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(54) **METHOD AND APPARATUS FOR DETERMINING ORIENTATION AND POSITION OF A MOVEABLE OBJECT**

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(57) **ABSTRACT**

An orientation and position tracking system in three-dimensional space and over a period of time utilizing multiple inertial and other sensors for determining motion parameters to measure orientation and position of a moveable object. The sensors, for example vibrational and angular velocity sensors, generate signals characterizing the motion of the moveable object. The information is received by a data acquisition system and processed by a microcontroller. The data is then transmitted via wireless communication to an external data reception system (locally based or a global network). The information can then be displayed and presented to the user through a variety of means including audio, visual, and tactile.

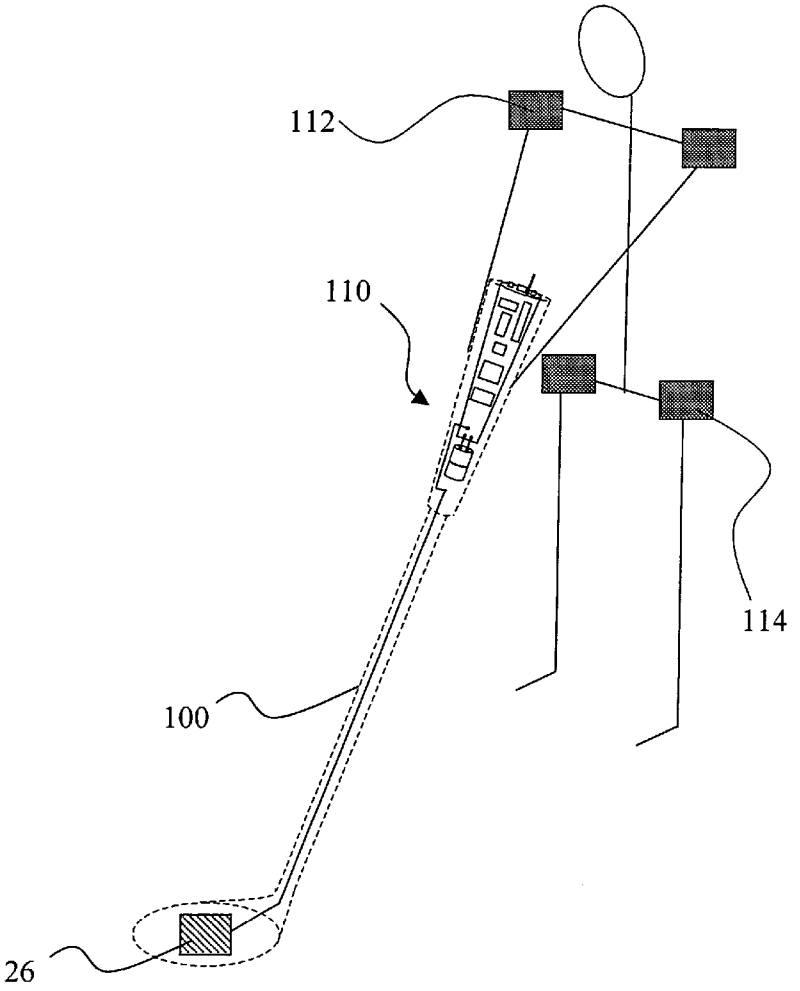


FIG. 1

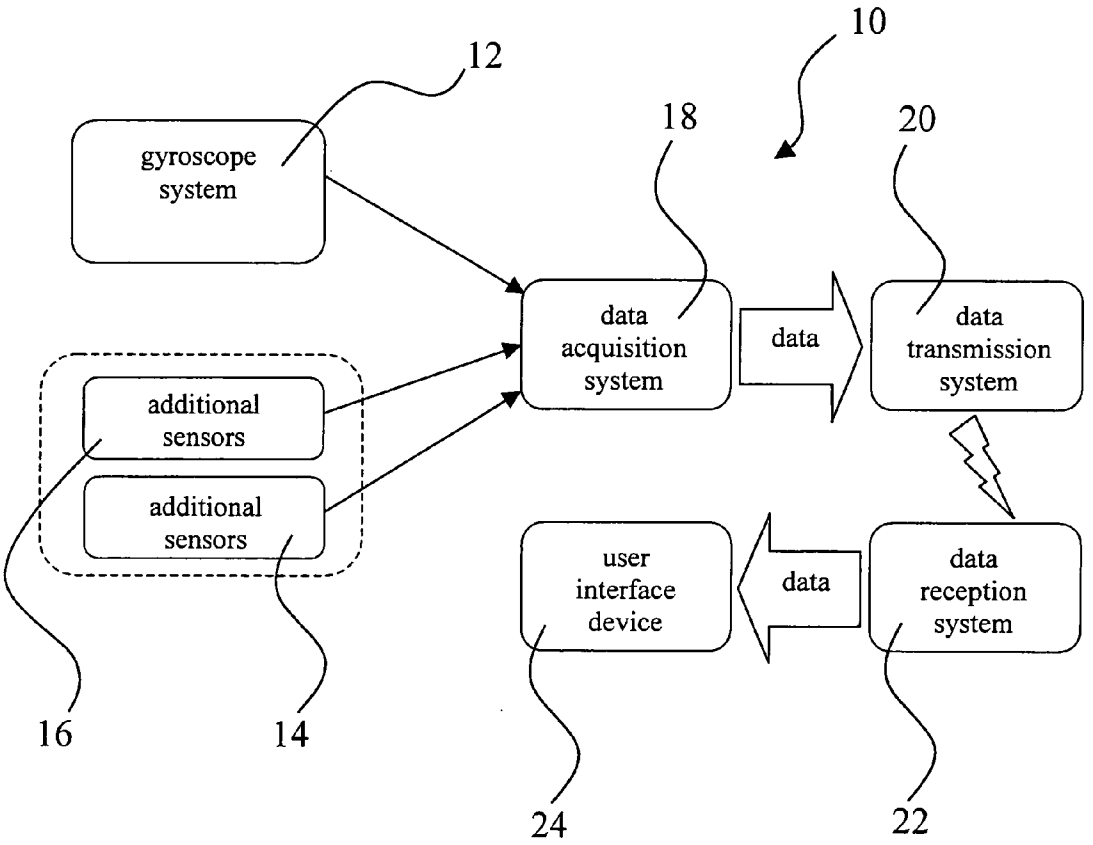

10
12
18
20
gyroscope system
data acquisition system
data
data transmission system
additional sensors
additional sensors
user interface device
data
data reception system
16
14
24
22

