

(51) International Patent Classification:
A63F 13/06 (2006.01)(21) International Application Number:
PCT/US2011/046423(22) International Filing Date:
3 August 2011 (03.08.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/370,439 3 August 2010 (03.08.2010) US
61/371,161 5 August 2010 (05.08.2010) US
61/386,207 24 September 2010 (24.09.2010) US(71) Applicant (for all designated States except US): **INTEL-LISYS GROUP, LLC** [US/US]; Cambridge Innovation Center, 1 Broadway, 14th Floor, Cambridge, MA 02142 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **ROGEL, Lawrence, S.** [US/US]; 115 Stedman Street, Brookline, MA 02446 (US). **OSSENMACHER, Jason, J.** [US/US]; 23052 Alicia Parkway, #506, Mission Viejo, CA 92692 (US). **WILLIAMS, Jon** [US/US]; 90 Norfolk Street, Cambridge, MA 02139 (US). **WITMER, David** [US/US]; 32 Hereford Street, Boston, MA 02115 (US). **GARCIA, Matt** [US/US]; Cambridge, MA (US).(74) Agents: **POWSNER, David, J.** et al.; Nutter Mcclennen & Fish LLP, Seaport West, 155 Seaport Boulevard, Boston, MA 02210-2604 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI,

[Continued on next page]

(54) Title: DIGITAL DATA PROCESSING SYSTEMS AND METHODS FOR SKATEBOARDING AND OTHER SOCIAL SPORTING ACTIVITIES

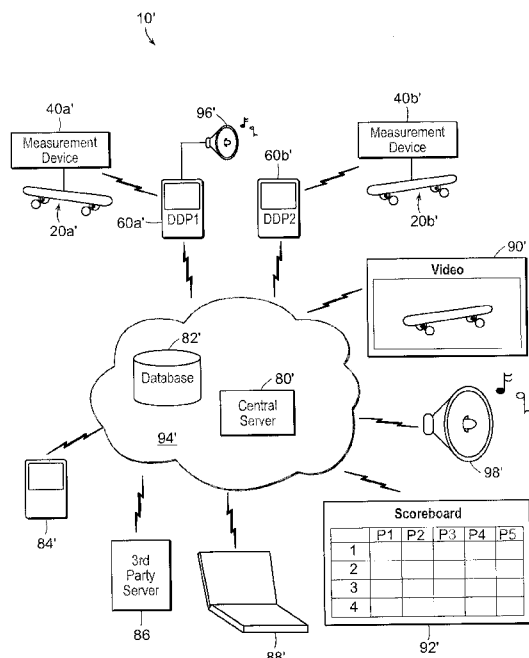


FIG. 4

(57) Abstract: Systems and methods for social and other sporting activities. A system according to one such aspect of the invention comprises a sensing device that is attached to an object, such as a skateboard (by way of non-limiting example), for measuring characteristics thereof. It communicates those characteristics wirelessly, e.g., via bluetooth, to a mobile device, such as a cell phone, personal digital assistant, or the like (by way of non-limiting example). That device can log and/or display those characteristics, graphically, for study or analysis by the operator (e.g., the skateboard enthusiast) or others.



NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU,
SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM,
TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM,
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EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,
LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,
SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, ML, MR, NE, SN, TD, TG).

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

DIGITAL DATA PROCESSING SYSTEMS AND METHODS FOR SKATEBOARDING AND OTHER SOCIAL SPORTING ACTIVITIES

Background of the Invention

This claims the benefit of filing of co-pending, commonly assigned United States Patent Application Serial No. 61/370,439, filed August 3, 2010, United States Patent Application Serial No. 61/371,161, filed August 5, 2010, and United States Patent Application Serial No. 61/386,207, filed September 24, 2010, all entitled "DIGITAL DATA PROCESSING SYSTEMS AND METHODS FOR SKATEBOARDING AND OTHER SOCIAL SPORTING ACTIVITIES," the teachings of all of which are incorporated by reference herein.

The invention relates to sensing devices and systems for skateboarding and other social sporting activities. It has application in publicizing feats and facilitating competition among like-minded enthusiasts.

Skateboarders, as well as other social sporting enthusiasts, like to perform tricks using their skateboards. They practice the tricks over and over, either alone or in groups. They may perform these tricks in a skatepark, playground, or other spaces that have not been designed for skateboarding. They share their tricks, have similar musical interests, and are always in search of new places to try out their tricks. Moreover, skateboarders often buy their equipment from local skateboard shops. Skateboarders usually listen to music while they skate.

