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(54) **RFID BASED POSITIONING SYSTEM**

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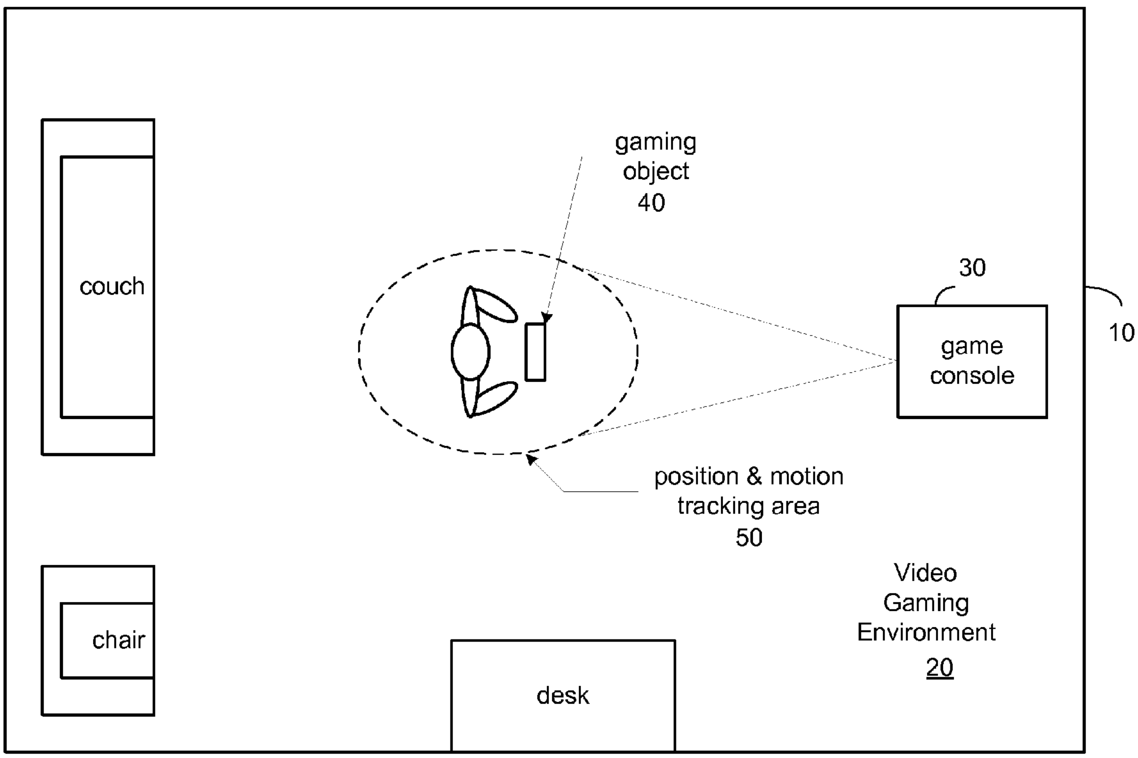
(52) **U.S. Cl.** **463/39**

(57) **ABSTRACT**

The position of a mobile gaming object within a video gaming environment is determined using radio frequency identification (RFID) signals transmitted between RFID devices, at least one of which is positioned on a gaming element. Based on signal information regarding the RFID signals, the distances between the gaming element and various RFID devices can be determined. The position of the gaming element within the video gaming environment is then determined based on the distances.



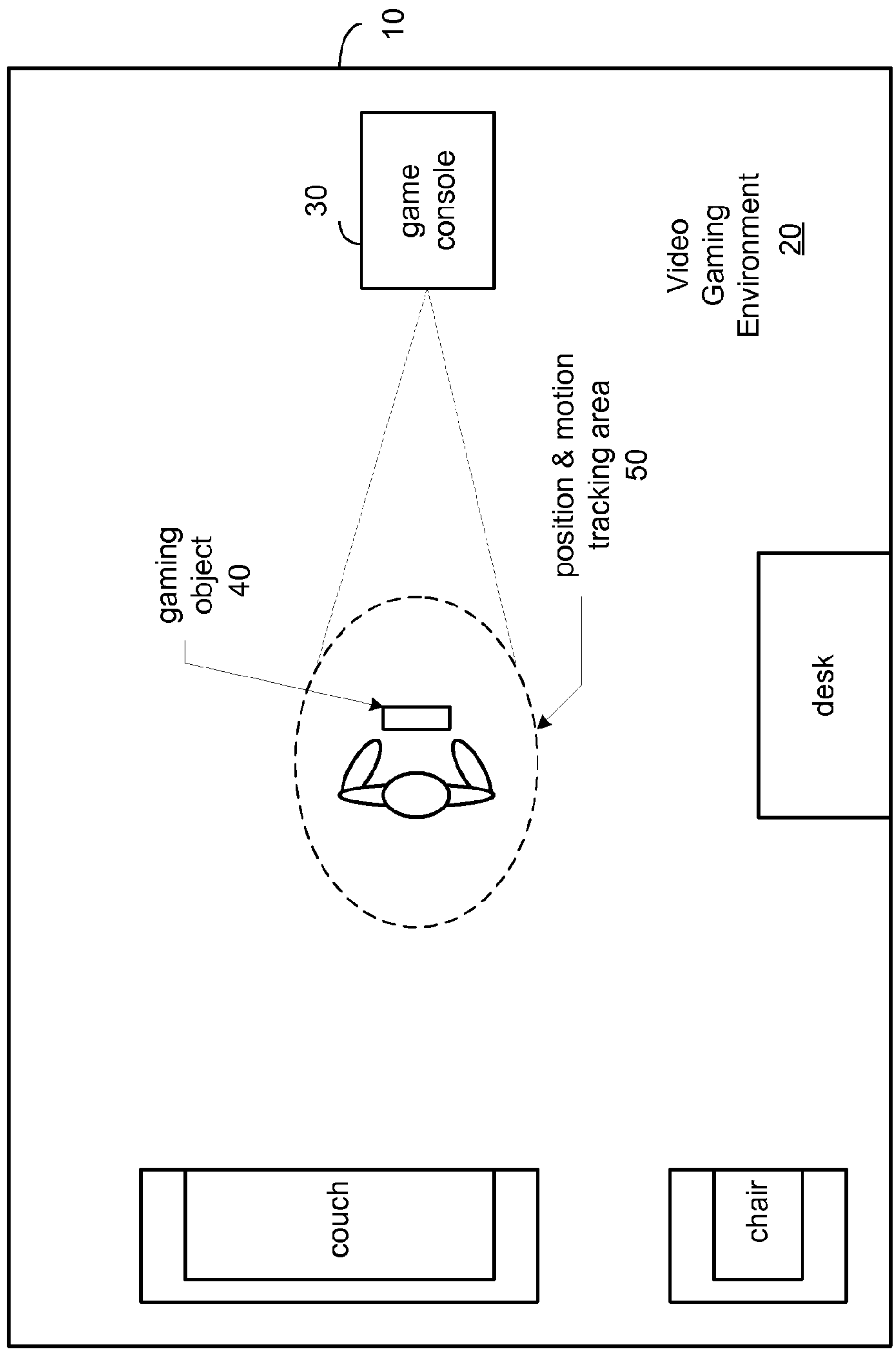

10
game console
30
Video Gaming Environment
20
position & motion tracking area
50
gaming object
40
desk
couch
chair

FIG. 1

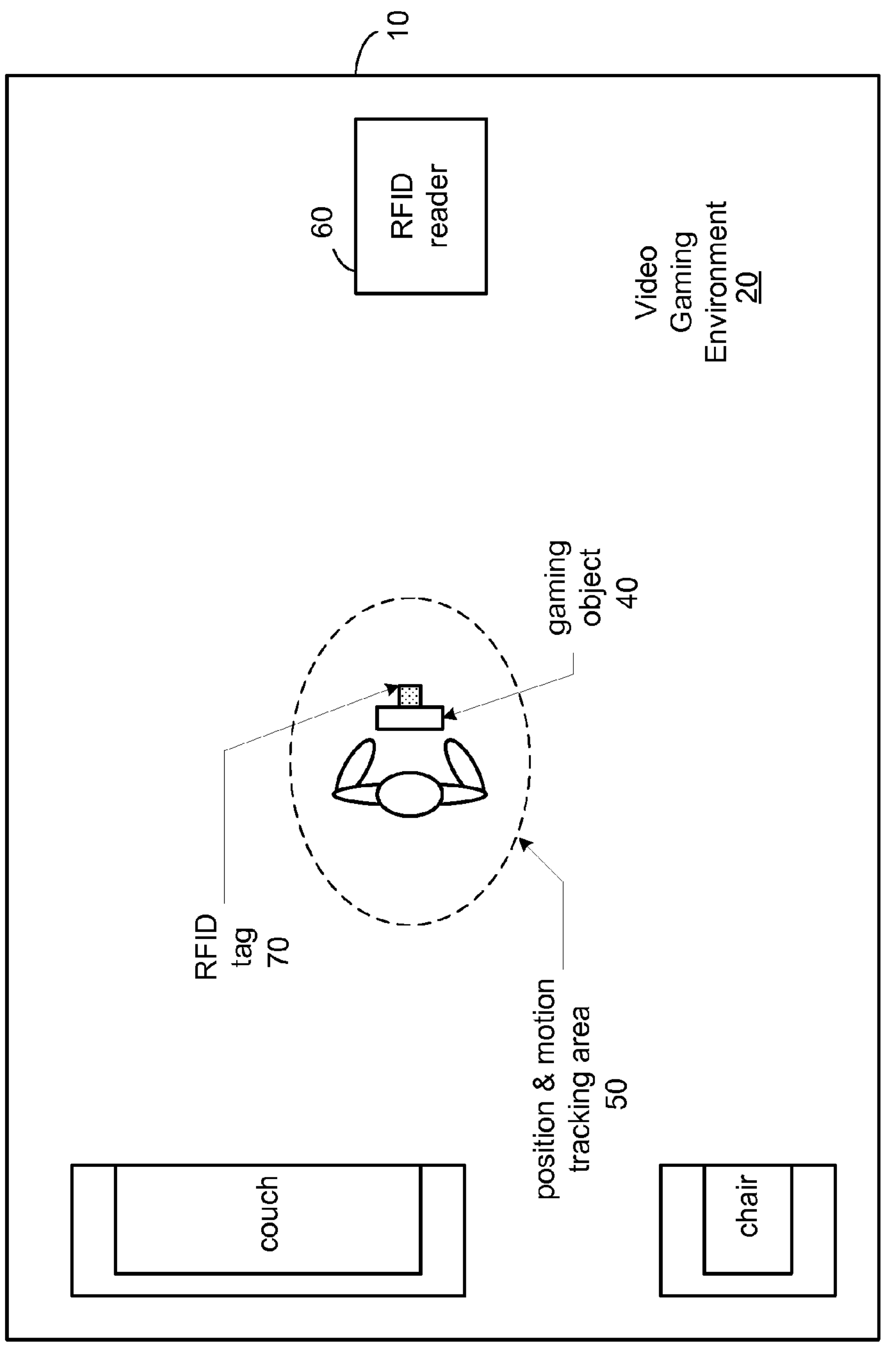

10
60
RFID reader
Video Gaming Environment 20
gaming object 40
RFID tag 70
position & motion tracking area 50
couch
chair

FIG. 2

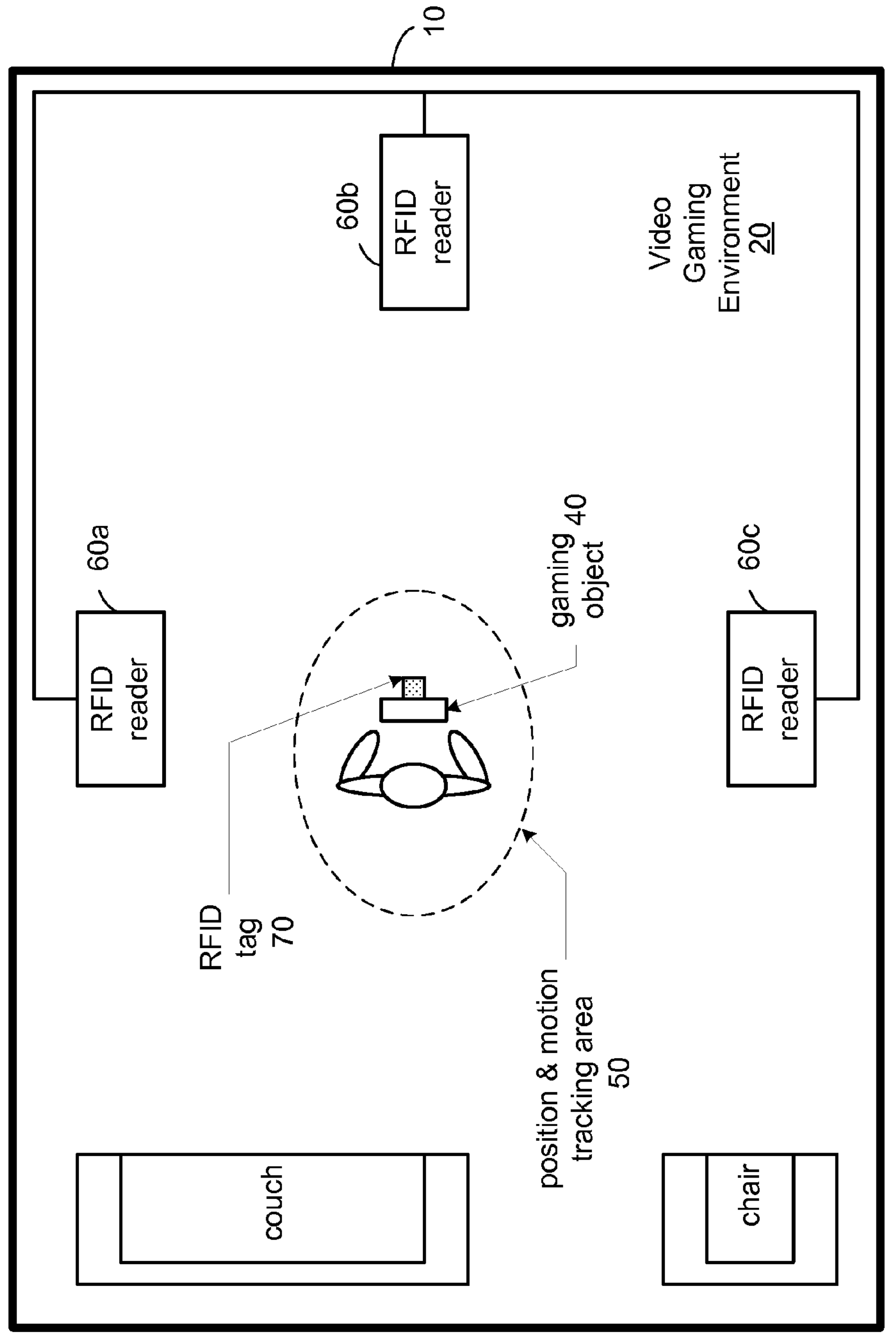

10
RFID reader
60a
RFID reader
60b
RFID reader
60c
Video Gaming Environment 20
gaming object 40
RFID tag 70
position & motion tracking area 50
couch
chair