FIG. 2

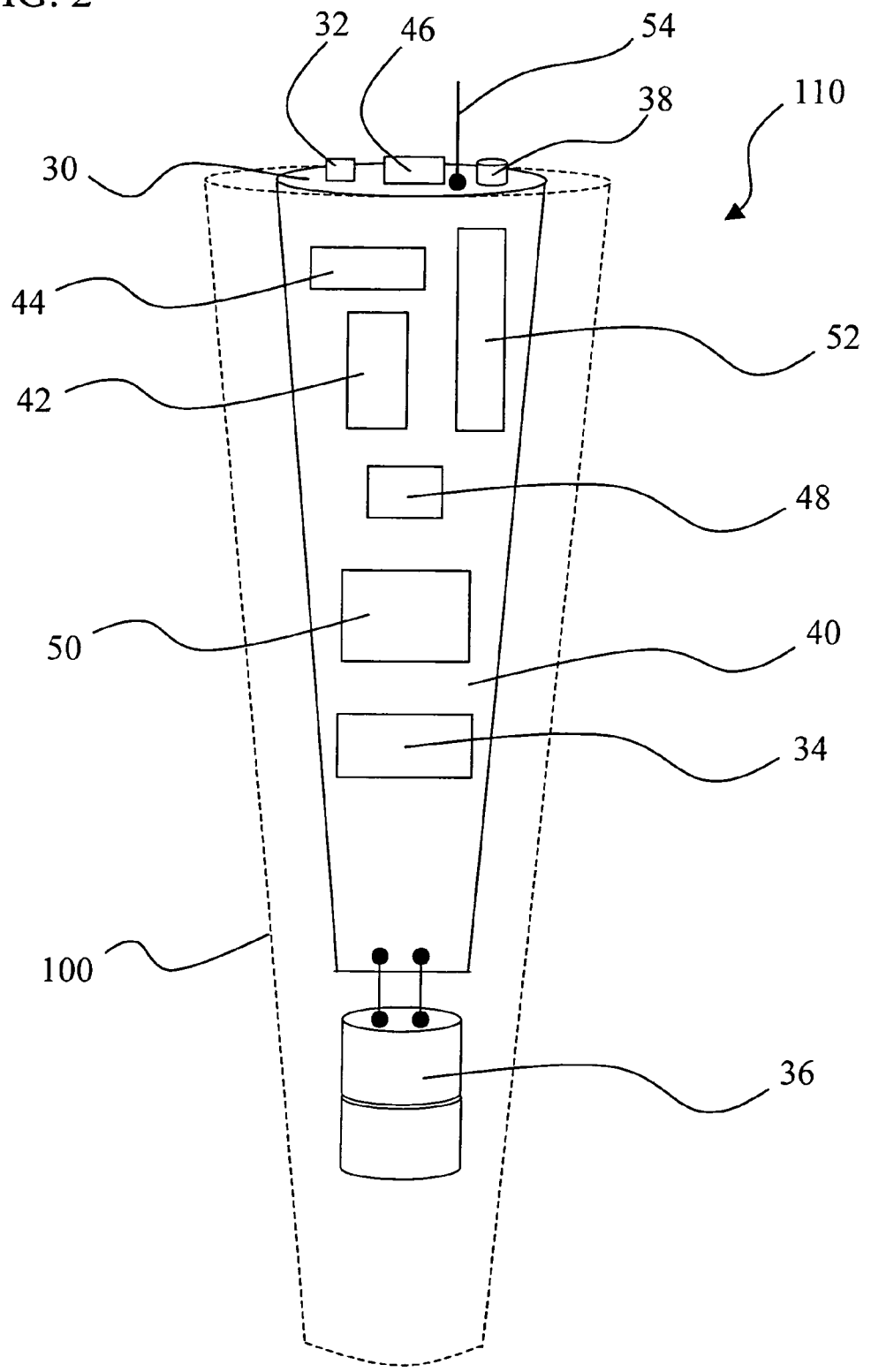


FIG. 3

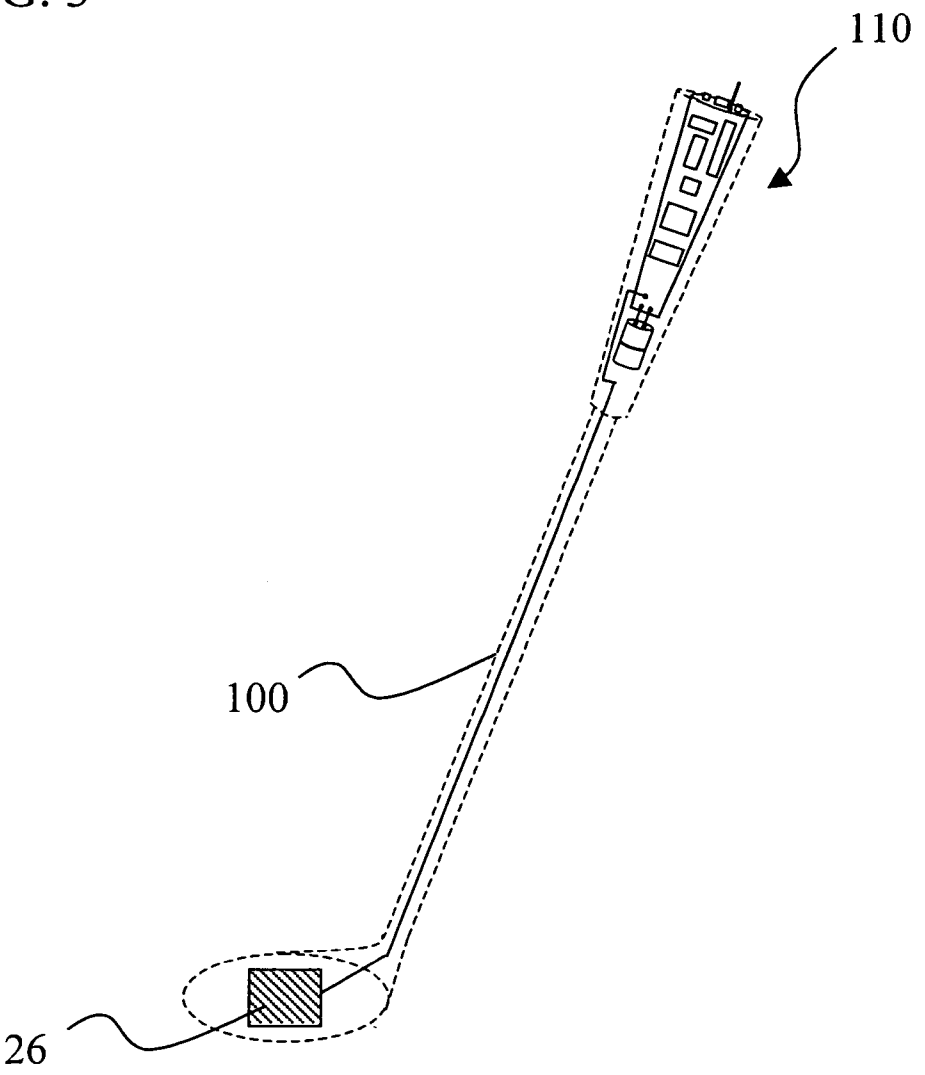


FIG. 4

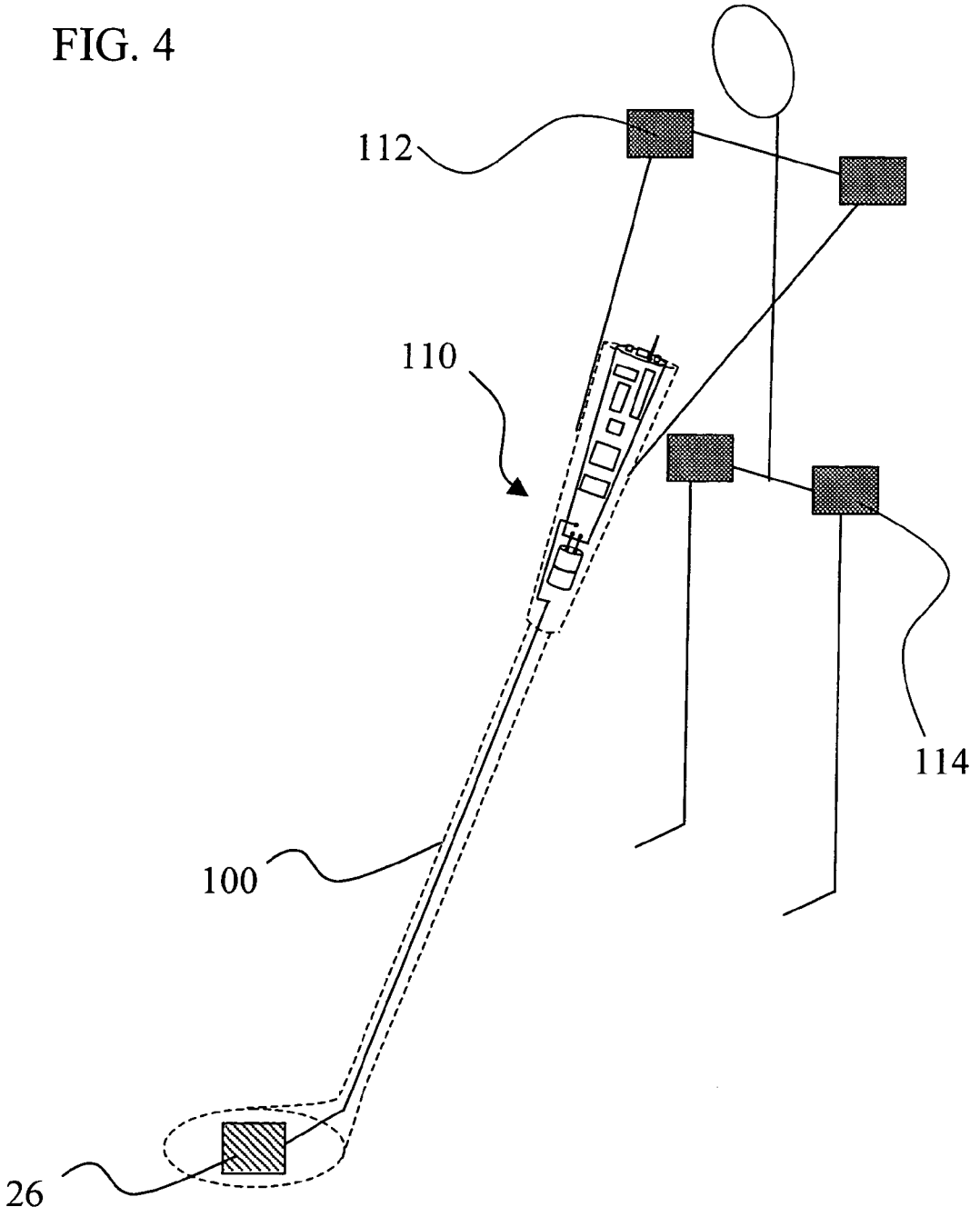