Social sporting enthusiasts can typically only display their feats to others in the same locale. For example, a skateboarder who has perfected a multiple varial heel flip, is usually limited to proving his/her prowess to friends at the local park. One of them might text or "tweet" news of the feat to others, but that is likely to be dismissed as unbelievable, particularly, if the feat is extraordinary. Some of that disbelief might be dispelled by posting of a video of the feat, but even that may be subject to skepticism.

An object of the invention is to provide improved sensing devices, improved systems and improved methods for skateboarding.

A related object is to provide such improved sensing devices, systems and methods as can be used in connection with other social sporting activities.

A related object is to provide such improved sensing devices, systems and methods as can be used in connection with other physical activities, regardless of whether social or sporting.

A further related object of the invention is to provide such improved sensing devices, systems and methods as can be used to publicize feats of skateboarders, other social sports enthusiasts and others.

A further related object of the invention is to provide such improved sensing devices, systems and methods as can be used to facilitate interaction and/or competition among remotely disposed skateboarders, other social sports enthusiasts and others.

Summary of the Invention

The foregoing are among the objects attained by the invention, which provides in some aspects devices, systems and methods for social and other sporting activities. A system according to one such aspect of the invention comprises a sensing device that is attached to an object, such as a skateboard (by way of non-limiting example), for measuring characteristics thereof. It communicates those characteristics wirelessly, e.g., via bluetooth, to a mobile device, such as a cell phone, personal digital assistant, or the like (by way of non-limiting example). That device can log and/or display those characteristics, graphically, for study or analysis by the operator (e.g., the skateboard enthusiast) or others.

Related aspects of the invention provide a system, for example, as described above, in which the mobile device—in addition to or instead of logging and/or displaying the measured characteristics—transmits them to a server digital data processor, e.g., along with still images, video images, location and/or other information generated by the mobile device. The still/video images may be, for example, images generated by a camera on-board the mobile device. The location information may be, for example, GPS or other location data collected by that device. That other information may be identifying information specific to the mobile device, e.g., phone number, ESN, serial number, or so forth.

Further related aspects of the invention provide a system, for example, as described above, in which the server digital data processor logs the measured characteristics, along with still/video images, location information and/or other information, and makes them available for access by the aforementioned mobile device and/or by other data processing apparatus, such as, cell phones, personal digital assistants, portable computer, desktop computers, and so forth, of other enthusiasts—including other operators.

Still further related aspects of the invention provide a system, for example, as described above, in which the server digital data processor makes the measured characteristics,

still/video images, location information and/or other information available for access via an addressable site on the Internet and/or via a social networking web site.

Yet still further aspects of the invention provide a system, for example, as described above, in which the server digital data processor, mobile devices, cell phones, personal digital assistants, portable computer, desktop computers and/or other data processing apparatus of the first aforesaid operator and/or of the other enthusiasts facilitate a challenge by one of those other enthusiasts, e.g., to surpass some or all of the measured characteristics of the first aforesaid operator, and/or vice versa—e.g., to engage in a competition.

Related aspects of the invention provide a system, for example, as described above, in which the mobile device of a competing enthusiast collects like information measured by a sensing device attached to an object, again, for example, a skateboard, operated by that enthusiast, and transmits that to the server digital data processor, e.g., along with still images, video images, location and/or other information generated by that mobile device.

Still yet further related aspects of the invention provide a system, for example, as described above, in which the server digital data processor, mobile devices, cell phones, personal digital assistants, portable computer, desktop computers and/or other data processing apparatus of the first aforesaid operator and/or of the other enthusiasts initiate communications to operators when their measured characteristics have been exceeded by other enthusiast-operators.

Still yet further aspects of the invention provide a system, for example, as described above, in which the server digital data processor, mobile devices, cell phones, personal digital assistants, portable computer, desktop computers and/or other data processing apparatus of the first aforesaid operator and/or of the other enthusiasts facilitate a live competition among operators.

Still yet further aspects of the invention provide a system, for example, as described above, in which the server digital data processor, mobile devices, cell phones, personal digital assistants, portable computer, desktop computers and/or other data processing apparatus of the first aforesaid operator and/or of the other enthusiasts facilitate display the live competition to other enthusiasts, e.g., by webcast or otherwise.