FIG. 3A

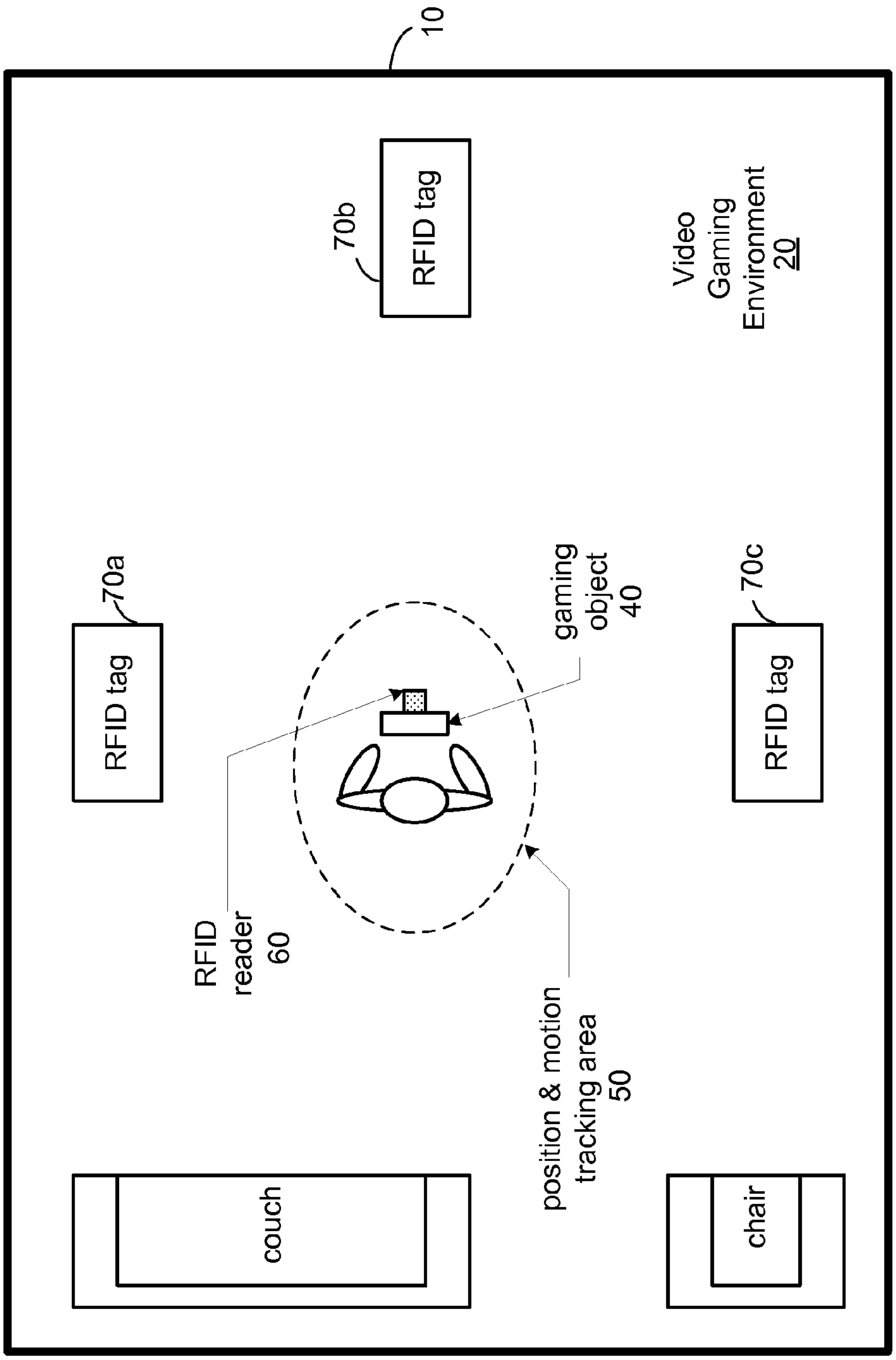

10
RFID tag
70b
Video
Gaming
Environment
20
RFID tag
70a
gaming
object
40
70c
RFID tag
RFID
reader
60
position & motion
tracking area
50
couch
chair

FIG. 3B

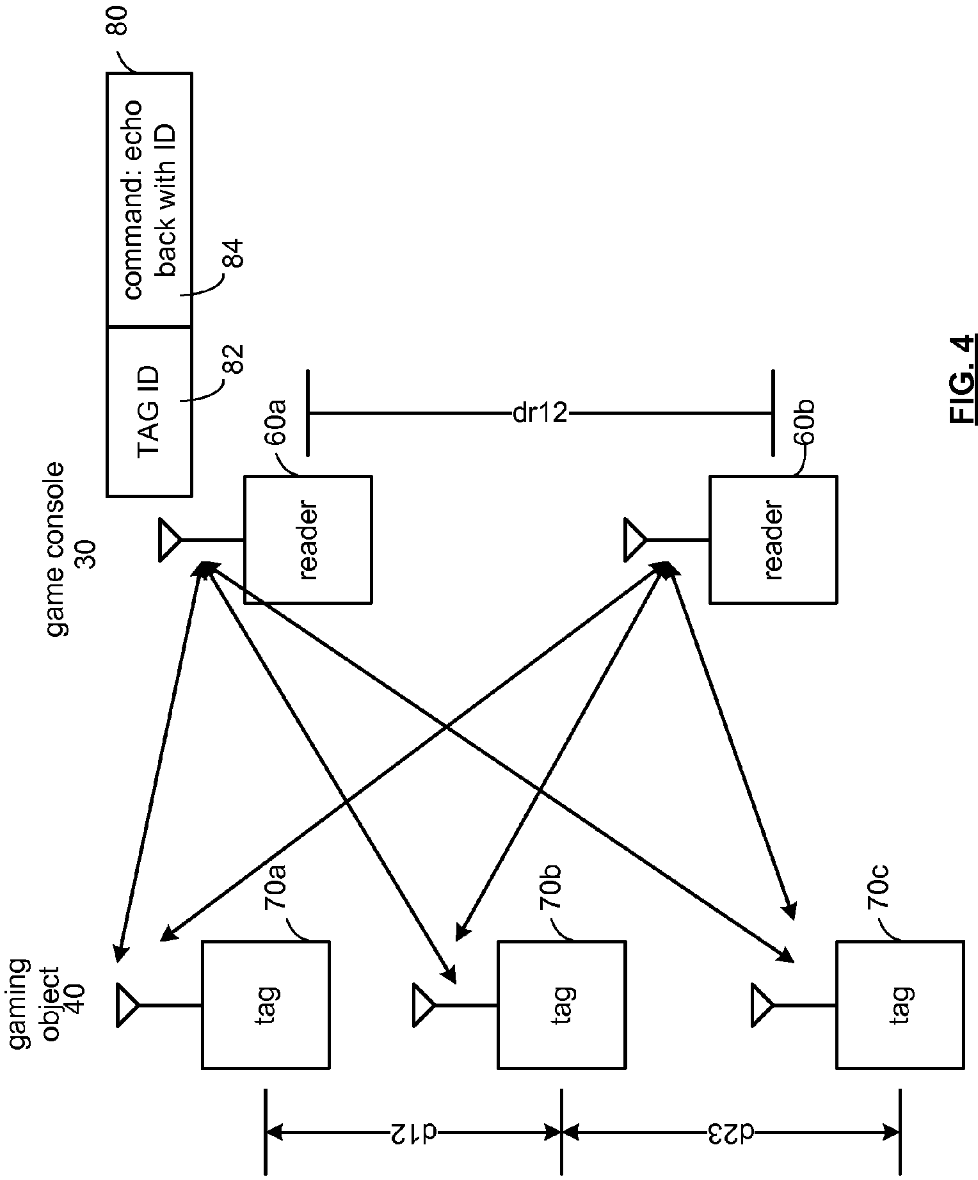

80
TAG ID
82
command: echo back with ID
84
game console 30
60a
reader
dr12
60b
reader
gaming object 40
70a
tag
70b
tag
70c
tag
d12
d23

FIG. 4

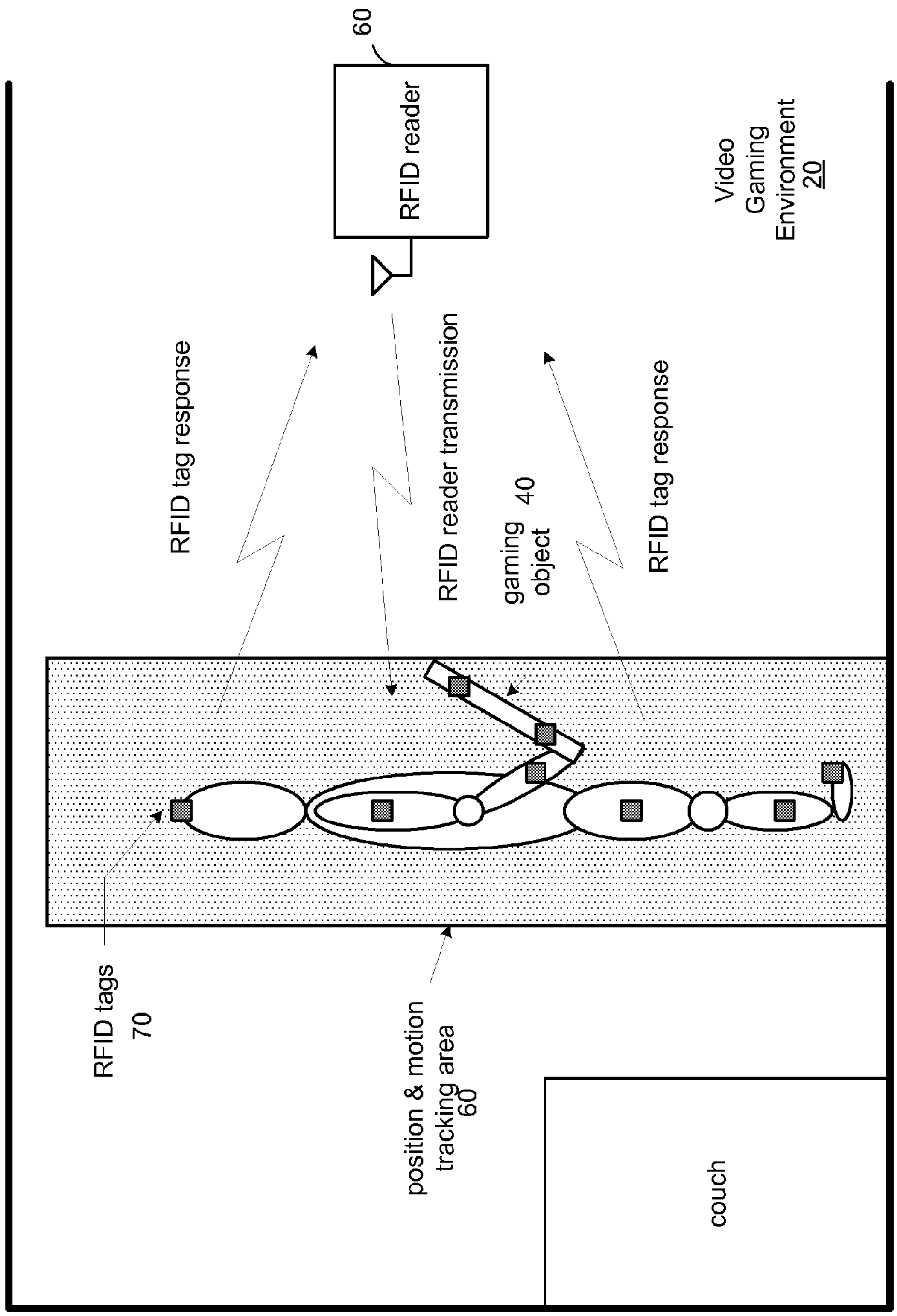

60
RFID reader
Video Gaming Environment 20
RFID tag response
RFID reader transmission
gaming object 40
RFID tag response
RFID tags 70
position & motion tracking area 60
couch

FIG. 5

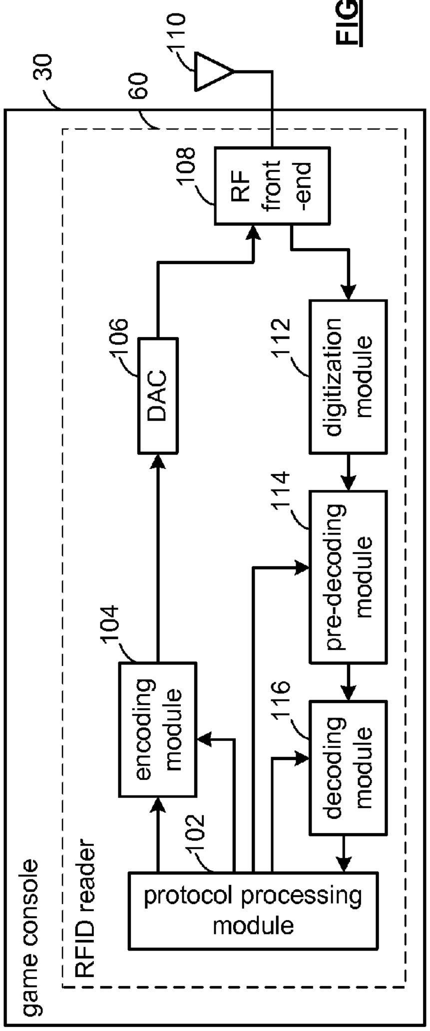

game console
RFID reader
30
60
110
108
RF front -end
106
DAC
104
encoding module
102
protocol processing module
112
digitization module
114
pre-decoding module
116
decoding module

FIG. 6A

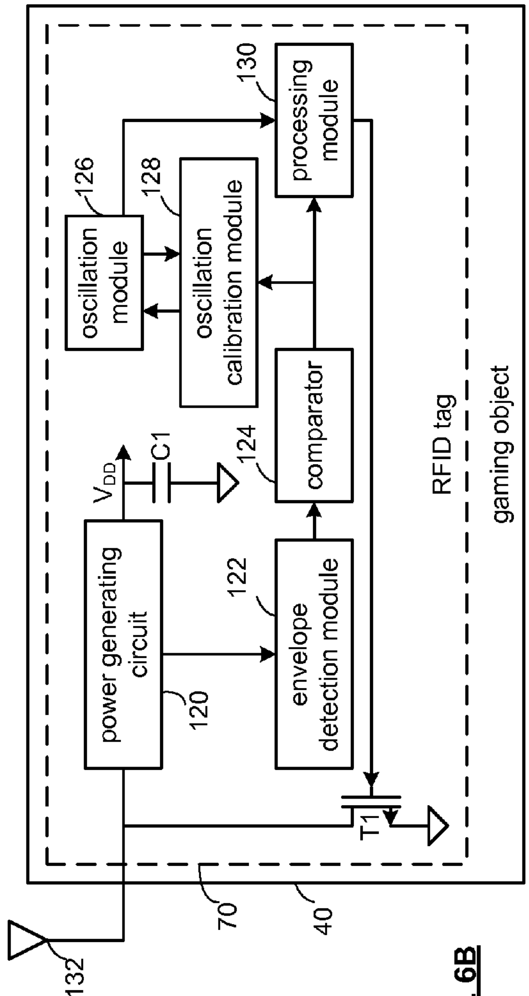

130
processing module
126
oscillation module
128
oscillation calibration module
V_{DD}
C1
124
comparator
122
envelope detection module
power generating circuit
120
T1
RFID tag
gaming object
70
40
132