FIG. 5

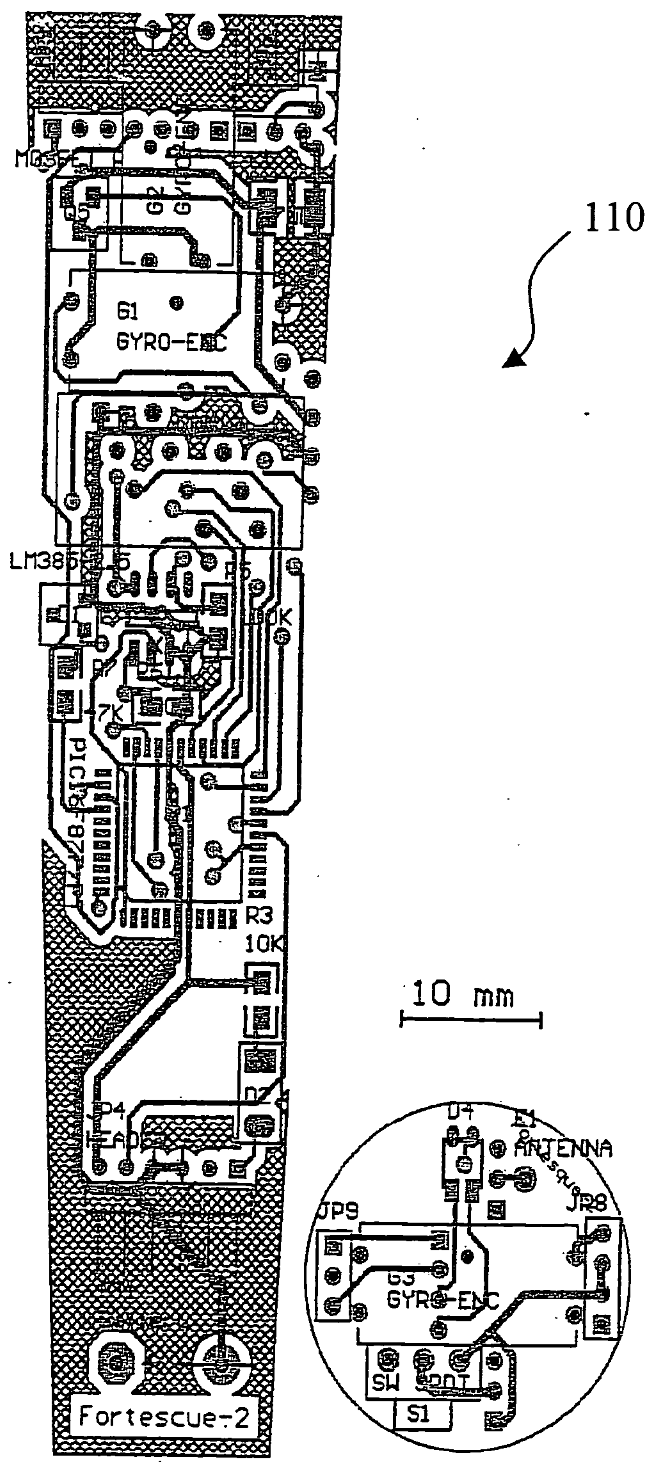

110
MOSFET
G2
G1
GYRO-ENC
LM385
P5
10K
P7
47K
PIC16F877
R3
10K
10 mm
D4
E1