Other aspects of the invention provide a system, for example, as described above, in which the sensing device includes a motion and/or other physical characteristic sensor (e.g., a sensor for speed, acceleration, jerk, yaw, pitch, roll, and so forth), as well as a bluetooth or other wireless transmitter.

Other aspects of the invention provide a system, for example, as described above, in which the mobile device includes (i) a bluetooth or other wireless receiver for receiving measured characteristics transmitted by the sensing device, and (ii) wifi, Edge, or other radio for transmitting measured characteristics, along with still/video images, location information and/or other information, to the server digital data processor.

Other aspects of the invention provide a system, as described above, for example, that generates an audio output based on the determined characteristic(s) of the object.

Related aspects of the invention provide a system, as described above, for example, in which the mobile device includes an audio output module capable of generating an audio output based on a prompt by the user and/or the data transmitted by the sensing device. In one aspect, the mobile device is capable of manipulating the audio output generated by the audio output device based on the data transmitted by the sensing device.

Other aspects of the invention provide a system, as described above, for example, which includes an audio output device remote from the mobile device.

Other aspects of the invention provide a system, for example, as described above, in which the mobile device executes applications software providing one or more of the functions that are attributed above to the mobile device.

Other aspects of the invention provide a system, as described above, for example, that generates an action to be performed by one or more objects, and determining if the actions were completed successfully. Related aspects allow a user to select the action to be performed or to prompt the mobile device to generate an action (which may be pre-selected, randomly selected, or otherwise) to be performed. Related aspects allow the mobile device to determine a winner between users of two or more objects performing the actions. Related aspects include allowing users of the primary or a secondary mobile device to alert the primary mobile device that the actions were completed successfully.

Related aspects of the invention provide a sensing device as described above.

Related aspects of the invention provide a mobile as described above.

Related aspects of the invention provide a server digital data processor as described above.

Related aspects of the invention provide methods of operating one or more of the a sensing device, mobile device, and/or server digital data processor as described above.

Brief Description of the Drawings

A more complete understanding of the invention may be attained by reference to the drawings, in which:

FIGURE 1 depicts a system according to the invention for generating, transmitting, and analyzing data related to the physical characteristic(s) of an object for use, e.g., in connection social and other sporting activities;

FIGURE 2 schematically depicts a measurement device (a/k/a sensing device) according to the invention for generating and transmitting data for use in the system of FIGURE 1;

FIGURES 3A-3B depict user interfaces of a system according to the invention for the display of information regarding a physical characteristic of the object of FIGURE 1;

FIGURE 4 depicts another embodiment of a system according to the invention for generating, transmitting, analyzing, and sharing data related to the physical characteristic(s) of an object;

FIGURE 5 depicts an exemplary user interface for the display of information in the system of FIGURE 4.

Detailed Description of the Illustrated Embodiment

Introduction

Despite the multitude of advanced technology found in the components of modern skateboards, there is very little technology dedicated to measuring the tricks that skateboarders perform. The old adage due to Lord Kelvin, “if you can’t measure it, you can’t improve it” applies to skateboarders. Systems according to the invention—hereinafter, referred to as “shuss”—comprise hardware and software that measures the feats (e.g., tricks) that skateboarders and enthusiasts of other sporting and non-sporting activities perform. For sake of convenience, and without loss of generality, the shuss system will be described in connection with skateboarding in much of the discussion below, though, it will be appreciated that it can be used in connection other sporting and non-sporting activities, as well.

As will be evident below, there are several uses of the shuss. It can be used to “score” or “rate” a particular trick. Unlike the prior art, where tricks are based on the opinion of judges, shuss provides an unbiased, objective measure. In addition, the trajectory and motion of the skateboard through space can be visualized, replayed, and compared any number of times on a computer or even a smartphone. This can be used to improve the skaters performance.

The shuss helps to engage a community of skaters with the extended shuss system. Using geolocation and a database, it is possible for individuals to declare themselves “king of the park”. Yet another use of shuss is as a way of engaging a set of visitors to a festival. For example, contestants that can jump higher than a certain amount will win a T-shirt.

Skateboarders, as well as other social sporting activities, like to perform tricks using their skateboards. They practice the tricks over and over, either alone or in groups. They may perform these tricks in a skatepark, playground, or other spaces that have not been designed for skateboarding. They share their tricks, have similar musical interests, and are always in

search of new places to try out their tricks. Moreover, skateboarders often buy their equipment from local skateboard shops. Skateboarders usually listen to music while they skate.