FIG. 6B

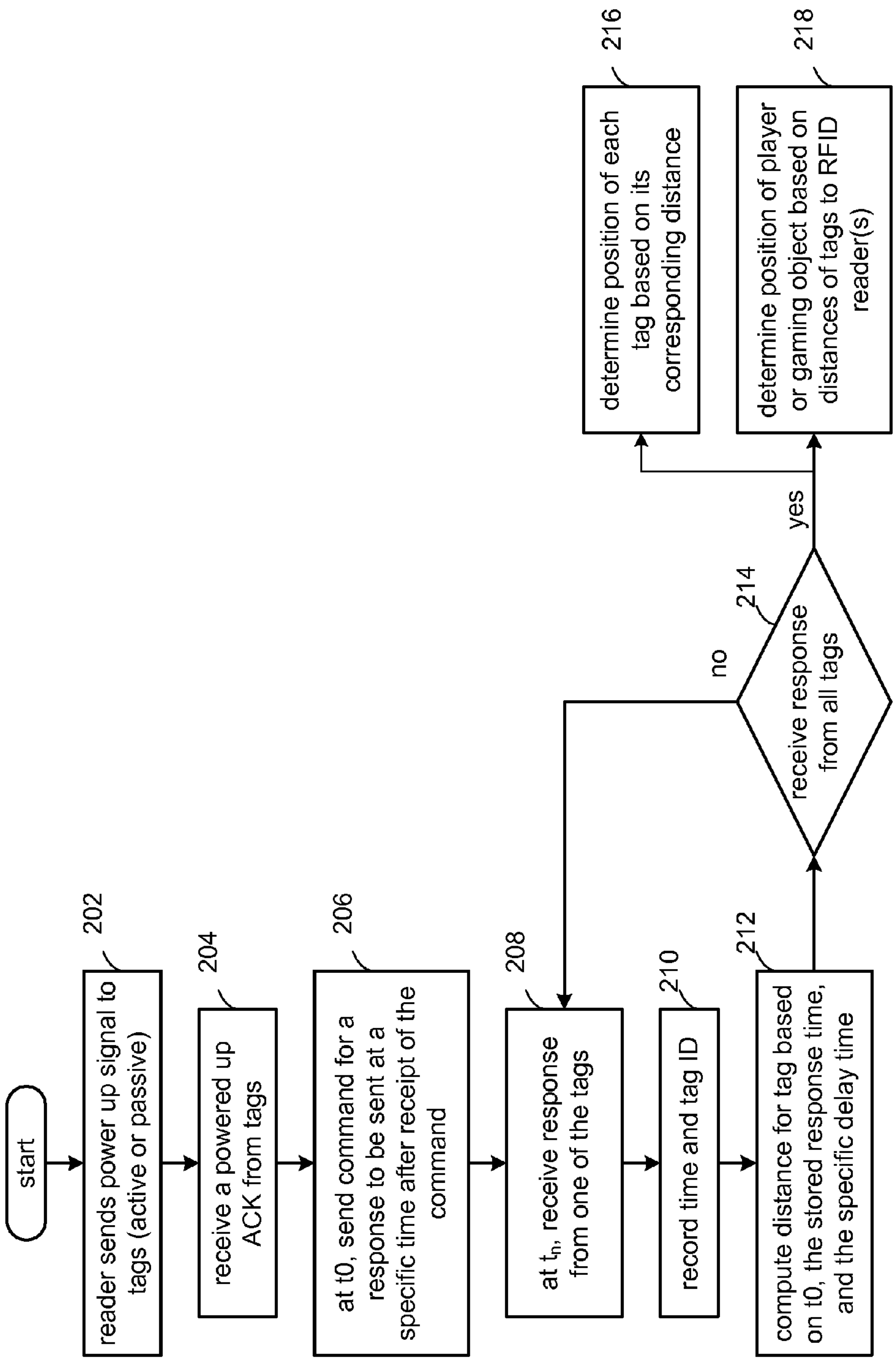

start
202
reader sends power up signal to tags (active or passive)
204
receive a powered up ACK from tags
206
at t0, send command for a response to be sent at a specific time after receipt of the command
208
at t_n, receive response from one of the tags
210
record time and tag ID
212
compute distance for tag based on t0, the stored response time, and the specific delay time
214
receive response from all tags
no
yes
216
determine position of each tag based on its corresponding distance
218
determine position of player or gaming object based on distances of tags to RFID reader(s)

FIG. 7

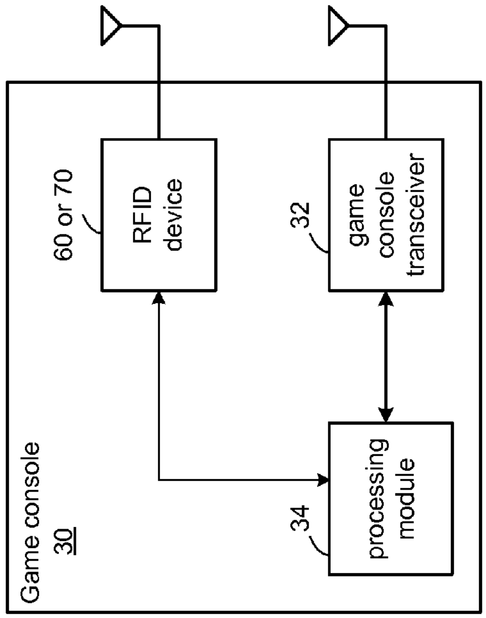

Game console
30
60 or 70
RFID device
32
game console transceiver
34
processing module

FIG. 9

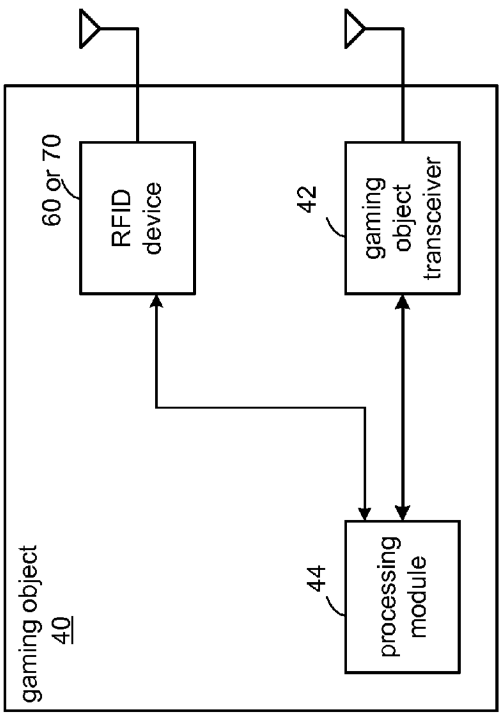
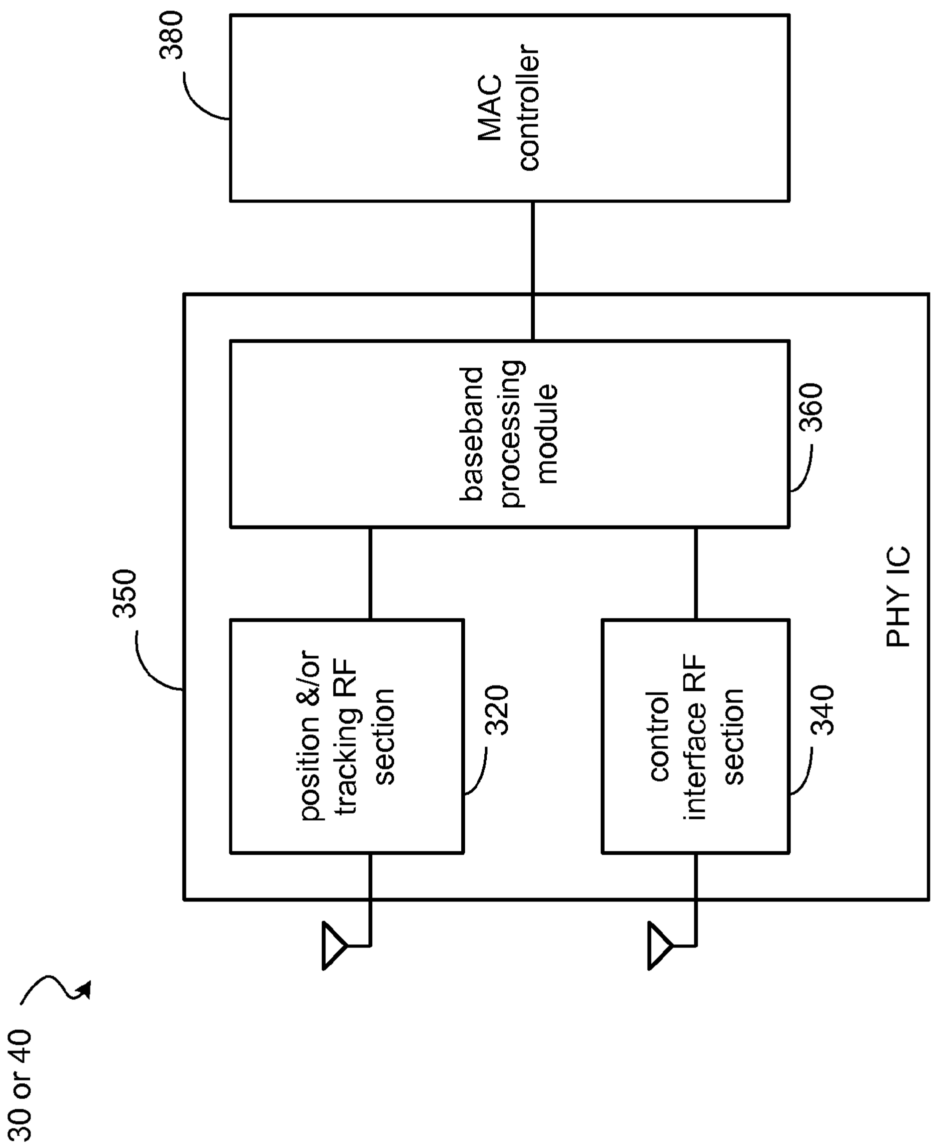

gaming object
40
60 or 70
RFID device
42
gaming object transceiver
44
processing module

FIG. 8



380
MAC controller
350
baseband processing module
360
position &/or tracking RF section
320
control interface RF section
340
PHY IC
30 or 40