ANTENNA
JP9
JP8
G3
GYRO-ENC
SW
S1
Fortescue-2

FIG. 6

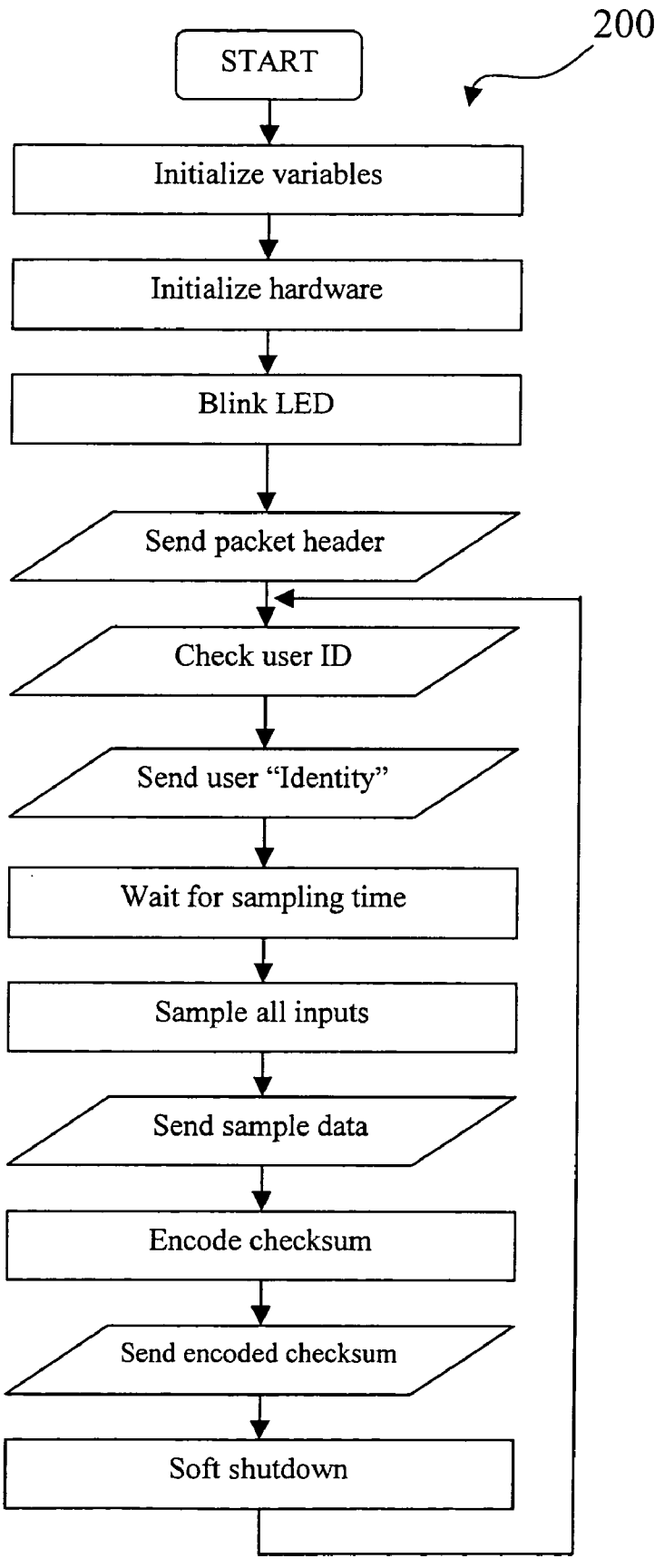
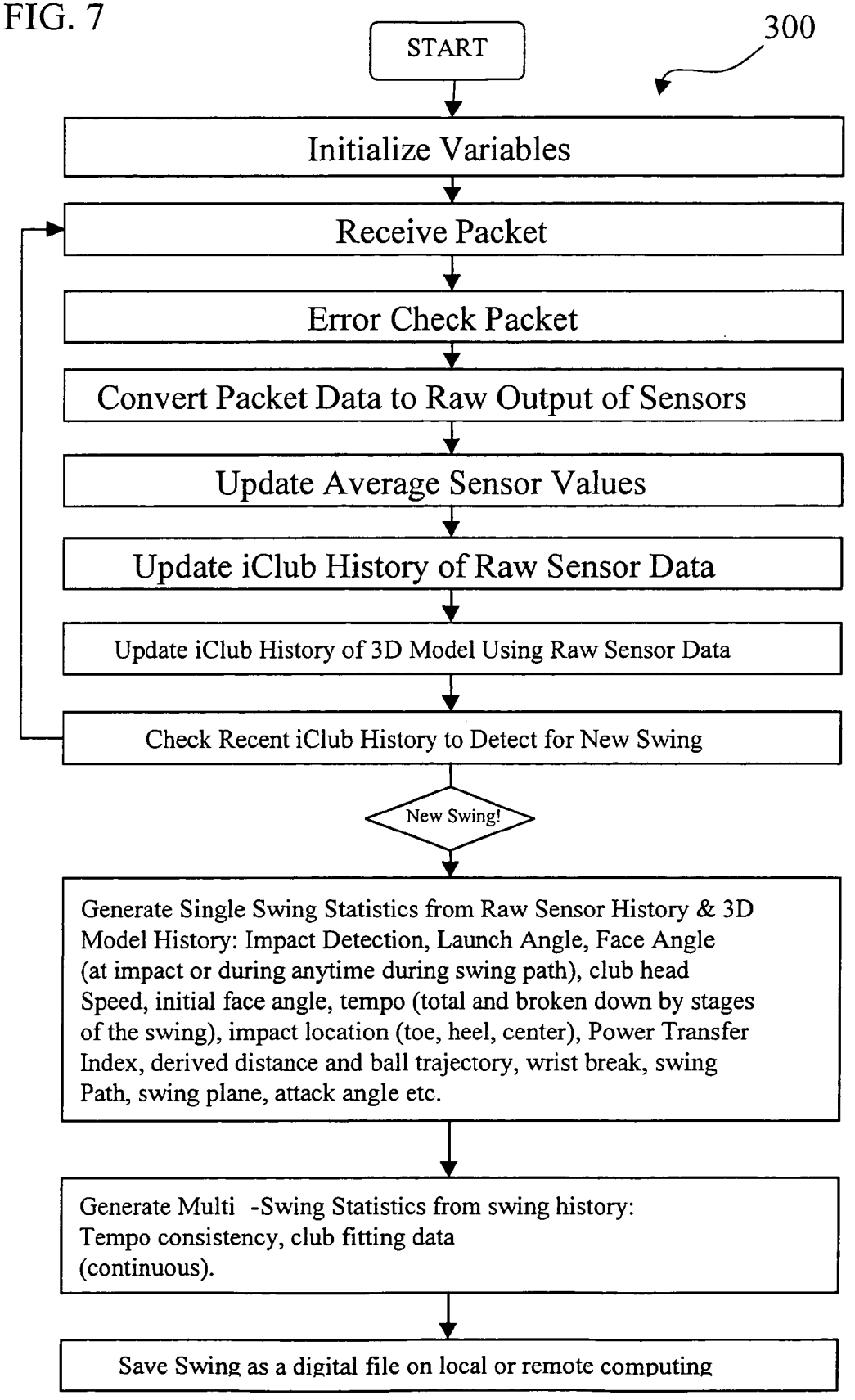