The invention leverages these different and unique characteristics of skateboarders. There are other groups that share these characteristics and so our invention is not limited to skateboarders. The invention involves hardware, mobile devices, and computer services, although we believe that not all components are necessary.

FIGURE 1 depicts the shuss or other system 10 according to the invention for generating, transmitting, and analyzing data related to the physical characteristic(s) of an object for use, e.g., in connection social and other sporting activities. The illustrated system includes measurement device (a/k/a sensing device) 40 that is attached to a skateboard or other operator-enthusiasts's object 20 and that is in wireless communications coupling with a mobile device (a/k/a portable digital data processor) 60.

The measurement device 40 measures motion and/or other physical characteristic of the object, e.g., speed, acceleration, jerk, yaw, pitch, roll, and so forth), and communicates those to the mobile device 60, which executes application or other software, firmware or the like, to log, analyze, and/or display that information.

Object

The object 20 of the illustrated embodiment is a skateboard. However, in other embodiments, it may be a surfboard, rollerblade boot, or other object having a characteristic that can be measured according to the teachings herein. The sensing device can be applied to measure or determine a wide variety of characteristics of such objects, the following list of which is intended to provide non-limiting examples of characteristics that can be measured and/or determined in accord with the teachings herein: position, velocity, acceleration, jerk, orientation, rotation, altitude, wind speed, temperature, vibration, etc. By way of non-limiting examples, the object (and an exemplary characteristic) can be, inter alia, a golf club (swing

profile), a person diving off a springboard (rotation rate), or a dog on an agility course (path and speed through weave sticks).

The measurement device 40 can be coupled to any portion of the object 20. Preferably, the coupling is such that the measurement device 40 is protected from damage and maintains a given orientation relative to the object to provide accurate data regarding the characteristic(s) of interest. For example, because nearly the entire surface of the skateboard 20 depicted in FIGURE 1 gets stepped on, grinded, or slammed against another object, the measurement device 40 can be coupled to or disposed within a riser or spacer 24 that is disposed between the deck 22 and one of the trucks 26 (which connects the wheels 28 to the deck 22). The measurement device 40 is preferably placed in the riser or spacer 24 such that the deck 22 and the truck 26 protect the measurement device 40 from collisions. In some embodiments, more than one measurement device 40 can be coupled to the object to allow for additional data to be generated regarding the characteristic(s) of interest. For example, a skateboard 20 can have two measurement devices attached thereto, with each measurement device 40 coupled to one of the risers 24.

Measurement Device

The measurement device 40 coupled to the object 20 can have a variety of configurations according to the intended use of the measurement device 40 and the object 20 to which it is coupled. As shown in FIGURE 2, the measurement device 40 generally contains one or more sensor(s) 42a-d, a controller 44, a wireless communication module 46, and a power source 48, although fewer, more, or different components can be included within the measurement device.

In a preferred embodiment as depicted in FIGURE 2, the measurement device 20 is an Inertial Measurement Unit (IMU) chip. A person skilled in the art will appreciate that IMUs of the type commercially available in the marketplace, modified in accord with the teachings

of herein, can be used to generate kinetic data. The IMU chip depicted in FIGURE 2 contains four sensor(s) 42a-d, a controller 44, a power source 46, and a wireless communication module 48.

The sensors 42a-d can be configured to generate or obtain data about a characteristic of the object 20. The sensor(s) 42a-d can be any sensor known in the art or hereafter developed, modified in accord with the teachings of the invention, capable of generating data about a characteristic of the object 20. The sensors can be used alone or in combination according to the teachings of this invention, and it is within the skill of the ordinary artisan to select the particular sensor(s) to be included within the measurement device 20 depending on the data to be collected for a particular application, in light of the teachings herein. By way of example, the sensors 42a-d can obtain kinetic data that includes measurements about any one of, inter alia, the object's 20 location, orientation, velocity, acceleration, and rotation.