FIG. 10

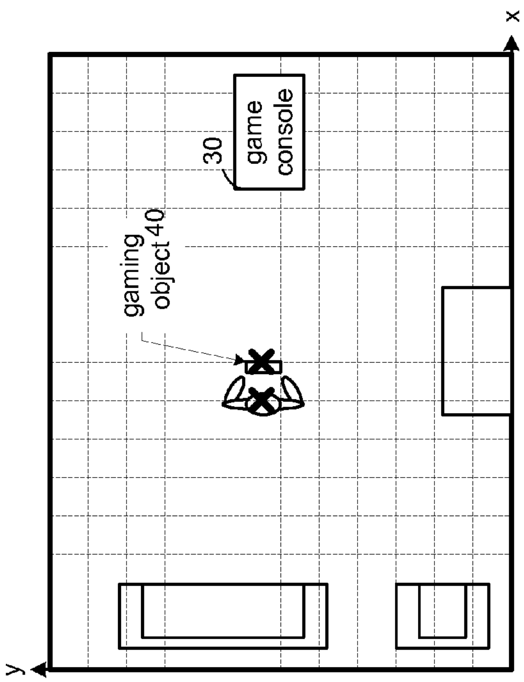


FIG. 12

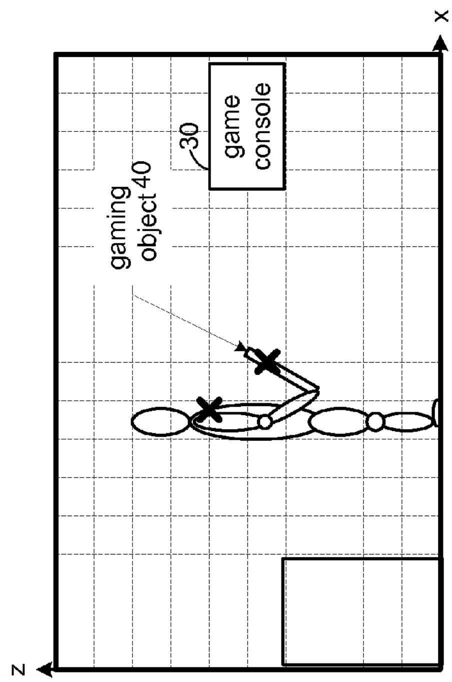


FIG. 13

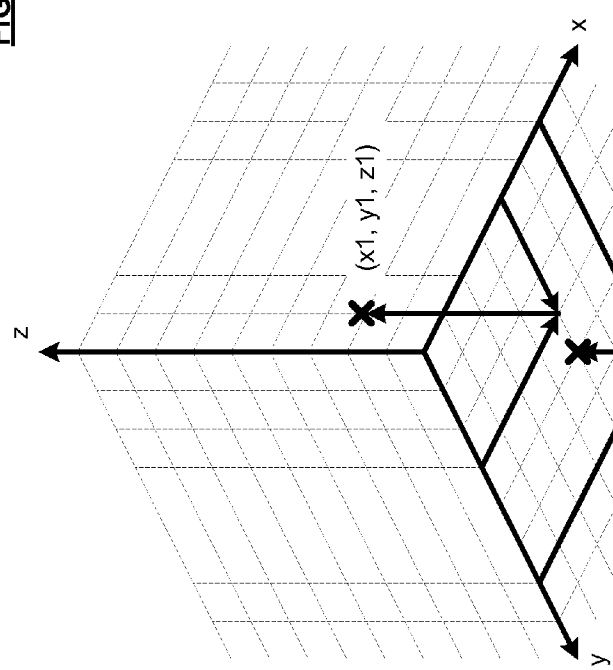


FIG. 11

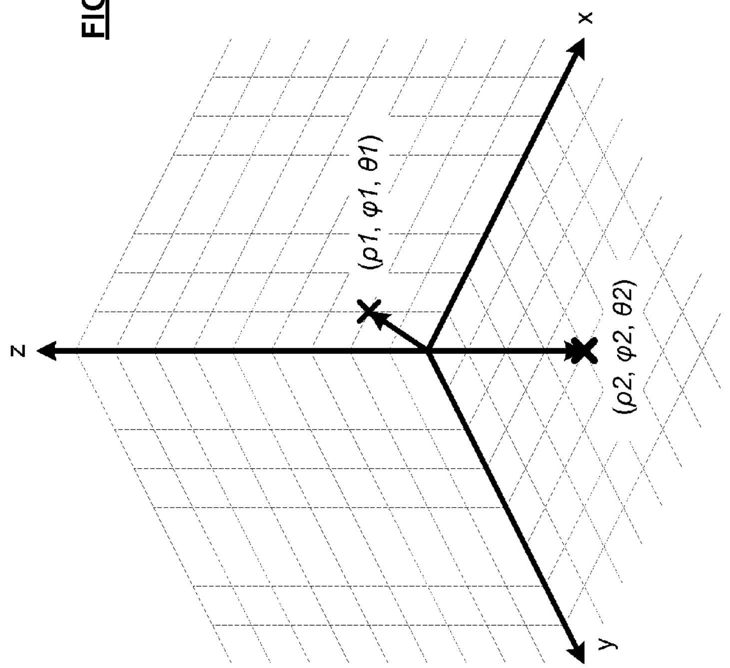


FIG. 14

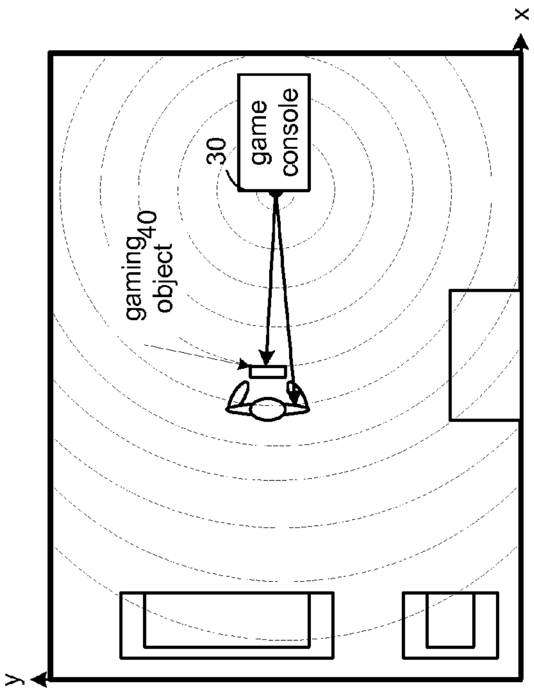


FIG. 15

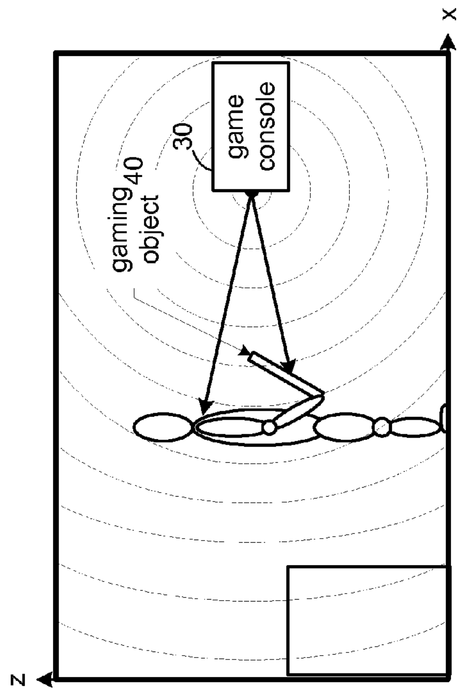


FIG. 16

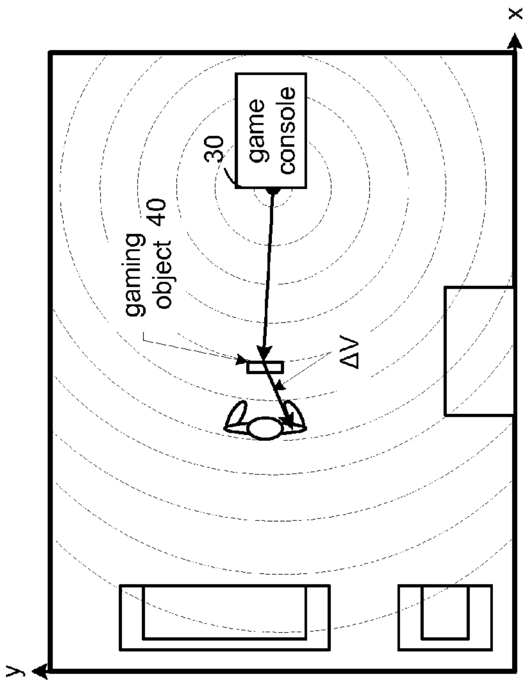


FIG. 18

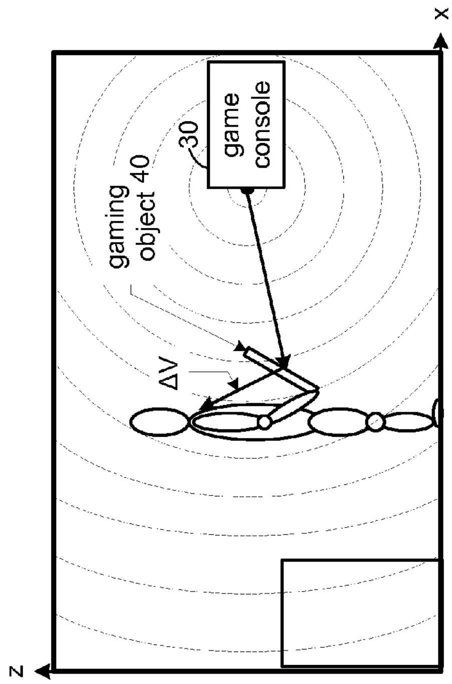


FIG. 19

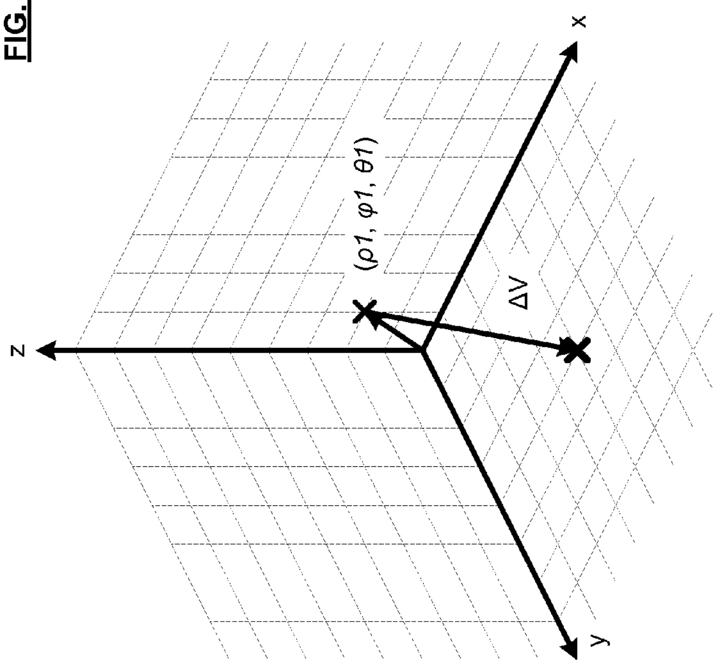


FIG. 17

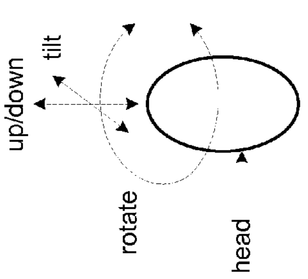


FIG. 20

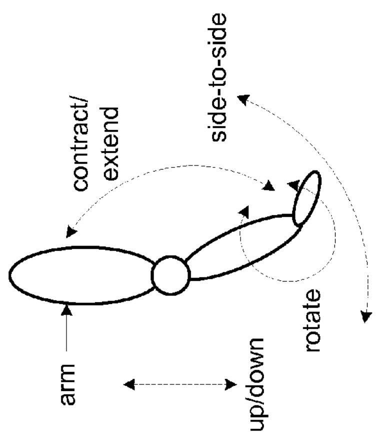


FIG. 21

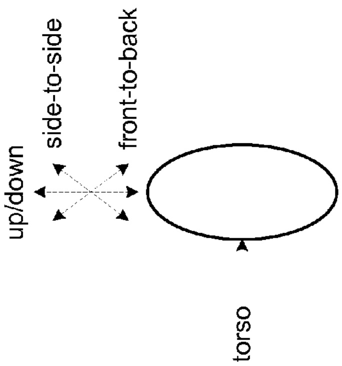


FIG. 22

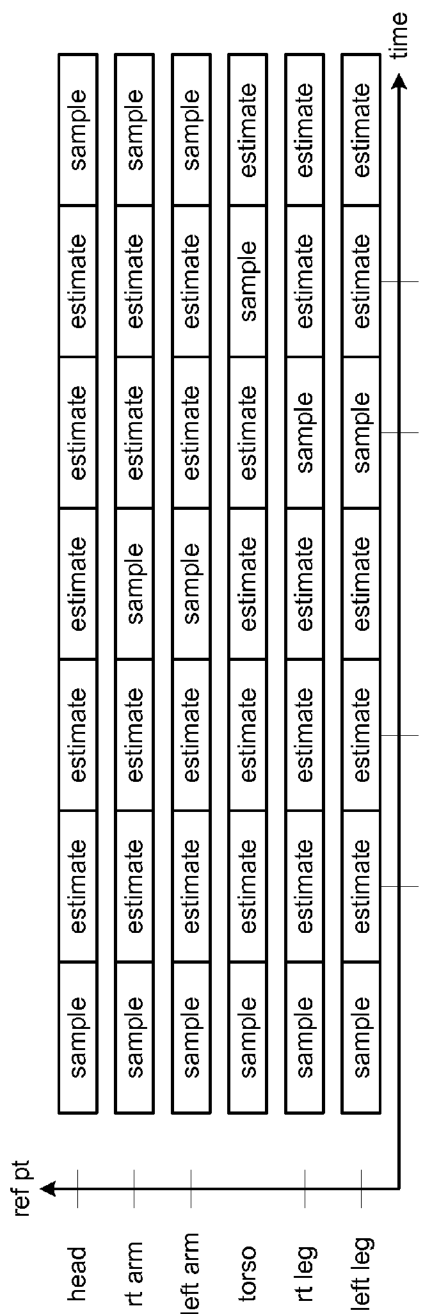


FIG. 23

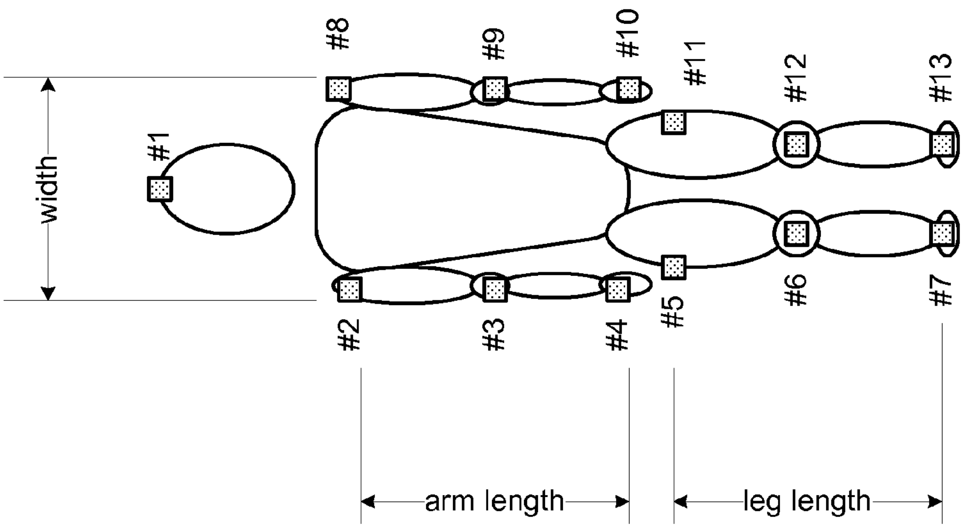

width
#1
#2
#3
#4
#5
#6
#7
#8
#9
#10
#11
#12
#13
arm length
leg length

FIG. 25

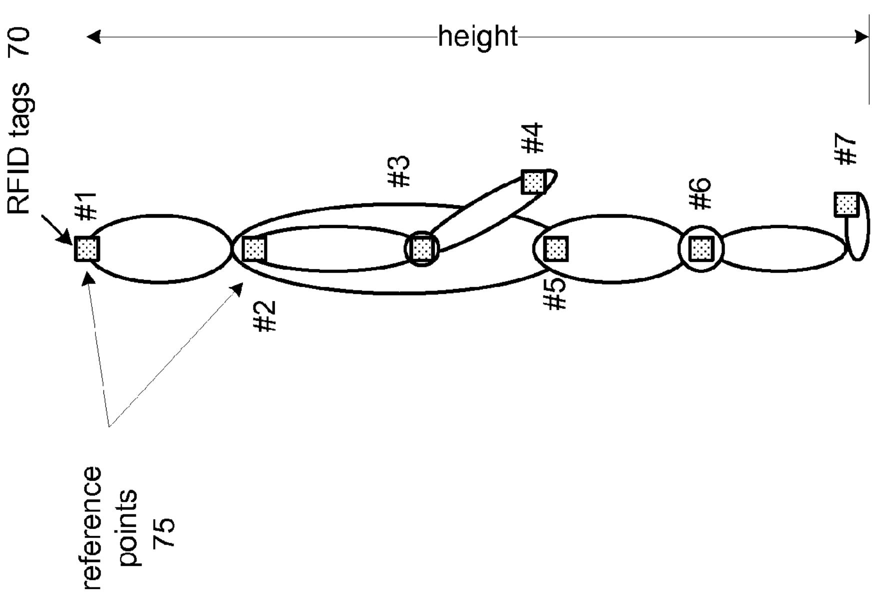

RFID tags 70
reference points 75
height
#1
#2
#3
#4
#5
#6
#7

FIG. 24

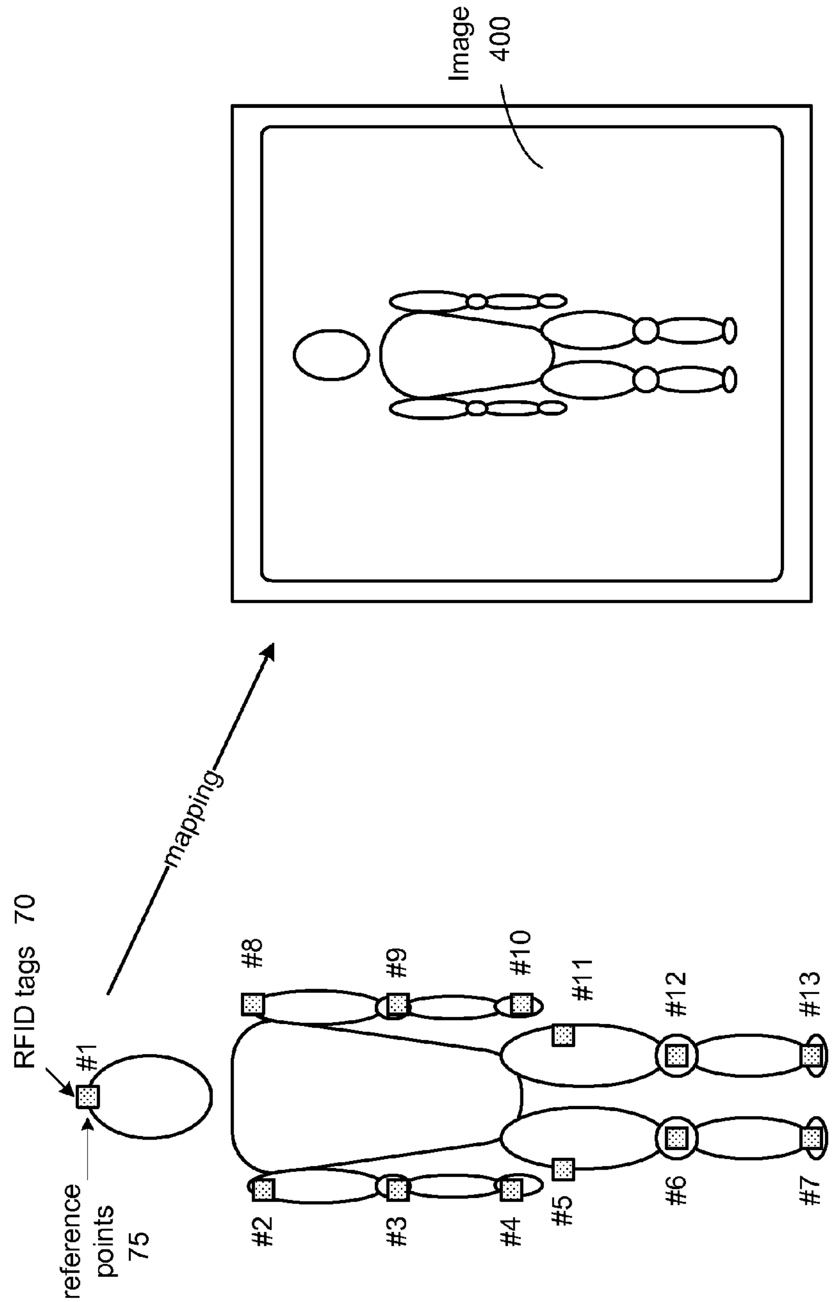


Image
400
mapping
RFID tags 70
reference
points
75
#1
#2
#3
#4
#5
#6
#7
#8
#9
#10
#11
#12
#13

FIG. 26

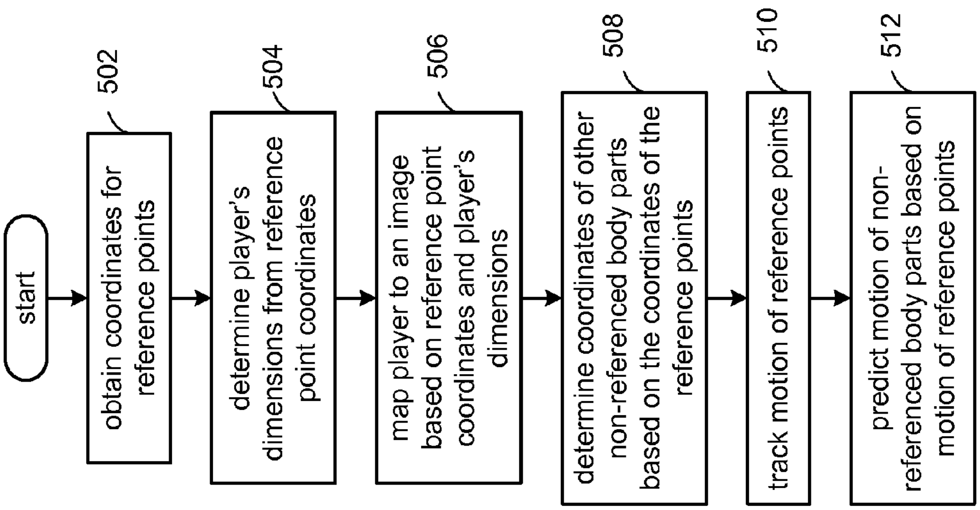

start
obtain coordinates for reference points
502
determine player's dimensions from reference point coordinates
504
map player to an image based on reference point coordinates and player's dimensions
506
determine coordinates of other non-referenced body parts based on the coordinates of the reference points
508
track motion of reference points
510
predict motion of non-referenced body parts based on motion of reference points
512

FIG. 27

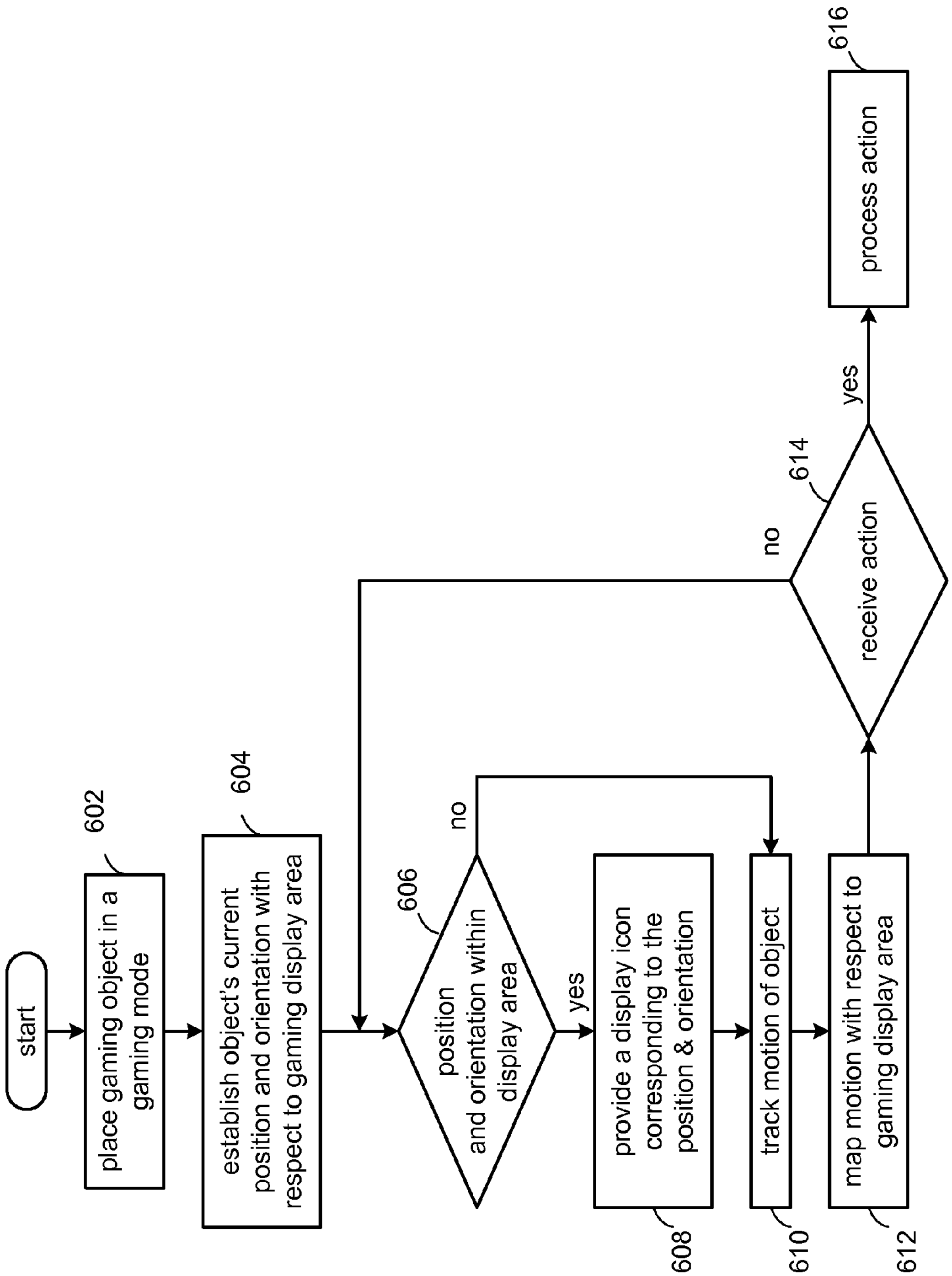

start
place gaming object in a gaming mode
602
establish object's current position and orientation with respect to gaming display area
604
position and orientation within display area
606
yes
no
provide a display icon corresponding to the position & orientation
608
track motion of object
610
map motion with respect to gaming display area
612
receive action
614
no
yes
process action
616

FIG. 28

RFID BASED POSITIONING SYSTEM

CROSS REFERENCE TO RELATED PATENTS

[0001] This patent application is claiming 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. 22, 2007, and a provisional Ser. No. 60/936,724.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] NOT APPLICABLE

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

[0003] NOT APPLICABLE

BACKGROUND OF THE INVENTION

[0004] 1. Technical Field of the Invention

[0005] This invention relates generally to wireless systems and more particularly to determining position within a wireless system and/or tracking motion within the wireless system.

[0006] 2. Description of Related Art

[0007] 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).

[0008] IR communications are commonly used 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 to detect 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.

[0009] 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.

[0010] 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.

[0011] Therefore, a need exists for motion tracking and positioning determination for video gaming and other applications that overcome the above limitations.

BRIEF SUMMARY OF THE INVENTION

[0012] 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)

[0013] FIG. **1** is a schematic block diagram of an overhead view of an embodiment of a gaming system in accordance with the present invention;

[0014] FIG. **2** is a schematic block diagram of an overhead view of another embodiment of a gaming system in accordance with the present invention;

[0015] FIG. **3**A is a schematic block diagram of an overhead view of another embodiment of a gaming system in accordance with the present invention;

[0016] FIG. **3**B is a schematic block diagram of an overhead view of another embodiment of a gaming system in accordance with the present invention;

[0017] FIG. **4** is a schematic block diagram of another embodiment of a gaming system in accordance with the present invention;

[0018] FIG. **5** is a schematic block diagram of a side view of another embodiment of a gaming system in accordance with the present invention;

[0019] FIGS. **6**A and **6**B are schematic block diagrams of an embodiment of an RFID reader and an RFID tag in accordance with the present invention;

[0020] FIG. **7** is a diagram of a method for determining position and/or motion tracking in accordance with the present invention;

[0021] FIG. **8** is a schematic block diagram of an embodiment of a gaming object in accordance with the present invention;

[0022] FIG. **9** is a schematic block diagram of an embodiment of a game console in accordance with the present invention;

[0023] FIG. **10** is a schematic block diagram of an embodiment of a gaming object and/or game console in accordance with the present invention;

[0024] FIGS. **11-13** are diagrams of an embodiment of a coordinate system of a gaming system in accordance with the present invention;

[0025] FIGS. **14-16** are diagrams of another embodiment of a coordinate system of a gaming system in accordance with the present invention;

