object within a physical area comprising:
capturing first position location information regarding the object using a first position location sub-system using a first position location technique;
capturing second position location information regarding the object using a second position location sub-system using a second position location technique that differs from the first position location technique; and
processing the first position location information and the second position location information to determine a position of the object within a coordinate system.

13. The method of claim 12, further comprising:
processing the first position location information as primary information to locate the object; and
processing the second position location information as secondary information to locate the object.

14. The method of claim 12, further comprising processing the second position location information to calibrate the first position location information.

15. The method of claim 12, further comprising processing the second position location information to augment the first position location information.

16. The method of claim 12, further comprising:
processing the first position location information to determine a location of at least one first reference point on the object; and
processing the second position location information to determine a location of at least one second reference point on the object.

17. The method of claim 16, further comprising determining a position and orientation of the object based upon the first position location information and the second position location information.

18. The method of claim 12, further comprising:
   processing the first position location information to determine the position of the object within the coordinate system; and
   processing the second position location information to determine motion of the object within the coordinate system.

19. The method of claim 12, wherein the first position location technique and the second position location technique are selected from the group consisting of:
   acoustic wave detection, wherein the object includes at least one sound energy source and the first position location sub-system includes a plurality of sound energy receivers;
   Radio Frequency (RF) signal detection, wherein the object includes at least one RF transmitter and the first position location sub-system includes a plurality of RF receivers;
   RF signal detection, wherein the object includes at least one RF receiver and the first position location sub-system includes a plurality of RF transmitters;
   RF signal detection, wherein the first position location sub-system includes at least one RF transmitter and a plurality of RF receivers;
   digital imaging, wherein the object includes a plurality of digital cameras;
   digital imaging, wherein the first position location sub-system includes a plurality of digital cameras;
   Infrared (IR) detection wherein the object includes an IR source and the first position location sub-system includes a plurality of IR receivers;
   IR detection, wherein the first position location sub-system includes at least one IR source and a plurality of IR receivers;
   laser distance measurement;
   thermal imaging; and
   multiple axis accelerometer sensing.

20. A video gaming system comprising:
a first position location sub-system to determine first position location information regarding a gaming object using a first position location technique;
a second position location sub-system to determine second position location information regarding the gaming object, the second position location sub-system using a second position location technique that differs from the first position location technique; and
   a gaming console coupled to the first position location sub-system and to the second position location sub-system and operable to:
   process the first position location information and the second position location information to determine a position of the object within a coordinate system; and
   integrate the position of the object within the coordinate system within a video game function.

21. The video gaming system of claim 20, wherein the coordinate system comprises at least one of:
a three-dimensional Cartesian coordinate system; and
a spherical coordinate system.

22. The video gaming system of claim 20, wherein the gaming console is further operable to process the first position location information and the second position location information to determine motion of the object within the coordinate system.
23. The video gaming system of claim 20, wherein:
the first position location sub-system includes a plurality of
receivers for orientation about a physical area;
the second position location sub-system includes a plurality
of receivers for orientation about the physical area.
24. The video gaming system of claim 20, wherein the
gaming console is operable to:
process the first position location information as primary
information to locate the object; and
process the second position location information as sec-
ondary information to locate the object.
25. The video gaming system of claim 20, wherein the
gaming console is operable to process the second position
location information to calibrate the first position location
information.
26. The video gaming system of claim 20, wherein the
gaming console is operable to:
process the first position location information to determine
the position of the object within the coordinate system; and
process the second position location information to deter-
mine motion of the object within the coordinate system.
27. The video gaming system of claim 20, wherein the first
position location technique and the second position location
technique are selected from the group consisting of:
acoustic wave detection, wherein the object includes at
least one sound energy source and the first position
location sub-system includes a plurality of sound energy
receivers;
Radio Frequency (RF) signal detection, wherein the object
includes at least one RF transmitter and the first position
location sub-system includes a plurality of RF receivers;
RF signal detection, wherein the object includes at least
one RF receiver and the first position location sub-sys-
tem includes a plurality of RF transmitters;
RF signal detection, wherein the first position location
sub-system includes at least one RF transmitter and a
plurality of RF receivers;
digital imaging, wherein the object includes a plurality of
digital cameras;
digital imaging, wherein the first position location sub-
system includes a plurality of digital cameras;
Infrared (IR) detection wherein the object includes an IR
source and the first position location sub-system includes a plurality of IR receivers;
IR detection, wherein the first position location sub-system
includes at least one IR source and a plurality of IR
receivers;
laser distance measurement;
thermal imaging; and
multiple axis accelerometer sensing.

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