In a preferred embodiment, the sensor(s) 42a-d can be any of an accelerometer, a gyroscope, or a magnetometer. By way of non-limiting example, the measurement device 20 depicted in FIGURE 2 includes each of an accelerometer 42a, a single-axis gyroscope 42b, a dual-axis gyroscope 42c, and a triple-axis magnetometer 42d. Generally, each of these components can be used to generate kinetic data about the object to which the measurement device 20 is attached. For example, the accelerometer 42a can generate data concerning the linear acceleration of the measurement device 40. In a preferred embodiment, the accelerometer 42a can generate data concerning the acceleration of the measurement device 20 along three orthogonal axes (i.e., along an x-, y-, and z-axis). The ADXL335 manufactured by Analog Devices of Norwood, Massachusetts is an example of a suitable three-dimensional accelerometer for use in accord with the teachings of the invention.

The single- and dual-axis gyroscopes 42b, 42c can generate data concerning the rotational motion of the measurement device 40. The LY530AL manufactured by STMicroelectronics of Geneva, Switzerland is an example of a suitable single-axis gyroscope for use in

accord with the teachings of the invention. The LPR530AL manufactured by STMicroelectronics of Geneva, Switzerland is an example of a suitable dual-axis gyroscope for use in accord with the teachings of the invention.

The magnetometer 42d can generate data concerning the orientation of the measurement device 42. In a preferred embodiment, the magnetometer 42d is a triple-axis magnetometer that generates data concerning the three-dimensional orientation of the measurement device 40. The HMC5843 manufactured by Honeywell International, Inc. of Plymouth, Minnesota is an example of a suitable triple-axis magnetometer for use in accord with the teachings of the invention.

As depicted in FIGURE 2, the exemplary measurement device 40 includes a communication module 46 that enables the transfer of data generated by the sensors 42a-d to the portable digital data processor 60. Although the communication module 46 can be configured to allow for wired transmission of data (e.g. through a cable connection, USB device, flash-drive, or otherwise) between the measurement device 40 and the portable digital data processor 60, the measurement device 40 is preferably wirelessly connected to the portable digital data processor 60 via a wireless communication system arranged in known manners and utilizing known protocols to effect remote communication therebetween, modified in accord with the teachings herein.

In a preferred embodiment, the wireless communication module 46 is a Bluetooth SMD chip that enables remote communication with a receiver that is configured to receive a Bluetooth signal. As will be appreciated by a person skilled in the art, other wireless communication modules, either known in the art or developed hereafter and modified according to the teachings herein, can be used to establish wireless communication between the measurement device 40 and the portable digital data processor 60. By way of non-limiting example, the data may be transferred using WiFi, radio, infrared communication, or otherwise.

As depicted in FIGURE 2, the exemplary measurement device 40 also includes a controller 44 that controls or configures the various components of the measurement device 40. The controller 44 can perform any number of functions, as will be appreciated by a person skilled in the art, depending on the particular application for which the measurement device 40 is used. By way of example, the controller 44 can configure the communication module 46 upon initially powering up or upon reset of the measurement device 40. The controller 44 can direct the communication module 46 to pair with a first-detected portable digital data processor 60. This first-detected portable digital data processor 60 can be recognized by the controller 44 as the primary portable digital data processor. The controller 44 can be configured to respond to commands given by the primary portable digital data processor to have the measurement device 40 perform any number of tasks such as, inter alia, powering off, entering sleep mode, gathering and/or transmitting data, controlling the transmission rate of data (e.g., 100 Hz) and/or pairing with additional portable digital data processors, as will be described in detail below.

The controller 44 can also process or control the processing of data. For example, the generated data can be processed locally to generate information related to a characteristic of the object or can be transmitted to the digital data processor 60 for analysis. For example, the controller 44 can compress the data generated by the components of the measurement device 40 (e.g., kinetic data generated by sensors 42a-d) and/or perform some initial analysis of the data to reduce the amount of data transmitted by the communication module 46. By way of non-limiting example, the controller 44 can determine if the data generated by the magnetometer 42d appears faulty or distorted (as can occur when the magnetometer 42d is located in proximity to an object that alters the local magnetic field), and if so, prevent the transmission of this data. The controller 44 can also command the communication module 46 to transmit data only from selected sensors (e.g., only the three readings from the accelerometer 42a). As will be discussed in further detail below in regards to the processing of data which can be performed by the portable digital processor 60, the controller 44 can also be programmed to process the data generated by the sensors 42a-d to generate information about a

characteristic of the device. For example, the controller can process the data substantially the same as, or even in place of the portable digital data processor 60. Alternatively, the controller can be configured to recognize, for example, the start of an action of interest such that the communication module 46 will not transmit data until the action is initiated. By way of example, the controller 44 can be configured to recognize an “Ollie” such that the communication module 46 only transmits data related to that particular trick.