[0026] FIGS. **17-19** are diagrams of yet another embodiment of a coordinate system of a gaming system in accordance with the present invention; and

[0027] FIGS. **10-22** are diagrams of examples of motion patterns in accordance with the present invention;

[0028] FIG. **23** is a diagram of an example of motion estimation in accordance with the present invention;

[0029] FIGS. **24-25** are diagrams of examples of reference points on a player to determine player's physical measurements in accordance with the present invention;

[0030] FIG. **26** is a diagram of an example of mapping a player to an image in accordance with the present invention;

[0031] FIG. **27** is a diagram of an method for determining motion in accordance with the present invention; and

[0032] FIG. **28** is a diagram of a method for processing a position and/or motion based gaming action in accordance with the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0033] FIG. **1** is a schematic block diagram of an overhead view of an embodiment of a gaming system **10** that includes a game console device **30** and a mobile gaming object **40**. The gaming system has an associated video gaming environment **20** corresponding to a physical area in which the game console device **30** and the mobile gaming object **40** are located. The physical area may be a room, portion of a room, and/or any other space where the mobile gaming object **40** and game console device **30** are proximally co-located (e.g., airport terminal, on a bus, on an airplane, etc.).

[0034] The mobile gaming object **40** 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 mobile gaming object **40** may be a simulated sword, a simulated gun, a helmet, a vest, a hat, shoes, socks, pants, shorts, gloves, etc. The mobile gaming object **40** is able to move within a position and motion tracking area **50** of the gaming environment **20**. For example, motion of the mobile gaming object **40** may be achieved through user manipulation of the mobile gaming object **40** within the gaming environment **20**.

[0035] The game console device **30** operates to determine the position of the mobile gaming object **40** within the gaming environment **20** using one or more positioning techniques, as subsequently discussed. Once the mobile gaming object's **40** position is determined, the game console device **30** tracks the motion of the mobile gaming object **40** to facilitate video game play. For example, the game console device **30** may determine the position of the mobile gaming object **40** 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 track the motion within a motion tracking tolerance (e.g., within a few millimeters) at a motion tracking update rate (e.g., once every 10-100 milliseconds).

[0036] In operation, the game console device **30** operates to determine the environment parameters of the gaming environment **20** corresponding to the physical area in which the gaming object **40** moves. 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. The game console device **30** then maps the environment parameters to a particular coordinate system. 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 a portion of the room. In addition, objects in the room (e.g., a couch, a chair, etc.) may be mapped to the coordinate system based on their physical location in the room.

[0037] Based on the mapped coordinate system, the game console device **30**, in conjunction with the mobile gaming object **40**, is able to determine the coordinates of the gaming object's **40** initial position in the gaming environment **20** using the one or more positioning techniques described below. It should be noted that the position of the mobile gaming object **40** may be used to determine the position of the player(s) if the mobile gaming object **40** is something worn by the player or is in close proximity to the player. In addition, the game console device **30**, in conjunction with the mobile gaming object **40**, is able to update the coordinates of the mobile gaming object's **40** position to track its motion.

[0038] FIG. **2** is a schematic block diagram of an overhead view of another embodiment of a gaming system **10** that includes the mobile gaming object **40**, an RFID reader **60** and at least one RFID tag **70** within the gaming environment **20**. The RFID tag **70** may be physically attached to the mobile gaming object **40** and/or worn or held by a player. In addition, the RFID tag **70** may be an active device that includes an internal power source or a passive device that derive powers from the RFID reader **60**. In one embodiment, the RFID reader **60** is included within the game console device of FIG. **1**. In another embodiment, the game console device may be separate from the RFID reader **60**, but electronically connected to the RFID reader **60** (e.g., direct connection, WLAN, WAN, telephone, DSL modem, cable modem, etc.).