200
START
Initialize variables
Initialize hardware
Blink LED
Send packet header
Check user ID
Send user "Identity"
Wait for sampling time
Sample all inputs
Send sample data
Encode checksum
Send encoded checksum
Soft shutdown

FIG. 7


300
START
Initialize Variables
Receive Packet
Error Check Packet
Convert Packet Data to Raw Output of Sensors
Update Average Sensor Values
Update iClub History of Raw Sensor Data
Update iClub History of 3D Model Using Raw Sensor Data
Check Recent iClub History to Detect for New Swing
New Swing!
Generate Single Swing Statistics from Raw Sensor History & 3D Model History: Impact Detection, Launch Angle, Face Angle (at impact or during anytime during swing path), club head Speed, initial face angle, tempo (total and broken down by stages of the swing), impact location (toe, heel, center), Power Transfer Index, derived distance and ball trajectory, wrist break, swing Path, swing plane, attack angle etc.
Generate Multi -Swing Statistics from swing history: Tempo consistency, club fitting data (continuous).
Save Swing as a digital file on local or remote computing

METHOD AND APPARATUS FOR DETERMINING ORIENTATION AND POSITION OF A MOVEABLE OBJECT

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority to U.S. Provisional Application No. 60/435,183, filed Dec. 19, 2002, which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to motion tracking systems and more particularly to a method and apparatus for determining position and orientation of one or more moveable object(s).

BACKGROUND OF THE INVENTION

[0003] Technologies are known for determining and analyzing object motion through transmission of position and orientation information of the object to a processing system. Such technologies are utilized today in a variety of industries including navigation and entertainment. (See, for example, U.S. Pat. Nos. 6,001,014 to Ogata, et al.; U.S. Pat. No. 5,903,228 to Ohgaki, et al.; and U.S. Pat. No. 5,875,257 to Marrin, et al.; the teachings of all of which are incorporated herein by reference). In particular, wireless transmission of object motion data for analysis is continuing to be developed and utilized, and applications of such technology include the expanding industry of simulated "virtual reality" environments. (See, for example, U.S. Pat. No. 5,819,206 to Horton, et al., the teachings of which are incorporated herein by reference).

[0004] Object motion can be measured using sensors for determining motion parameters such as accelerometers and gyroscopes. Gyroscopes and accelerometers are well-known in the automotive and aerospace industries for providing motion information, establishing an inertial space reference, and allowing measurement of pitch and roll relative to a gravitational vector. Historically, the use of these sensors have been limited to large devices due to the weight and bulk of the sensors. However, technology improvements have produced smaller gyroscopes and accelerometers that can be utilized in a wide variety of applications where limited sensor space is available. (See, for example, U.S. Pat. No.: 5,898,421 to Quinn; and RE37,374 to Roston, et al.; the teachings of which are incorporated herein by reference).

[0005] Acceleration sensors, including accelerometers and strain gauges, have been utilized in sporting equipment, such as golf clubs, to provide analysis of golf swings. (See, for example, U.S. Pat. No. 5,694,340 to Kim and U.S. Pat. No. 5,233,544 to Kobayashi, the teachings of which are incorporated herein by reference). Such acceleration sensors can provide rotational information about the golf club, but the accuracy of such rotational information can be problematic.

[0006] U.S. Pat. No. 6,224,493 to Lee, et al., the teachings of which are incorporated herein by reference, discloses an instrumented golf club system with sensors to measure characteristics of a golf swing, including the use of an angular rate sensor. A distinctive feature of this instrumented golf club is the use of a data storage memory device located within the golf club that eliminates the need for radio transmission hardware. The data from a golf swing is captured internally and stored until the user is ready to download the data for further processing. Swing analysis can only be conducted after the internally stored swing information is downloaded to the external processing device.

[0007] There is therefore a need for an orientation and position tracking system installed on a moveable object, such as a golf club, which utilizes motion sensors and real-time wireless data transmission of orientation and position information for analysis and display.

SUMMARY OF THE INVENTION

[0008] An orientation and position tracking system in three-dimensional space and over time is disclosed utilizing inertial and other sensors for determining motion parameters to measure orientation and position of a moveable object. The sensors, for example vibrational and angular velocity sensors, generate signals characterizing the motion of the moveable object. The information is received by a data acquisition system and processed by a microcontroller. The data is then transmitted via wireless communication to an external data reception system (locally based or a global network). The information can then be displayed and presented to the user through a variety of means including audio, visual, and tactile.

[0009] In one aspect, the present invention provides for an intelligent golf club that provides golfers with real-time, precise and dynamically presented data, including swing analysis. A golfer takes a swing and a detailed analysis of club motion, launch conditions, club speed information, as well as contextual feedback is automatically downloaded into a computer system (including PDA, cellular phone, or over a network) for processing and display.

[0010] In another aspect, the present invention provides a method for determining orientation and position of a moveable object, comprising the steps of: generating orientation and position signals to measure orientation and position of the moveable object with at least one sensor for determining motion parameters; processing these signals with a microcontroller to generate orientation and position data; wirelessly transmitting said orientation and position data in real-time to a receiving device external to the moveable object; and analyzing and displaying orientation and position data.