As depicted in FIGURE 2, the measurement device 40 can also include a power source 48. As will be appreciated by the skilled artisan, any of a variety of power sources modified in accord with the teachings herein can be used to provide power to the components of the measurement device 40. Preferably, the power source is rechargeable. For example, a LiPo battery can be integrated on the IMU chip. Though not shown, the measurement device 40 can include a socket into which a plug may be inserted to charge the power source 48. A cap can be used to cover the socket when the power source 48 is not being charged to keep out dirt and dust. Other methods of charging a power source 48 are known and can be adapted to work in concert with the teachings of this invention.

In order to extend the life of the power source 48, the measurement device 40 can be configured to enter sleep mode during non-use or inactivity. For example, the measurement device 40 can enter sleep mode if the communication module 46 is unable to connect to the portable digital data processor 60 for a pre-determined time (e.g., five minutes). Sleep mode can also be initiated, for example, by a prompt from a user (e.g., a command generated by the portable digital data processor 60 and transmitted to the measurement device 40 through the communication module 46) or by physically pressing a switch coupled to the measurement device 40. Additionally, the communication module 46 (e.g., a Bluetooth SMD chip) can default to operate in low-power mode such that the measurement device 40 conserves the power source. By way of example, a wireless communication module 46 operating in low-power mode can reduce the signal strength such that the portable digital data processor 60 must be within a given distance (e.g., 10 meters) of the measurement device 40 in order to communi-

cate.

The measurement device 40 can be configured to exit sleep mode (i.e., activate) following a stimulus and/or prompt by the user. Because the communication module 46 typically consumes the most power, the measurement device 40 is preferably activated without the communication module 46 having to be on to detect the stimulus or prompt. By way of example, the measurement device 40 can be configured to activate when the accelerometer 42a generates an interrupt in response to movement of the measurement device 40 and the object 20 to which it is attached. The interrupt could be generated by the detection of any movement, or alternatively, by a specific pattern of movement (e.g. three taps of the object 20 to which the measurement device 40 is coupled). Alternatively, the measurement device 40 can be activated by actuating a switch.

The measurement device 40 can also include an audio output device or module that generates an audio output (e.g., a song and/or sound or series of sounds), as will be discussed in detail below.

Portable Digital Data Processor

Again referring to FIGURE 1, the system 10 also includes a portable digital data processor 60. As will be appreciated by a person skilled in the art, the portable digital data processor 60 can be any of a variety of commercially available processors or computers, modified in accord with the teachings herein, capable of receiving data from the measurement device 40 and capable of processing the data so as to generate information about a characteristic of the object 20 to which the measurement device 40 is attached. By way of non-limiting example, any of a computer, laptop, personal data assistant (PDA), or smart phone can be configured according to the teachings herein.

The portable digital data processor 60 can process the data about a characteristic of the object 20 to which the measurement device is attached. The portable digital data proces-

sor 60 can process the data, using known filters (e.g., high-pass, low-pass, and Kalman filters), formulas, and/or algorithms hereafter developed and modified according to the teachings herein, to generate information about a characteristic of the object (e.g., kinetic and/or spatial information) and/or assign that characteristic a rating (e.g., a tabulated score). For example, because a particular action can be defined by a sequence of transitions and overlaps between the values associated with different sensors 42a-d, the portable digital data processor 60 can identify the action (e.g., a specific trick) and assign a rating relative to a pre-determined standard.

As shown in FIGURE 1, the portable digital data processor 60 can include one or more modules for the receiving, transmitting, processing, storage, generation and/or display of data and/or information about the characteristic(s) of the object 20. The portable digital data processor (e.g. mobile device) can also include an audio output device or module that generates an audio output (e.g., a song and/or a sound or series of sounds).

In an exemplary embodiment, the portable digital data processor 60 is a smart phone having a communication module capable of receiving the wireless communication signals generated by the measurement device 40. In this way, the smart phone can be held, for example, in a skateboarder's pocket within transmission range of the measurement device 40. Alternatively, the portable digital data processor 60 can be stationary relative to the object 40. For example, the portable digital data processor 60 can be a laptop computer that is positioned in proximity to a ramp or jump on which a characteristic of the skateboard will be determined. Alternatively, the measurement device 40 can generate and store the data such that the data can be transmitted to the portable digital data processor 60 when the measurement device 40 is brought within range of the portable digital data processor 60, or alternatively, upon a command generated by the portable digital data processor 60 for the measurement device 40 to transmit the data.