[0039] In this system, the RFID reader **60** periodically (e.g., in the range of once every 1 millisecond to once every 10 seconds) communicates with the RFID tag **70** to determine distances between the RFID reader **60** and the player and/or gaming object within the gaming environment **20**. In one embodiment, the RFID reader **60** and RFID tag **70** communicate using a backscatter technique in which the RFID reader **60** transmits an RFID outbound radio frequency (RF) signal that is received by the RFID tag **70** and retransmitted (i.e., backscattered) by the RFID tag **70** towards the RFID reader **60** as an RFID inbound RF signal. For example, the RFID reader **60** can request data (e.g., a tag **70** identifier) from the RFID tag **70** via the RFID outbound RF signal, and the RFID tag **70** can respond with the requested data by modulating and backscattering the RFID outbound RF signal provided by the RFID reader **60**. Typically, the RFID tag **70** provides the requested data to the RFID reader **60** on the same RF carrier frequency as the RFID outbound RF signal. By noting the difference in time between the initial time that the RFID outbound RF signal is transmitted by the RFID reader **60** and the time that the backscattered RFID inbound RF signal is received by the RFID reader **60**, the distance between the RFID reader **60** and RFID tag **70** can be measured.

[0040] In an exemplary operation involving a passive RFID tag **70**, the RFID reader **60** first transmits an unmodulated, continuous wave (CW) RF signal to activate and provide power to the passive RFID tag **70**. After a period of time sufficient to power the RFID tag **70**, the RFID reader **60** generates and transmits an amplitude modulated RF interrogation signal to the RFID tag **70**, requesting data (e.g., a tag **70** identifier) from the RFID tag **70**. After the RF interrogation signal has been transmitted for a predetermined length of time, the RFID reader **60** begins transmitting the CW signal again to provide additional power to the tag **70** and to allow backscattering of the signal by the tag **70** with the requested data.

[0041] In another embodiment, the RFID reader **60** and RFID tag **70** communicate using frequency modulation. In this embodiment, the RFID reader **60** transmits a frequency modulated RFID outbound RF signal. Upon receiving the RFID outbound RF signal, the RFID tag **70** retransmits the frequency modulated RFID outbound RF signal as an RFID inbound RF signal that is received by the RFID reader **60**. By determining the phase shift of the envelope of the received frequency modulated RFID inbound RF signal, the distance between the RFID reader **60** and RFID tag **70** can be measured.

[0042] In yet another embodiment, the RFID reader **60** and RFID tag **70** communicate using a continuous wave radar technique. In this embodiment, the RFID reader **60** frequency modulates a "carrier" RF signal in a predictable way over a fixed period of time, typically by varying up and down with a sine wave or sawtooth pattern at audio frequencies or other desired frequency, to produce an RFID outbound RF signal. The RFID outbound RF signal is then transmitted by the RFID reader **60** towards the RFID tag **70**. Upon receiving the RFID outbound RF signal, the RFID tag **70** retransmits the RFID outbound RF signal as an RFID inbound RF signal that is received at the RFID reader **60**. The RFID outbound signal is typically sent out from one antenna on the RFID reader **60**, while the RFID inbound RF signal is received on another antenna of the RFID reader **60**. Since the signal frequency is changing, by the time the RFID inbound RF signal returns to the RFID reader **60**, the RFID outbound RF signal has shifted to some other frequency. The amount of frequency shift is greater over longer periods of time. As such, greater frequency differences translate into greater distances between the RFID reader **60** and the RFID tag **70**. The amount of frequency shift can therefore be used to directly measure the distance between the RFID reader **60** and the RFID tag **70**.

[0043] The measured distance between the RFID reader **60** and RFID tag **70** can be used to determine an initial position of the mobile gaming object **40** and/or the player within the gaming environment **40**, as described below. Once the player's and/or mobile gaming object's **40** position is determined, the RFID reader **60** may be adjusted to focus on the player and/or mobile gaming object **40** movement. For example, subsequently determined distances can be processed using a two-dimensional and/or three-dimensional algorithm to determine the motion of the mobile gaming object **40** and/or of the player.

[0044] FIG. **3**A is a schematic block diagram of an overhead view of another embodiment of a gaming system **10** that includes a mobile gaming object **40**, a plurality of RFID readers **60***a*-**60***c* and at least one RFID tag **70** within a gaming environment **50**. The RFID tag **70** may be physically attached to or included within the mobile gaming object **40** and/or worn or held by the player. In one embodiment, at least one of the RFID readers is included within the game console device of FIG. **1**. For example, one of the RFID readers, e.g., RFID reader **60***b*, can be included within the game console device and the other RFID readers **60***a* and **60***c* can be physically distributed throughout the gaming environment **20**. As another example, all of the RFID readers **60***a*-**60***c* can be included within or attached to the game console device at disparate locations on the game console device. In another embodiment, the game console device may be separate from the RFID readers **60***a*-**60***c*, but electronically connected to at least one of the RFID readers (e.g., direct connection, WLAN, WAN, telephone, DSL modem, cable modem, etc.). Regardless of the configuration of the RFID readers **60***a*-**60***c*, all of the RFID readers **60***a*-**60***c* communicate with the game console device either directly (via a wired or wireless connection) or indirectly through another RFID reader or other device.

[0045] In embodiments in which at least some of the RFID readers **60***a*-**60***c* are positioned outside of the game console device, the RFID readers **60***a*-**60***c* may be stand-alone devices that are physically distributed throughout the gaming environment **20** or may be included within device(s) that are already positioned within the gaming environment **20**. For example, the RFID readers **60***a*-**60***c* may be included in access points of a WLAN, 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. Typically, once the RFID readers **60***a*-**60***c* are positioned within the gaming environment **20**, a calibration of the RFID readers **60***a*-**60***c* is performed to determine the fixed three-dimensional locations of the RFID readers **60***a*-**60***c* within the gaming environment **20**.

[0046] Each of the RFID readers **60***a*-**60***c* periodically (e.g., in the range of once every 1 millisecond to once every 10 seconds) communicates with the RFID tag **70** to determine the respective distances between the RFID readers and the RFID tag **70**. For example, each RFID reader **60***a*-**60***c* can request data (e.g., a tag identifier) from the RFID tag **70** by sending a respective RFID outbound RF signal toward the RFID tag **70**, and the RFID tag **70** can respond with the requested data by separately modulating and backscattering each of the RFID outbound RF signals provided by the RFID readers **60***a*-**60***c* as respective RFID inbound RF signals. Each RFID reader **60***a*-**60***c* receives a respective RFID inbound RF signal that was modulated and backscattered in response to the RFID outbound RF signal transmitted by that RFID reader **60***a*-**60***c*. The RFID readers **60***a*-**60***c* analyze the received RFID inbound RF signals to determine signal properties of the received RFID inbound RF signals. These signal properties are used to determine the respective distances between the RFID readers **60***a*-**60***c* and the RFID tag **70**, as described above.

[0047] Each RFID reader **60***a*-**60***c* may operate with the same frequency or different frequencies using a frequency sharing protocol. In the former situation where the same frequencies are used, the RFID readers **60***a*-**60***c* may transmit their RFID outbound RF signals in a Time Division Multiple Access (TDMA) or round-robin manner so as to avoid interference between the RFID outbound RF signals. In the latter situation where different frequencies may be used for each RFID outbound RF signal, the RFID readers **60***a*-**60***c* may transmit their RFID outbound RF signals in a Frequency Division Multiple Access (FDMA) manner.

[0048] By obtaining multiple distances from multiple RFID readers **60***a*-**60***c*, and with knowledge of the fixed locations of the RFID readers **60***a*-**60***c*, the position and/or motion of the RFID tag **70** (mobile gaming object **40**) can be determined using a triangulation technique. For example, with the known position of a particular RFID reader, e.g., RFID reader **60***b*, and the measured distance between the that RFID reader **60***b* and the mobile gaming object **40**, the mobile gaming object **40**'s location can be determined to be somewhere on the surface of an imaginary sphere (shown as a circle in two-dimensions) centered on that RFID reader **60***b*, and whose radius is the distance to it. When the distance to at least three RFID readers **60***a*-**60***c* is known, the intersection of the three imaginary spheres reveals the position of the mobile gaming object **40**. To determine the position of the mobile gaming object **40** in three-dimensions, the distance to four or more RFID readers may be preferred.

[0049] In one embodiment, the RFID readers **60**a-**60**c calculate their respective distances to the RFID tag **70** and provide the distances to the game console for use in calculating the position of the mobile gaming object **40** within the gaming environment **20**. In another embodiment, the RFID readers **60**a-**60**c provide the signal properties of the received RFID inbound RF signals to the game console, and the game console calculates the respective distances between the RFID tag **70** and the RFID readers **60**a-**60**c and the position of the mobile gaming object **40** within the gaming environment **20** based on these signal properties.

[0050] FIG. 3B is a schematic block diagram of an overhead view of another embodiment of a gaming system **10** that includes a gaming object **40**, a plurality of RFID tags **70**a-**70**c and at least one RFID reader **60** within a gaming environment **20**. In this embodiment, it is the RFID reader **60**, instead of the RFID tag **70**, that is physically attached to or included within the mobile gaming object **40**. The RFID tags **70**a-**70**c may be placed throughout the gaming environment **20** and/or within the game console device. For example, one of the RFID tags, e.g., RFID tag **70**b, can be included within the game console device and the other RFID tags **70**a and **70**c can be physically distributed throughout the gaming environment **20**. As another example, all of the RFID tags **70**a-**70**c can be included within or attached to the game console device at disparate locations on the game console device. In another embodiment, the game console device may be separate from the RFID tags **70**a-**70**c.

[0051] In embodiments in which the RFID tags **70**a-**70**c are positioned outside of the game console device, the RFID tags **70**a-**70**c may be stand-alone RFID devices that are physically distributed throughout the gaming environment **20** or may be included within device(s) that are already positioned within the gaming environment **20**. For example, the RFID tags **70**a-**70**c may be included in access points of a WLAN, 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. Typically, once the RFID tags **70**a-**70**c are positioned within the gaming environment **20**, a calibration of the RFID tags **70**a-**70**c is performed to determine the fixed three-dimensional locations of the RFID tags **70**a-**70**c within the gaming environment **20**.

[0052] The RFID reader **60** periodically (e.g., in the range of once every 1 millisecond to once every 10 seconds) communicates with the RFID tags **70**a-**70**c to determine the respective distances between the RFID reader **60** and each of the RFID tags **70**a-**70**c. For example, the RFID reader **60** can request data (e.g., a tag identifier) from each RFID tag **70**a-**70**c by sending an RFID outbound RF signal toward each RFID tag **70**a-**70**c. In one embodiment, the RFID reader **60** generates a single RFID outbound RF signal that is received and responded to by all RFID tags **70**a-**70**c. For example, each RFID tag can respond to the RFID outbound RF signal with the requested data by modulating and backscattering the received RFID outbound RF signal to produce a respective RFID inbound RF signal. In another embodiment, multiple RFID outbound RF signals can be sent. For example, each RFID outbound signal can include a tag identifier of a particular one of the RFID tags, e.g., RFID tag **70**b. Upon receipt of the RFID outbound signal at one of the RFID tags, e.g., RFID tag **70**b, that RFID tag **70**b compares the tag identifier included in the received RFID outbound RF signal with its internally stored tag identifier to determine whether to respond to the received RFID outbound RF signal. If the tag identifiers match, the RFID tag **70**b responds with the requested data by modulating and backscattering the received RFID outbound RF signal to produce an RFID inbound RF signal.

[0053] The RFID reader **60** receives the RFID inbound RF signals from all of the RFID tags **70**a-**70**c and determines signal properties of each of the RFID inbound RF signals. The signal properties of the RFID inbound RF signals are used to determine the respective distances between the RFID reader **60** and the RFID tags **70**a-**70**c. By obtaining multiple distances from multiple RFID tags **70**a-**70**c, and with knowledge of the fixed locations of the RFID tags **70**a-**70**c, the position and/or motion of the RFID reader **60** can be determined, as described above. In one embodiment, the RFID reader **60**/mobile gaming object **40** calculates the respective distances to the RFID tags **70**a-**70**c and provides the distances to the game console device for use in calculating the position of the mobile gaming object **40** within the gaming environment **20**. In another embodiment, the RFID reader **60**/mobile gaming object **40** provides the signal properties of the received RFID inbound RF signals to the game console device, and the game console device calculates the respective distances between the RFID tags **70**a-**70**c and the RFID reader **60** and the position of the mobile gaming object **40** within the gaming environment **20** based on these signal properties.

[0054] FIG. **4** is a schematic block diagram of another embodiment of a gaming system **10** that includes a gaming object **40**, a game console device **30**, a plurality of RFID tags **70**a-**70**c and two or more RFID readers **60**a and **60**b within a gaming environment **20**. The RFID readers **60**a and **60**b, as shown, are physically attached to or included within the game console device **30**. However, in other embodiments, one or both of the RFID readers **60**a and **60**b may be separate from the game console device **30**. The RFID tags **70**a-**70**c, as shown, are physically attached to or included within the mobile gaming object **40**. However, in other embodiments, one or more of the RFID tags **70**a-**70**c may be worn or held by a player.

[0055] In an exemplary operation, each RFID reader **60**a and **60**b generates and transmits a respective RFID outbound RF signal **80** toward each of the RFID tags **70**a-**70**c. Each RFID outbound RF signal **80** includes a tag identifier (TAG ID) **82** identifying the particular RFID tag **70**a-**70**c that the RFID outbound RF signal is directed to, along with a command **84** instructing that RFID tag **70**a-**70**c to echo back with its TAG ID. Upon receiving an RFID outbound RF signal at an RFID tag, e.g., RFID tag **70**b, to which the RFID outbound RF signal is directed (as indicated by the TAG ID therein), that RFID tag **70**b responds with its TAG ID by modulating and backscattering the received RFID outbound RF signal to produce an RFID inbound RF signal. The RFID readers **60**a and **60**b receive the RFID inbound RF signals from all of the RFID tags **70**a-**70**c and determine signal properties of each of the RFID inbound RF signals. The signal properties of the RFID inbound RF signals are used to determine the respective distances between the RIFD readers **60**a and **60**b and the RFID tags **70**a-**70**c.

[0056] For example, in one embodiment, the signal properties include the total time of travel of the combination of the RFID outbound RF signal and the RFID inbound RF signal. The total amount of time that it takes for the RFID outbound RF signal to travel from an RFID reader, e.g., RFID reader

60a, to an RFID tag, e.g., RFID tag **70**a, and return to that RFID reader **60**a as an RFID inbound RF signal is equal to:

$$t_{TOT}=2t_d+t_{TAG}, \quad \text{(Equation 1)}$$

where t_d is the time of travel between the RFID reader **60**a and the RFID tag **70**a and t_{TAG} is the internal processing time of the RFID tag **70**a. The internal processing time of the RFID tag **70**a is known (based on data sheets, a calibration of the RFID tag or other measurement process). In addition, the total travel time (t_{TOT}) can be determined by calculating the difference between the time that the RIFD outbound RF signal is transmitted by the RFID reader **60**a and the time that the responsive RFID inbound RF signal is received at the RFID reader **60**a. Therefore, Equation 1 can be used to calculate the time of travel between the RFID reader **60**a and the RFID tag **70**a (t_d).