BRIEF DESCRIPTION OF THE DRAWING

[0011] The invention is described with reference to the several figures of the drawing, in which:

[0012] **FIG. 1** is a functional diagram of an orientation and position tracking system according to one embodiment of the invention;

[0013] **FIG. 2** is a schematic illustration of a device utilizing the orientation and position tracking system according to one embodiment of the invention;

[0014] **FIG. 3** is a schematic illustration of a device utilizing the orientation and position tracking system and including a pressure sensor according to one embodiment of the invention;

[0015] **FIG. 4** is a schematic illustration showing the utilization of multiple devices in an orientation and position tracking system according to one embodiment of the invention;

[0016] **FIG. 5** is a detailed data flow model for a device utilizing the orientation and position tracking system according to one embodiment of the invention;

[0017] **FIG. 6** is a flow chart of the operational software for a motion and position sensing device installed on or in a moveable object according to one embodiment of the invention;

[0018] **FIG. 7** is a flow chart of the operational software installed on a computer system for analyzing and displaying transmitted orientation and position information according to one embodiment of the invention.

DETAILED DESCRIPTION OF VARIOUS EMBODIMENTS

[0019] The present invention provides for an orientation and position tracking system in three-dimensional space installed on or in a moveable object that utilizes inertial and other sensors for determining real-time motion parameters and real-time wireless transmission of that motion information to an external computer system (including PDA, cellular phone, or over a network). In one embodiment, the present invention provides for an intelligent golf club, the iClub™ (trademarked by Fortescue Corporation), that provides golfers with real-time, precise and dynamically presented data, including swing analysis. A golfer takes a swing and a detailed analysis of club motion, launch conditions, club speed information, as well as contextual feedback is automatically downloaded into an computer system (such as a PDA, cellular phone, or network). Swing history is stored and tracked over time, allowing users to monitor their progress, make swing adjustments, maintain a practice regime, and develop desired swing characteristics.

[0020] Referring now to the figures of the drawing, the figures constitute a part of this specification and illustrate exemplary embodiments of the invention. It is to be understood that in some instances various aspects of the invention may be shown exaggerated or enlarged to facilitate an understanding of the invention.

[0021] **FIG. 1** is a functional diagram of an orientation and position tracking system **10** according to one embodiment of the invention. A sensing device fitted with inertial and other sensors for determining motion parameters is installed on a moveable object, such as a golf club. In one embodiment, the sensors include multiple angular rate sensors, such as 3-axis vibration and rotational gyroscopes **12**. A variety of additional sensors **14**, **16** may also be added for determining position and orientation for additional applications. For example, a dual axis accelerometer may be added to the system to determine position and orientation relative to the earth's gravity, an electronic compass can be used to provide absolute position and orientation relative to a permanent magnetic field, and a GPS system may be added for similar results

[0022] Signals from the sensors are sent to a data acquisition system **18** that processes the information. In one embodiment, the data acquisition system **18** is installed internally on the moveable object; however, the system may also be an external component. The data is delivered to a wireless data transmission system **20** which transmits the data to a data reception system **22** on a computer (PDA, cellular phone, or network). The data is further processed and displayed to a user by means of an interface device **24**, such as a PC, a PDA, cellular phone, or network. The interface device **24** comprises software to process the data. This software can be configured based on the characteristics of the moveable object. For example, a user may select the style of golf club that he or she is using that comprises information on the physical and material properties of the golf club. This information is utilized by the software to enhance the accuracy of the information displayed. For example, the type of material of the golf club allows for an accurate analysis of the flex characteristics of the golf club shaft and the length of the golf club can be utilized for an accurate determination of the club head speed.

[0023] **FIG. 2** is a schematic illustration of one embodiment of a device **110** utilizing the orientation and position tracking system **10** according to one embodiment of the invention. The device **110** is attached to a desired moveable object **100**. Such objects may include sporting equipment, such as the golf club as shown in **FIG. 2**. In a preferred embodiment, the device **110** is attached to or otherwise integrated within the handle, grip, or shaft of the object **100**.

[0024] **FIG. 2** further illustrates the support body and schematic layout for the components of device **110** of the orientation and position tracking system **10** when disposed in a handle of object **100**. The system can be manually activated by a power switch **32** positioned on an orthogonal board **30** at the end of the handle that activates a power control circuit **34** to power up the system from an attached battery pack or other power source **36**. Alternatively, the system can be activated by a motion activation component that provides power upon movement of the object. An indicator LED **38** can be used as a visual cue to assess whether the system is operating properly.

[0025] In one embodiment, angular rate sensors **42**, **44**, **46** are positioned on the orthogonal board **30** and main board **40** to measure angular motion changes about three axes. In an embodiment utilizing a golf club, these motion changes comprise rotational motion within a swing plane of a golf stroke, motion perpendicular to the swing plane of the golf stroke, and rotation about a axis along the handle of the club. These motion changes can also be determined using combinations of motion parameter determining sensors such as gyroscopes or other additional sensors **48** such as accelerometers, electronic compasses and GPS units.

[0026] The data acquisition system **18** positioned on main board **40** comprises a microcontroller **50** having Analog to Digital inputs and pulse width modulating inputs. The microcontroller **50** receives data from the sensors **42**, **44**, **46**, and delivers data to the data transmission system. The data transmission system **20** comprises a transmitter circuit **52** and an antenna **54** for wireless transmission of data to a data reception system such as a PC, PDA, cellular phone, or network. The wireless transmission can be performed at any suitable frequency(s) and using any protocol(s) for transmitting the data, as known to one of ordinary skill in the art.

[0027] In another embodiment, the microcontroller **50** of the data acquisition system **18** may receive analog signals from the angular rate sensors **42**, **44**, **46** containing the

orientation and position information of the object **100** and then digitize the analog signals into digital data with an analog to digital converter component. The microcontroller **50** delivers the digital data to the data transmission system **20** for wireless transmission to the data reception system **22**. The user interface device **24** then analyzes and displays the received digital data.

[**0028**] In another embodiment, the inertial sensors, data acquisition system and data transmission system are incorporated within the handle, grip, or shaft of the object for which orientation and position are desired. In a golf club, these systems can be incorporated on or in the handle or grip portions of the shaft. This modular design provides for the present invention to be incorporated into pre-existing golf clubs.

[**0029**] **FIG. 3** is a schematic illustration of a device utilizing the orientation and position tracking system and including a pressure sensor according to one embodiment of the invention. One or more pressure sensors **26** installed on, within or behind an impact head of the moveable object **100**, i.e. golf club. These sensors can measure data including, strike location of the ball on the head, the spin imparted to the ball, and the impact force of the head on the golf ball which can be utilized to provide launch conditions of the golf ball's flight. This information can be processed by a controller and transmitted along with the motion information to the data receiving unit for analysis and display to a user.