The data generated by the measurement device 40 and transmitted to the communica-

tion module of the portable digital data processor 60 can be processed according to methods and algorithms known by those skilled in the art modified according to the teachings herein to obtain information about the object's 20 characteristic(s) of interest. The use of software, currently available or hereafter developed and modified in accord with the teachings herein, can be used to process the data generated by the measurement device 40.

For example, kinetic data generated by the sensor(s) 42a-d concerning the linear acceleration, rotational motion, and orientation of the measurement device 40 can be transmitted from the measurement device 40 to the portable digital data processor 60. The kinetic data received from the measurement device 40 can be processed by the portable digital data processor 60 to generate information about the object 20 to which the measurement device 40 is coupled. By way of non-limiting example, the portable digital data processor 60 can process the kinetic data to determine information relating to the motion, position, and/or orientation of the object 20 ("kinetic information").

In one embodiment, the portable digital data processor 60 can include a data generation module capable of generating data that can be used to generate additional information about a characteristic of the object 20 and/or the circumstances in which the characteristic was measured. By way of non-limiting example, the data generation module can be a location sensor that generates information about the physical location of the portable digital data processor 60. As will be appreciated by one of skill in the art, commercially available portable digital data processors can include a location sensor (e.g., GPS) that generates position data that can be processed according to the teachings herein. In this way, the portable digital data processor 60 can correlate the data received from the measurement device 40 and the data generated by the location sensor to generate a record containing information about the characteristic(s) of the object 20 and the location of the object 20 at which the characteristic was determined. By way of example, if the portable digital data processor 60 is carried in the pocket of a skateboarder, the location sensor of the portable digital data processor 60 can generate data that can be processed to associate the location of the skateboarder (e.g., a par-

ticular skate park and even a particular ramp/trick site) with the characteristic(s) of interest.

In one embodiment, the data generation module of the portable digital data processor 60 can help determine, for example, the airtime and height associated with a jump. By way of example, the portable digital data processor 60 can analyze the data of the data generation module capable of sensing vibrations caused by the object rolling over the ground, and the reduction in vibrations when the object is in the air) to determine characteristic information of height and airtime.

The portable digital data processor 60 can also include a multimedia capture module that allows the user of the portable digital data processor 60 to capture or generate multimedia content (e.g., text, images, video, and/or audio). As will be appreciated by one of skill in the art, commercially available portable digital data processors modified in accord with the teachings herein can include, inter alia, a keypad, a camera, or a microphone capable of generating multimedia content. Alternatively, the portable digital data processor 60 can acquire the multimedia content via a built-in or attached camera and/or via downloading from other devices/systems (e.g., web sites, networked computers, hard drives, memory sticks, DVD/CDs, and so forth). In this way, the portable digital data processor 60 can generate a record which associates and/or references multimedia content with other data and/or information about the characteristic(s) of the object 20. By way of non-limiting example, the portable digital data processor 60 can associate the determined characteristic with any one of, inter alia, a picture of a skateboard ramp, a video of a jump, or a song that was played while performing a trick. The multimedia content can be associated with a particular record automatically or, for example, by a command from the user of the portable digital data processor 60. In this way, if a skateboarder performs a trick over a given ramp and the portable digital data processor 60 has generated kinetic information regarding this trick (i.e., a characteristic of interest), the portable digital data processor can capture multimedia (e.g., text regarding the jump or a picture of the ramp) and associate it with the characteristic of interest.

The portable digital data processor 60 can be configured to store the data, information, and/or record in a central store module which is based on database management, content management or other data storage technology known in the art, as adapted in accord with the teachings hereof. In this way, the user of the portable digital data processor 60 can access information related to a particular characteristic of interest and its associated content by referencing a particular record maintained within the central store.