[0057] Once the time of travel (t_d) is determined, the distance between the RFID reader **60**a and RFID tag **70**a (d) can be calculated as:

$$d=c*t_d, \quad \text{(Equation 2)}$$

where c is the speed of light. With knowledge of the distances between each of the RFID readers **60**a and **60**b and each of the RFID tags **70**a-**70**c, and since the RFID tags **70**a-**70**c are separated by known distances, d**12** and d**23**, and the two RFID readers **60**a and **60**b are separated by a known distance dr**12**, the position of the mobile gaming object **40** within the gaming environment **20** can be determined. With three or more RFID readers **60**a and **60**b, the position of the mobile gaming object **40** can be determined without knowledge of the distances between the RFID tags **70**a-**70**c.

[0058] FIG. **5** is a schematic block diagram of a side view of another embodiment of a gaming system **10** that includes a mobile gaming object **40**, one or more RFID readers **60**, a plurality of RFID tags **70** associated with the player, and a plurality of RFID tags **70** associated with the gaming object **40**. In this illustration, the player and the mobile gaming object **40** are within the position and motion tracking area **50**. To track the player's and gaming object **40**'s motion with respect to the area **50**, the one or more RFID readers **60** transmit a plurality of RFID outbound RF signals towards the RFID tags **70** and receive a plurality of RFID inbound RF signals from the RFID tags **70** to determine the position of the player and gaming object **40** over time.

[0059] As described above, the communication between the RFID reader(s) **60** and RFID tags **70** may be done in a variety of ways, including, but not limited to, a broadcast transmission and a collision detection and avoidance response scheme, in a round robin manner, in a TDMA manner or in an ad hoc manner based on a desired updating rate for a given RFID tag (e.g., a slow moving tag may need to be updated less often than a fast moving tag).

[0060] FIGS. **6**A is schematic block diagrams of an embodiment of an RFID reader **60**. In FIG. **6**A, the RFID reader **60** is shown within the game console device **30**, but in other embodiments, the RFID reader **60** may be a stand-alone device, included within the mobile gaming object or included within another device, as discussed above. The RFID reader **60** includes a protocol processing module **102**, an encoding module **104**, a digital-to-analog converter **106**, an RF front-end **108**, an antenna **110**, a digitization module **112**, a pre-decoding module **114** and a decoding module **116**.

[0061] The protocol processing module **102** is operable to prepare data for encoding in accordance with a particular RFID standardized protocol. In an exemplary embodiment, the protocol processing module **102** is programmed with multiple RFID standardized protocols to enable the RFID reader **60** to communicate with any RFID tag, regardless of the particular protocol associated with the tag. In this embodiment, the protocol processing module **102** operates to program filters and other components of the encoding module **104**, decoding module **116**, pre-decoding module **114** and RF front end **108** in accordance with the particular RFID standardized protocol of the tag(s) currently communicating with the RFID reader **60**.

[0062] In operation, once the particular RFID standardized protocol has been selected for communication with one or more RFID tags, the protocol processing module **102** generates and provides digital data to be communicated to the RFID tag to the encoding module **104** for encoding in accordance with the selected RFID standardized protocol. By way of example, but not limitation, the RFID protocols may include one or more line encoding schemes, such as Manchester encoding, FM0 encoding, FM1 encoding, etc. Thereafter, the digitally encoded data is provided to the digital-to-analog converter **106** which converts the digitally encoded data into an analog signal. The RF front-end **108** modulates the analog signal to produce an RFID outbound RF signal at a particular carrier frequency that is transmitted via antenna **110** to one or more RFID tags.

[0063] The RF front-end **108** further includes transmit blocking capabilities such that the energy of the transmitted RF signal does not substantially interfere with the receiving of a back-scattered or other RF signal received from one or more RFID tags via the antenna **110**. Upon receiving an RFID inbound RF signal from one or more RFID tags, the RF front-end **108** converts the received RFID inbound RF signal into a baseband signal. The digitization module **112**, which may be a limiting module or an analog-to-digital converter, converts the received baseband signal into a digital signal. The pre-decoding module **114** converts the digital signal into an encoded signal in accordance with the particular RFID protocol being utilized. The encoded data is provided to the decoding module **116**, which recaptures data therefrom in accordance with the particular encoding scheme of the selected RFID protocol. The protocol processing module **102** processes the recovered data associated with the RFID tag(s) to determine properties of the RFID inbound RF signal and/or provides the recovered data to the game console device for further processing.

[0064] The protocol processing module **102**, along with all other processing modules herein, 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 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 protocol processing module **102** implements one or more of its functions via a state machine, analog circuitry, digital circuitry, and/or logic circuitry, the 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 protocol processing module **102** executes, hard coded and/or operational instructions corresponding to at least some of the steps and/or functions illustrated in FIGS. **1-28**.

[0065] Referring now to FIG. **6**B, there is illustrated an exemplary RFID tag **70**. In FIG. **6**B, the RFID tag **70** is shown within the mobile gaming object **40**, but in other embodiments, the RFID tag **70** may be a stand-alone device, included within the game console device or included within another device, as discussed above. The RFID tag **70** includes a power generating circuit **120**, an oscillation module **126**, a processing module **130**, an oscillation calibration module **128**, a comparator **124**, an envelope detection module **122**, a capacitor C**1**, and a transistor T**1**. The oscillation module **122**, the processing module **130**, the oscillation calibration module **128**, the comparator **124**, and the envelope detection module **122** may be a single processing device or a plurality of processing devices.

[0066] In operation, the power generating circuit **120** generates a supply voltage (V_{DD}) from an RFID outbound RF signal that is received via an antenna **132**. The power generating circuit **120** stores the supply voltage V_{DD} in capacitor C**1** and provides it to modules **122-130**. When the supply voltage V_{DD} is present, the envelope detection module **122** determines an envelope of the RFID outbound RF signal. In one embodiment, the RFID outbound RF signal is an amplitude modulation signal, where the envelope of the RFID outbound RF signal includes transmitted data. The envelope detection module **122** provides an envelope signal to the comparator **124**. The comparator **124** compares the envelope signal with a threshold to produce a stream of recovered data.

[0067] The oscillation module **126**, which may be a ring oscillator, crystal oscillator, or timing circuit, generates one or more clock signals that have a rate corresponding to the rate of the RFID outbound RF signal in accordance with an oscillation feedback signal. For instance, if the RFID outbound RF signal is a 900 MHz signal, the rate of the clock signals will be n*900 MHz, where "n" is equal to or greater than 1.

[0068] The oscillation calibration module **128** produces the oscillation feedback signal from a clock signal of the one or more clock signals and the stream of recovered data. In general, the oscillation calibration module **128** compares the rate of the clock signal with the rate of the stream of recovered data. Based on this comparison, the oscillation calibration module **128** generates the oscillation feedback to indicate to the oscillation module **126** to maintain the current rate, speed up the current rate, or slow down the current rate.

[0069] The processing module **130** receives the stream of recovered data and a clock signal of the one or more clock signals. The processing module **130** interprets the stream of recovered data to determine a command or commands contained therein. The command may be to store data, update data, reply with stored data, verify command compliance, acknowledgement, etc. If the command(s) requires a response, the processing module **130** provides a signal to the transistor T**1** at a rate corresponding to the RFID outbound RF signal. The signal toggles transistor T**1** on and off to generate a response RFID inbound RF signal that is transmitted via the antenna **132**. In one embodiment, the RFID tag **70** utilizes a back-scattering RF communication.

[0070] FIG. **7** is a diagram of a method for determining position of a player and/or gaming object that begins at step **202** with an RFID reader transmitting a power up signal to one or more RFID tags, which may be active or passive tags. In one embodiment, the power up signal may be a tone signal such that a passive RFID tag can generate power therefrom. In another embodiment, the power up signal may be a wake-up signal for an active RFID tag. The method continues at step **204** with the RFID tag providing an acknowledgement that it is powered up. It should be noted that, in some embodiments, step **202** may be skipped.

[0071] The method continues at step **206** with the RFID reader transmitting a command (e.g., an RFID outbound RF signal) at time t**0**, where the command requests a response to be sent at a specific time after receipt of the command. In response to the command, at step **208**, an RFID tag provides the response (e.g., an RFID inbound RF signal). The method continues at step **210** with the RFID reader recording the time and the tag ID. The reader then determines at step **212** the distance to the RFID tag based on the stored time, time t**0**, and the specific time delay.

[0072] The method continues at step **214** by determining whether all or a desired number of tags have provided a response. If not, the process loops as shown. If yes, the method continues at step **218** by determining the general position of the player and/or mobile gaming object based on the distances. As an alternative, at step **216**, the general position of each of the tags may be determined from their respective distances. Note that at least three, and preferably four, distances need to be accumulated from different sources (e.g., multiple RFID readers, an RFID reader with multiple physically separated transmitters or multiple RFID tags) to triangulate the player and/or mobile gaming object position.

[0073] FIG. **8** is a schematic block diagram of an embodiment of a gaming object **40** that includes a gaming object transceiver **42**, an RFID device **60** or **70** and a processing module **44**. In one embodiment, the RFID device includes an RFID tag **70** operable to receive RFID outbound RF signals transmitted from RFID readers and to transmit back to the RFID readers RFID inbound RF signals responsive to the received RFID outbound RF signals. In another embodiment, the RFID device includes an RFID reader **60** operable to transmit RFID outbound RF signals towards RFID tags and to receive from the RFID tags RFID inbound RF signals produced responsive to the RFID outbound RF signals.

[0074] The gaming object transceiver **42** is coupled to transmit and receive RF signals to and from the game console device. For example, in one embodiment, the gaming object transceiver **42** can transmit signal information (i.e., signal properties, distances and/or positions) associated with RFID signals for use in determining the position and/or motion of the mobile gaming object **40**. In another embodiment, the gaming object transceiver **42** can transmit and/or receive control information or other information, such as video game control information, to/from the game console device.

[0075] The RFID device **60** or **70** may use a different frequency than the gaming object transceiver **42** 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 device **60** or **70** and the gaming object transceiver **42** 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. 11/648,826, and a filing date of Dec. 29, 2006, patent application entitled, "MULTIPLE BAND ANTENNA STRUCTURE, having a Ser. No. 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. 11/529,058, and a filing date of Sep. 28, 2006, all of which are incorporated herein by reference.

[0076] The processing module **44** is operable to process RF signals that are transmitted and/or received via the RF transceiver **42**. In embodiments in which the RFID device is an RFID reader **60**, the processing module **44** may further be operable to process the RFID inbound RF signals to produce signal information representative of properties of the received RFID inbound RF signals and to provide this signal information, via the gaming object transceiver **42**, to the game console device. In addition, although not shown, the processing module **44** may further couple to an input device (e.g., one or more navigation or selection buttons) and an output device (e.g., a speaker or display) on the mobile gaming device **40**.

[0077] FIG. **9** is a schematic block diagram of an embodiment of a game console device **30** that includes a game console transceiver **32**, an RFID device **60** or **70** and a processing module **34**. In one embodiment, the RFID device includes an RFID tag **70** coupled to receive RFID outbound RF signals transmitted from an RFID reader associated with a mobile gaming object and operable to transmit back to the RFID reader RFID inbound RF signals responsive to the received RFID outbound RF signals. In another embodiment, the RFID device includes an RFID reader **60** operable to transmit RFID outbound RF signals towards RFID tags associated with the mobile gaming object and/or player and to receive from the RFID tags, RFID inbound RF signals produced responsive to the RFID outbound RF signals.

[0078] The game console transceiver **32** is coupled to transmit and receive RF signals to and from the mobile gaming object and/or other RFID readers. For example, in one embodiment, the game console transceiver **32** can receive signal information (i.e., signal properties and/or distances) from other RFID readers for use in determining the position and/or motion of the mobile gaming object. In another embodiment, the game console transceiver **32** can transmit and/or receive control information or other information, such as video game control information, to/from the mobile gaming object.

[0079] The RFID device **60** or **70** may use a different frequency than the game console transceiver **32** 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 device **60** or **70** and the game console transceiver **32** 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. 11/648,826, and a filing date of Dec. 29, 2006, patent application entitled, "MULTIPLE BAND ANTENNA STRUCTURE, having a Ser. No. 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. 11/529,058, and a filing date of Sep. 28, 2006, all of which are incorporated herein by reference.

[0080] The processing module **34** is operable to process RF signals received from the mobile gaming object and/or other RFID readers via the gaming transceiver **32**, to determine the position of the mobile gaming object and/or player and to provide data for transmission to the mobile gaming object via the game console transceiver **32**. The processing module **34** is further operable to run software providing a plurality of video game functions for playing a video game and to process one or more of the video game functions in accordance with the position of the mobile gaming object and/or player. In embodiments in which the RFID device is an RFID reader **60**, the processing module **34** is further operable to process the RFID inbound RF signals to produce signal information representative of properties of the received RFID inbound RF signals and to use this signal information in the determination of the position of the mobile gaming object and/or player.

[0081] FIG. **10** is a schematic block diagram of an embodiment of a mobile gaming object **40** and/or game console device **30** that includes a physical layer (PHY) integrated circuit (IC) **350** and a medium access control (MAC) layer controller **380**. The PHY IC **350** includes a position and/or motion tracking RF section **320**, a control interface RF section **340**, and a baseband processing module **360**. The game console device **30** may use a standardized protocol, a proprietary protocol, and/or a combination thereof to provide the communication between the mobile gaming object **40** and the game console device **30**.

[0082] The MAC controller **380** triggers position and/or tracking data collection, formatting of the data, processing of the data, and/or controlling position and/or tracking data communications and/or control interface communications. The position and/or tracking data may include, for example, the received combined RF signals and/or the signal information representing signal properties of the received combined RF signals. The position and/or tracking RF section **320** includes circuitry to transmit/receive one or more RF signals associated with the position and/or tracking data. The control interface RF section **340** includes circuitry to transmit/receive control information related to gaming functionality and/or the collection and/or processing of the position and/or tracking data.

[0083] When operating as a game console device **30**, the MAC controller **380** further operates to determine the environment parameters of the gaming environment corresponding to the physical area in which the gaming object moves, and to map the environment parameters to a particular coordinate system. In addition, the MAC controller **380** operates to determine the coordinates of the mobile gaming object's or players' position in the gaming environment based on distance information provided by one or more RFID readers and to facilitate video game play in accordance with the mobile gaming object's or player's coordinates.

[0084] FIGS. **11-13** are diagrams of an embodiment of a coordinate system of a localized physical area that may be used for a gaming system including a mobile gaming object **40** and a game console device **30**. In these figures, an xyz origin is selected to be somewhere in the localized physical area and each point being tracked and/or used for positioning on the mobile gaming object **40** is determined based on its Cartesian coordinates (e.g., **x1**, **y1**, **z1**). As the mobile gaming object **40** moves, the new position of the tracking and/or positioning points are determined in Cartesian coordinates with respect to the origin.