[**0030**] **FIG. 4** is a schematic illustration showing the utilization of multiple devices in an orientation and position tracking system according to one embodiment of the invention. In one embodiment, the sensor, the microcontroller and the wireless transmitter are integrated into at least one modular component or node that is removable from said moveable object. Multiple modular nodes, each having a separate complement of elements, may be integrated with both unconnected objects and interconnected objects. For example, as shown in **FIG. 4**, modular nodes **112** and **114** are affixed to the shoulders and hips of a user in order to detect body motion during the golf swing. The detection of the motion from nodes **112** and **114** may be integrated with the orientation and position data determined by the node (device **110**) on the golf club, thereby providing more detailed information on the entire golf club swing system. Alternatively, multiple nodes may be utilized with multiple golf clubs, as for example in a class or teaching environment, with each device transmitting orientation and position data to centralized receiving and display units.

EXAMPLE 1

[**0031**] **FIG. 5** is a detailed data flow model of device **110** utilizing the orientation and position tracking system **10** according to one embodiment of the invention. **FIG. 6** is a flow chart **200** of the operational software for a motion and position sensing device installed on a moveable object according to the embodiment of the invention. The system is initialized and the LED provides a visual cue that the system is operational. The system software controls the identification of a user, the sampling of inputs and the encoding and sending of data concerning orientation and position information. The hardware device need not have an on-board memory for storing the orientation and position information. Instead, the information is transmitted in real-time to a data reception system, for example a PC, PDA, cellular phone, or network.

[**0032**] The real time, wireless motion and position sensing system operates in three-dimensional space and over time based on four modules: the sensor module, the microcontroller, the wireless module, and the support system module. The sensor module continually sends orientation and position signals to the microcontroller. The microcontroller then packages the data received from the sensor module and sends it to the wireless module. The wireless module transmits the packaged data to a device such as a PC, PDA, cellular phone, or network. The support module surrounds the other three modules, providing power to the system, as well as designer access tools. The modules will now be further described in detail.

[**0033**] Sensor Module

[**0034**] In one embodiment, the underlying sensor nodes in the sensor module are gyroscopes (such as Murata ENC-03JA/B). Each gyroscope measures angular velocity about a single axis. In order to achieve 3-dimensional data three gyroscopes are used, each positioned so that its sensing axis is orthogonal to every other gyroscope. The gyros send their angular velocity data directly to the microcontroller. Additional sensors including accelerometers, compasses, GPS systems may provide additional information based on particular motion and position sensing needs.

[**0035**] Microcontroller

[**0036**] The microcontroller system relies on a single Microchip Technology PIC 16F877 microcontroller, running off a 20 Mhz Panasonic-ECG EF0-BM2005E5 resonator. The main objective of the microcontroller is to receive data from the sensors, manipulate the data and send it to the wireless transmitter. The microcontroller utilizes three of its on-board analog-to-digital converters and pulse width modulated inputs to process the data. Finally, the data is packaged sent to the wireless module.

[**0037**] Wireless Module

[**0038**] The wireless module sends data wirelessly using a radio frequency transmitter (e.g. Radiometrix TX3-914-50) and an optimal antenna. The sending system formats the data appropriately for the receiving system.

[**0039**] Support System Module

[**0040**] The support system module has two power supply functions. First, it uses a switch (E-switch EG1270) to allow power to flow from an onboard battery to the microcontroller. The microcontroller then switches on a P-channel MOSFET (Fairchild Semiconductor NDS352P), which provides power to all devices in the system. Its second power function is to allow for recharging of the onboard battery. The support module contains a set of headers (Sullins Electronics Corp. PPPN401BFCN and PRPN401AEN) for internal and external connections; one of the headers allows a recharge to access the battery directly, bypassing all other components.

[**0041**] Further, there are a number of designer access tools in the support system module. First, there is the programmer port which is used to initially program the microcontroller. The programmer port uses a header (same headers as above) in order to allow the external programmer access to the microcontroller.

[**0042**] Second, the support module provides a communication port. This port is used to reprogram the microcontroller or access data directly, bypassing the wireless transmitter.

[0043] The final tool is a visual cue to the user/designer that the system has received power and is working properly. The system provides this cue using a dual color LED (Lite-ON Inc. LTST-C155KGJRKT).

EXAMPLE 2

[0044] **FIG. 7** is a flow chart **300** of the operational software installed on a computer system for processing and presenting orientation and position information according to one embodiment of the invention. The operational steps of the software will now be described in detail.

[0045] 1) Initialize Variables

[0046] As soon as the software program starts, a number of variables are named and allocated in memory for the program to store and access information. These initial variables are split into three major categories (with other supporting categories): main class variables, sensor variables, and 3D model variables.

[0047] 2) Receive Packet

[0048] The software program is constantly processing bytes of data as they stream into the computer system. The software program looks for packets of appropriately formatted data, and sends them to the next step in the program.

[0049] 3) Error Check Packet

[0050] Before each packet is passed on to the next step in the program, the software program ensures that the packet was not corrupted during wireless transmission.

[0051] 4) Convert Packet Data to Sensor Data

[0052] Sensor data is encoded across each new packet; therefore, the packet must correctly reassembled into sensor data before it can be intelligibly deciphered by the rest of the software program.

[0053] 5) Update Sensor Parameters

[0054] This step corrects for variations in sensor hardware that could be caused by a number of environmental changes (e.g. temperature variance, electromagnetic interference, etc.).

[0055] 6) Create Swing Model

[0056] At this point, the system enters an iterative loop in which sensor data is used to update an internal 3D model of a golf club. The software system processes both the sensor data and the 3D club model to match for a possible golf swing pattern. If a match occurs, the system creates an internal Swing Object representing that golf swing, storing both the sensor data and 3D model history inside this object. This Swing Object can then be saved directly to an available storage medium, such as a local hard drive or a remotely server accessible through available networks. Saved Swing Objects can later be reinterpreted by the system individually or as part of a series of Swing Objects.

[0057] 7) Generate Single-Swing Statistics and Feedback

[0058] The software program uses the newly captured golf swing to generate swing statistics. These statistics include, but are not limited to, impact detection, launch angle, face angle (at impact and at various moments of the swing path), club head speed, initial face angle, tempo breakdown by swing stage (address-to-top, top-to-impact, impact-to-finish), impact location (toe, heel, center), power transfer index, derived distance, ball trajectory, wrist break, and swing plane alignment. Using algorithms, the 3D model and/or swing statistics are used to provide detailed feedback

[0059] 8) Generate Multi-Swing Statistics and Feedback

[0060] The software program uses the single swing 3D models and statistics to generate multi-swing statistics. These statistics include, but are not limited to, tempo consistency (at address-to-top, top-to-impact and, impact-to-finish), club fitting data, long-term trends, training regimes

[0061] 9) Save Swing as a File

[0062] The software program saves each new swing as a file.

EXAMPLE 3

[0063] The operational steps for using an iClub system according to the present invention are described below:

[0064] Step 1:

[0065] Take a swing. The iClub does not even need to be manually activated and is smart enough to activate based on the motion of the swing. Waggle or warm-up the golf club as normal; the iClub is intelligent and can sense a real swing versus your warm up.