[0085] FIGS. **14-16** are diagrams of another embodiment of a coordinate system of a localized physical area that may be used for a gaming system including a mobile gaming object **40** and a game console device **30**. In these figures, an origin is selected to be somewhere in the localized physical area and each point being tracked and/or used for positioning on the mobile gaming object **40** is determined based on its vector, or spherical, coordinates (ρ, ϕ, θ), which are defined as: $\rho \geqq 0$ is the distance from the origin to a given point P. $0 \leqq \phi \leqq 180°$ is the angle between the positive z-axis and the line formed between the origin and P. $0 \leqq \theta \leqq 360°$ is the angle between the positive x-axis and the line from the origin to the P projected onto the xy-plane. ϕ is referred to as the zenith, colatitude or polar angle, while θ is referred to as the azimuth.ϕ and θ lose significance when $\rho=0$ and θ loses significance when $\sin(\phi)=0$ (at $\phi=0$ and $\phi=180°$). To plot a point from its spherical coordinates, go ρ units 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. As the gaming object **40** moves, the new position of the tracking and/or positioning points are determined in vector, or spherical, coordinates with respect to the origin.

[0086] While FIGS. **11-16** 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.

[0087] FIGS. **17-19** are diagrams of a coordinate system for tracking motion of a mobile gaming object **40**. In these figures, an origin is selected to be somewhere in the localized physical area and the initial position of a point being tracked on the mobile gaming object **40** is determined based on its vector, or spherical coordinates (e.g., $\rho 1$, $\phi 1$, $\theta 1$). As the mobile gaming object **40** moves, the new position of the tracking and/or positioning points are determined as a vector, or spherical coordinates with respect to the preceding location (e.g., ΔV, or $\Delta\rho$, $\Delta\phi$, $\Delta\theta$). As another example, the positioning and motion tracking of the player may be done with reference to the position of the mobile gaming object **40**, such that the mobile gaming object's position is determined with reference to the origin and/or its previous position and the position of the player is determined with reference to the mobile gaming object's position.

[0088] FIGS. **20-22** are diagrams of examples of motion patterns in accordance with human bio-mechanics. As shown in FIG. **20**, a head can move up/down, it can tilt, it can rotate, and/or a combination thereof. For a given video game, head motion can be anticipated based on current play of the game. For example, during an approach shot, the head will be relatively steady with respect to tilting and rotating, and may move up or down along with the body.

[0089] FIG. **21** shows the motion patterns of an arm (or leg) in accordance with human bio-mechanics. As shown, the arm (or leg) may contract or extend, go up or down, move side to side, rotate, or a combination thereof. For a given video game, an arm (or leg) motion can be anticipated based on the current play of the game. Note that the arm (or leg) may be broken down into smaller body parts (e.g., upper arm, elbow, forearm, wrist, hand, fingers). Further note that the mobile gaming object's motion will be similar to the body part it is associated with.

[0090] FIG. **22** illustrates the likely motions of a torso, which can move up/down, side to side, front to back, and/or a combination thereof. For a given video game, torso motion can be anticipated based on current play of the game. As such, based on the human bio-mechanical limitations and ranges of motion along with the video game being player, the motion of the player and/or the associated gaming object may be anticipated, which facilitates better motion tracking.

[0091] FIG. **23** is a diagram of an example of motion estimation for the head, right arm, left arm, torso, right leg, and left leg of a video game player. In this game, it is anticipated that the arms will move the most often and over the most distance, followed by the legs, torso, and head. In this example the interval rate may be 10 milliseconds, which provides a 1 mm resolution for an object moving at 200 miles per hour. In this example, the body parts are not anticipated to move at or near 200 mph.

[0092] At interval **1**, at least some of the reference points on the corresponding body parts are sampled. Note that each body part may include one or more reference points. Since the arms are anticipated to move the most and/or over the greatest distances, the reference point(s) associated with the arms are sampled once every third interval (e.g., interval **1**, **4**, **7**). For intervals **2** and **3**, the motion of the reference points is estimated based on the samples of intervals **1** and **4** (and may be more samples at different intervals), the motion pattern of the arm, human bio-mechanics, and/or a combination thereof. The estimation may be a linear estimation, a most likely estimation, and/or any other mathematical technique for estimating data points between two or more samples. A similar estimation is made for intervals **5** and **6**.

[0093] The legs have a data rate of sampling once every four intervals (e.g., intervals **1**, **5**, **9**, etc.). The motion data for the intervening intervals is estimated in a similar manner as the motion data of the arms was estimated. The torso has a data rate of sampling once every five samples (e.g., interval **1**, **6**, **11**, etc.). The head has a data rate of sampling once every six samples (e.g., interval **1**, **7**, **13**, etc.). Note that the initial sampling does not need to be done during the same interval for all of the reference points.

[0094] FIGS. **24-25** are diagrams of examples of reference points **75** on a player corresponding to locations of RFID tags **70** on the player's body to determine the player's physical measurements. In this example, once the positioning of the reference points **75** is determined, their positioning may be used to determine the physical attributes of the player (e.g., height, width, arm length, leg length, shoe size, etc.).

[0095] FIG. **26** is a diagram of an example of mapping a player to an image **400** produced by the video game. In this embodiment, the image **400** displayed in the video game corresponds to the player such that, as the player moves, the image **400** moves the same way. The image **400** may a stored image of the actual player, a celebrity player (e.g., a professional athlete), a default image, and/or a user created image. The mapping involves estimating motion of the non-reference points of the player based on the reference points **75**/RFID tags **70** of the player. In addition, the mapping involves equating the reference points **75** on the player to the same points on the image. The same may be done for the mobile gaming object.

[0096] FIG. **27** is a diagram of a method for determining motion that begins at step **502** by obtaining coordinates for the reference points of the player and/or gaming object. The method continues at step **504** by determining the player's dimensions and/or determining the dimensions of the mobile gaming object. The method continues at step **506** by mapping the reference points of the player to corresponding points of a video image based on the player's dimensions. This step may also include mapping the reference points of the mobile gaming object (e.g., a sword) to the corresponding image of the mobile gaming object based on the mobile gaming object's dimensions.

[0097] The method continues at step **508** by determining coordinates of other non-referenced body parts and/or parts of the mobile gaming object based on the coordinates of the reference points. This may be done by a linear interpolation, by a most likely motion algorithm, by a look up table, and/or any other method for estimated data points from surrounding data points. The method continues at steps **510** and **512** by tracking motion of the reference points and predicting motion of the non-referenced body parts and/or parts of the mobile gaming object based on the motion of the reference points. This may also be done by a linear interpolation, by a most likely motion algorithm, by a look up table, and/or any other method for estimated data points from surrounding data points.

[0098] FIG. **28** is a diagram of a method for processing a position and/or motion based gaming action that begins at step **602** by placing the mobile gaming object (e.g., a controller) and/or game console device in a gaming mode. The method continues at step **604** by establishing the mobile gaming object's (e.g., controller, cell phone, etc.) current position and orientation with respect to an initial position in a gaming display area. For example, if the game being played is a shooing arcade game and the mobile gaming object is functioning as a gun, this step determines the initial aiming of the gun.

[0099] The method continues at step **606** by determining whether the position and orientation of the mobile gaming object is within the gaming display area. If yes, the method continues at step **608** by providing a display icon corresponding to the position and orientation. For example, the icon may be cross hairs of a gun to correspond to the aiming of the video game gun. The method continues at steps **610** and **612** by tracking the motion of the mobile gaming object and mapping the motion to the gaming display area.

[0100] The method continues at step **614** by determining whether an action has been received. For example, has the trigger of the gun been pulled? If not, the process repeats as shown. If yes, the process continues at step **616** by processing the action. For example, the processing may include mapping the shooting of the gun in accordance with the aiming of the gun.

[0101] As may be used herein, the term(s) "coupled to" and/or "coupling" 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 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.

[0102] 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.

[0103] 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 system comprises:

a radio frequency identification (RFID) reader associated with a video gaming environment including:

a radio frequency (RF) front end operable to transmit an RFID outbound Radio Frequency (RF) signal and receive an RFID inbound RF signal; and

a processing module operable to produce signal information regarding the received RFID inbound RF signal;

a gaming element associated with the video gaming environment and operable to facilitate a video game function of a video game, the gaming element including:

an RFID tag coupled to receive the RFID outbound RF signal and operable to produce the RFID inbound RF signal responsive to the RFID outbound RF signal; and

a controller coupled to receive the signal information from the RFID reader and operable to:

determine a distance between the gaming element and the RFID reader based on the signal information.

2. The system of claim **1** further comprises:

a plurality of radio frequency identification (RFID) readers, each including:

a radio frequency (RF) front end operable to transmit a respective one of a plurality of RFID outbound Radio Frequency (RF) signals and receive a respective one of a plurality of RFID inbound RF signals; and a processing module operable to produce respective signal information regarding the respective received RFID inbound RF signal;

wherein the RFID tag is further coupled to receive the plurality of RFID outbound RF signals and operable to produce the plurality of RFID inbound RF signals responsive to the plurality of RFID outbound RF signals; and

wherein the controller is further coupled to receive the signal information from the plurality of RFID readers and is operable to:

determine respective distances between the gaming element and the plurality of RFID readers based on the signal information; and

determine a position of the gaming element within the video gaming environment based on the distances.

3. The system of claim **2**, wherein the controller is further operable to:

process the video game function in accordance with the position of the gaming element.

4. The system of claim **2**, wherein the controller is further operable to map the position to a coordinate system, and wherein the coordinate system is applied to a given physical area defined by the video gaming environment.

5. The system of claim **1** wherein the gaming element further comprises a plurality of RFID tags, and wherein the system further comprises:

two or more radio frequency identification (RFID) readers, each including:

a radio frequency (RF) front end operable to transmit a respective RFID outbound Radio Frequency (RF) signal to each of at least some of the plurality of RFID tags and receive respective RFID inbound RF signals from the at least some of the plurality of RFID tags; and

a processing module operable to produce respective signal information regarding the respective received RFID inbound RF signals;

wherein the controller is further coupled to receive the signal information from the two or more RFID readers and is operable to:

determine respective distances between the gaming element and the plurality of RFID readers based on the respective signal information; and

determine a position of the gaming element within the video gaming environment based on the distances.

6. The system of claim **5**, wherein the RFID tags are physically attached to the gaming element at reference points thereof.

7. The system of claim **6**, wherein the video game function includes a video game image corresponding to the gaming element, and wherein the controller is further operable to:

determine object dimensions of the gaming element;

determine a respective position for each of the reference points on the gaming element using respective signal information associated with respective RFID inbound RF signals produced by respective ones of the plurality of RFID tags;

map each of the positions to a coordinate system to produce coordinates for each of the reference points; and

map the coordinates of the reference points to the video game image of the gaming element based on the object dimensions.

8. The system of claim **7**, wherein the controller is further operable to:

determine coordinates of other points on the gaming element based on the coordinates of the reference points using linear interpolation; and

map the coordinates of the other points to the video game image of the gaming element based on the object dimensions.

9. The system of claim **1** further comprises:

a game console device that comprises the RFID reader and at least a portion of the controller, the game console device operable to perform the video game function.

10. The system of claim **1**, wherein the gaming element further comprises:

a gaming object transceiver coupled to communicate with a game console device operating the video game using transceiver radio frequency (RF) signals; and

a processing module coupled to the gaming object transceiver and the RFID tag to coordinate communications between the gaming object transceiver and the RFID tag.

11. The system of claim **10**, wherein the transceiver RF signals are at one or more carrier frequencies that are different from frequencies of the RFID outbound RF signals and the RFID inbound RF signals.

12. The system of claim **10**, wherein the processing module is operable to coordinate communications between the gaming object transceiver and the RFID tag using a frequency sharing protocol.

13. The system of claim **1**, wherein the gaming element comprises an apparatus worn or held by a human video game player.

14. The system of claim **1**, wherein the RFID tag is operable to produce the RFID inbound RF signal using at least one of:

a backscatter technique;

a frequency modulation technique; and

a continuous wave radar technique.

15. The system of claim **1**, further comprises:

a plurality of gaming elements, each including a respective one of a plurality of RFID tags operable to produce a respective one of a plurality of RFID inbound RF signals responsive to a respective one of a plurality of RFID outbound signals; and

a mobile gaming object including the RFID reader, the RFID reader operable to transmit the plurality of RFID outbound RF signals, receive the plurality of RFID inbound RF signals and produce respective signal information representative of properties of the respective received RFID inbound RF signals;

wherein the controller is further coupled to receive the signal information from the RFID reader and is operable to:

determine respective distances between the RFID tags and the mobile gaming object based on the signal information; and

determine a position of the mobile gaming object within the video gaming environment based on the distances.

16. A game console device including:

a radio frequency identification (RFID) reader associated with a video gaming environment, the RFID reader including:

a radio frequency (RF) front end coupled to transmit at least one of a plurality of RFID outbound Radio Frequency (RF) signals and to receive at least one of a plurality of RFID inbound RF signals produced responsive to the respective RFID outbound RF signals by at least one RFID tag associated with a gaming element within the video gaming environment; and

a processing module operable to produce signal information regarding the at least one received RFID inbound RF signal; and

a controller coupled to receive the signal information and operable to determine a position of the gaming element within the video gaming environment based on the signal information.

17. The game console device of claim **16**, wherein the controller is further operable to map the position to a coordinate system, and wherein the coordinate system is applied to a given physical area defined by the video gaming environment.

18. The game console device of claim **17**, wherein the controller is further operable to:

determine object dimensions of the gaming element;

determine a respective position for each of a plurality of reference points on the gaming element using respective signal information associated with respective RFID inbound RF signals produced by respective RFID tags attached to each of the reference points;

map each of the positions to the coordinate system to produce coordinates for each of the reference points; and

map the coordinates of the reference points to a corresponding image of the gaming element based on the object dimensions to produce the image thereof.

19. The game console device of claim **18**, wherein the controller is further operable to:

determine coordinates of other points on the gaming element based on the coordinates of the reference points using linear interpolation; and

map the coordinates of the other points to a corresponding image of the gaming element based on the object dimensions to produce the image thereof.

20. The game console device of claim **16**, wherein other ones of the plurality of RFID outbound RF signals and the plurality of RFID inbound RF signals are transmitted and received by other RFID readers coupled to the game console device, and wherein the controller is further operable to:

receive respective signal information regarding each of the other ones of the plurality of RF inbound signals from the other RFID readers;

determine respective distances between the at least one RFID tag and the other RFID readers based on the respective signal information; and

determine the position of the gaming element within the video gaming environment based on the distances.

21. The game console device of claim **16**, wherein the RFID reader includes:

a plurality of transmitters coupled to transmit the plurality of RFID outbound RF signals; and

a plurality of receivers coupled to receive the plurality of RFID inbound RF signals;

wherein pairs of the plurality of transmitters and the plurality of receivers are physically separated from each other.

22. The game console device of claim **21**, wherein the controller is further operable to:

determine respective distances between the at least one RFID tag and the plurality of transmitters based on the signal information; and

determine the position of the gaming element within the video gaming environment based on the distances.

23. The game console device of claim **16**, wherein the controller is further operable to process a video game function in accordance with the position of the gaming element.

24. The game console device of claim **16**, wherein the plurality of RFID inbound RF signals are produced using one of:

a backscatter technique;

a frequency modulation technique; and

a continuous wave radar technique.

25. The game console device of claim **16**, wherein the controller is further operable to track the position of the gaming element by determining subsequent positions of the gaming element within the video gaming environment.

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