[0066] Step 2:

[0067] After you have swung the iClub, data is wirelessly transmitted to your hand held laptop, cell phone or other electronic device. There you can view real-time swing properties and gain feedback on your swing. If you would rather wait until later to view your results, go ahead, your feedback will be waiting for you whenever you want it.

[0068] Step 3:

[0069] If you happen to be connected to the Internet while at the golf course, you can gain valuable real-time analysis from our on-line swing engine which, among other things, is capable of correlating your long-term swing history with your handicap. Furthermore, the iClub System will let you know which equipment upgrades will improve your swing, which training methods to implement to eliminate a reoccurring problem, and even share information with your teaching professional.

[0070] The present invention is suitable for installation in a wide variety of objects and applications. Besides golf clubs, the present invention may be applied to tennis rackets, hockey sticks, fishing rods, baseball bats, swords, rifles, and other sporting equipment. Multiple sensors can be placed on the body to provide detailed body movement. Furthermore, the present invention can be utilized in joy sticks, 3D computer mice, and other computer user interface devices. In particular, the present invention can be utilized in virtual reality equipment for which position and orientation information is relied on extensively.

[0071] As described in Example 3, the present invention can be utilized as an instructional tool. The transmitted information can be stored by the computer analysis and display system for multiple swings of an individual golfer or other sport participant. The compilation of this data can be utilized to determine problems in a golfer's swing or to "fit" a golfer to an appropriate golf club. The large statistical

number of golf swings analyzed provided by the use of the present invention fosters the ability of these instructional techniques to provide accurate evaluations and a means for mass customization of golf and sporting equipment in general.

[0072] Other embodiments of the invention will be apparent to those skilled in the art from a consideration of the specification or practice of the invention disclosed herein. It is intended that the specification and examples be considered as exemplary only, with the true scope and spirit of the invention being indicated by the following claims.

What is claimed is:

1. An apparatus for determining orientation and position of a moveable object, comprising:

at least one sensor that determines motion parameters, wherein said at least one sensor generates orientation and position signals;

a microcontroller that processes the orientation and position signals to generate orientation and position data;

a wireless transmitter that transmits in real-time said orientation and position data;

wherein said sensors, said microcontroller and said wireless transmitter are integrated into or on said moveable object.

2. The apparatus of claim 1, further comprising a power source to provide power to said sensors, said microcontroller, and said transmitter.

3. The apparatus of claim 1, wherein said moveable object is a golf club.

4. The apparatus of claim 1, wherein the apparatus is disposed in or on the grip or shaft of said moveable object.

5. The apparatus of claim 1, wherein said at least one sensor includes an angular rate sensor.

6. The apparatus of claim 5, wherein said angular rate sensor includes a gyroscope.

7. The apparatus of claim 1, further comprising at least one additional sensor for determining motion parameters.

8. The apparatus of claim 1, wherein said at least one sensor includes three gyroscopes.

9. The apparatus of claim 1, wherein said at least one sensor is selected from the group consisting of: an accelerometer, a gyroscope, an electric compass, a GPS unit, and any combination thereof.

10. The apparatus of claim 1, wherein said microcontroller includes an integrated analog to digital conversion component, and wherein said microcontroller digitizes said orientation and position signals to generate digital orientation and position data.

11. The apparatus of claim 1, further comprising at least one pressure sensor installed on, within, or behind an impact surface of said moveable object.

12. The apparatus of claim 1, wherein said at least one sensor, said microcontroller and said wireless transmitter are integrated into at least one modular node that is removable from said moveable object.

13. The apparatus of claim 12, wherein said apparatus includes at least two modular nodes, each modular node including a separate complement of elements.

14. The apparatus of claim 13, wherein each said at least two modular nodes are integrated into unconnected objects.

15. The apparatus of claim 13, wherein each of said at least two modular nodes are integrated into inter-connected objects.

16. The apparatus of claim 13, wherein two modular nodes are affixed to the hips and shoulders of a user to detect body motion.

17. The apparatus of claim 13, wherein said at least two nodes detect the motion of multiple golf clubs.

18. The apparatus of claim 1, wherein said moveable object is a game controller.

19. The apparatus of claim 1, wherein said moveable object is a controller in a virtual reality simulation.

20. A system for determining orientation and position of a moveable object, comprising:

at least one sensor installed on or in a moveable object for generating orientation and position signals;

data acquisition means for processing orientation and position signals and that generates orientation and position data;

wireless data transmission means for wirelessly transmitting in real-time said orientation and position data;

data reception means for receiving said orientation and position data transmitted by said wireless data transmission means; and

processing and presenting means for processing and presenting said orientation and position data in a desired format.

21. The system of claim 20, wherein said data reception means is selected from the group consisting of: a laptop computer, a personal computer, a personal digital assistant, a cellular phone, a network, and any combination thereof.

22. The system of claim 20, wherein said at least one sensor includes an angular rate sensor.

23. The system of claim 22, wherein said angular rate sensor includes a gyroscope.

24. The system of claim 20, further comprising at least one additional sensor for determining motion parameters.

25. The system of claim 20, wherein said at least one sensor includes three gyroscopes.

26. The system of claim 20, wherein said at least one sensor is selected from the group consisting of: an accelerometer, a gyroscope, an electric compass, a GPS unit, and any combination thereof.

27. The system of claim 20, wherein said at least one sensor, said data acquisition means, and said wireless data transmission means are disposed in or on the grip or shaft of said moveable object.

28. A method for determining orientation and position of a moveable object, comprising:

generating orientation and position signals to measure orientation and position of the moveable object with at least one sensor for determining motion parameters;

processing said and orientation and position signals with a microcontroller to generate orientation and position data;

wirelessly transmitting said orientation and position data in real-time to a receiving device external to said moveable object;

processing and presenting said orientation and position data.

29. The method of claim 28, wherein said receiving device is selected from the group consisting of: a laptop computer, a personal computer, a personal digital assistant, a cellular phone, a network, and any combination thereof.

30. The method of claim 28, wherein orientation and position data from motion of the moveable object are stored in the receiving device.

31. The method of claim 28, wherein said at least one sensor comprises an angular rate sensor.

32. The method of claim 31, wherein said angular rate sensor includes a gyroscope.

33. The method of claim 32, wherein at least one additional sensor generates orientation and position signals.

34. The method of claim 32, wherein said at least one sensor includes three gyroscopes.

35. The method of claim 32, wherein said at least one sensor is selected from the group consisting of: an accelerometer, a gyroscope, an electric compass, a GPS unit, and any combination thereof.

36. The method of claim 32, wherein said at least one sensor, said microcontroller, and means for the wireless transmission of data are disposed in or on the grip or shaft of said moveable object.

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