In one embodiment, the portable digital data processor 60 includes an audio output module that generates audio output., e.g., a song selected by the user, a pre-recorded sound, a synthesized sound, or otherwise. This may be activated by the user and its volume, duration or other characteristics controlled by way of a switch (not shown) or otherwise. Alternatively, or in addition, the audio output can be a sound or series of sounds generated in response to the data received by the portable digital data processor 60 from the measurement device 40 regarding a characteristic of the object 20. For instance, as the object obtains a certain characteristic (e.g., a pre-determined speed, height, etc.), the portable digital data processor 60 can control the audio output device to generate a sound or series of sounds to alert the user as to the attainment of the characteristic(s). For example, while performing an “ollie,” the measurement device can generate data regarding the motion of the skateboard such that, for example, the audio output device generates a loud crashing noise when the skateboarder kicks down on the back edge of the skateboard. By way of another non-limiting example, the audio output device can generate a “whirling” sound when the object 20 is being spun. A user (e.g., skateboarder) can thus be alerted, for example, that the user has obtained a certain objective (e.g., reached a new personal best for the characteristic(s) of interest, successfully completed a trick, etc.).

In another exemplary embodiment, the audio output device can generate an audio output (e.g., a song with a given rhythm) that is manipulated based on the characteristic(s) of the object 20. By way of non-limiting example, the playback of the song can be sped up or slowed down in response to the speeding up or slowing down, respectively, of the object 20.

An increase in height (e.g., a jump), for example, of the object 20 can amplify the high tones of the audio output, while a decrease in height (e.g., a landing) can amplify the low tones. Variations in the audio output can also prompt the user (e.g., skateboarder), for example, to perform a certain task (e.g., speed up) or alert the user to attempt a new action. In this way, the portable digital data processor 60 can be used as a learning tool. In reference to a certain action desired to be performed by an object, for example, the audio output device can generate audio output (e.g., a signal) to alert the user to perform a sequence of actions, or perform the next in a sequence of actions, in order to attain the desired characteristic(s).

In addition to, or in the alternative to, outputting the audio output in real-time, the portable digital data processor 60' can associate an audio signal with a record. Subsequently accessing the record of a particular characteristic can access associated audio content such that the display and/or replay of the action of interest can provide the associated audio content.

In one embodiment, the portable digital data processor 60 can include a module that functions as a display interface 62e. The display interface 62e is configured to display information regarding a characteristic of the object and/or content associated therewith. The display interfaces 62e can include "widgets," "wizards," dedicated applications and other special-purpose programs that can be executed by users of the portable digital data processor 60. The display interface 62e can be integrated within the portable digital data processor 60 (e.g., an LCD screen on a smartphone), or alternatively, can comprise a separate display device in communication with the portable digital data processor 60. Operationally, the portable digital data processor 60 can process the data and/or information relating to the characteristic(s) of the object 20 to provide, for example, tables, graphs, scores, virtual images (or a series of images), video, plots, or other graphic or textual representations of the characteristic(s) of the object 20 to the display interface 62e. The display interface 62e can be configured to allow the user of the portable digital data processor 60 to interact with (e.g., view and manipulate) the display interface 62e and/or associate additional content or information with

the record from which the display was derived.

Exemplary display interfaces are depicted in FIGURES 3A-3B. As shown in FIGURE 3A, the display interface 62e is configured to display data and/or information generated by the measurement device 40 in accord with the teachings herein and one or more prompts 64 that allow the user of the portable digital data processor to manipulate the display (e.g., erase, save and/or associate the display with a record, associate the display with a note or picture). The display interface 62e depicts a graphical representation of the flight path of two “ollies” 66, 68 that were performed by a skateboarder using the methods and system 10 described above. That is, kinetic data related to the movement of the skateboard 20 with the measurement device 40 attached thereto can be generated and transmitted to the portable digital data processor 60. The kinetic data related to each of the “ollies” 64a, 64b can be analyzed by the digital data processor 60 to generate kinetic information related to the motion of the skateboard. The kinetic information can be further processed by the portable digital data processor to generate the kinetic interface display 62e. Although the graphical display interface 62e shown in FIGURE 3A depicts a line plot of a particular characteristic (e.g., the representation of two “ollies” 64a, 64b showing a flight path, height, and distance of the object 20), one skilled in the art will appreciate that the data generated by the measurement device 40 can be manipulated according to known methods and processes, modified in accord with the teachings herein, to generate any variety of graphical displays.

The portable digital data processor 60 can be configured to access a database of “ideal” actions (e.g. by professionals) such that the user of the portable digital data processor 60 can compare the determined characteristic(s) to a pre-determined standard. As shown in FIGURE 3A, the portable digital data processor 60 displays an “ideal ollie” 64c, for example, one performed by a famous skateboarder such that user can visually compare the measured characteristics with that of another skateboarder. In this way, the system 10' can serve as an interactive teaching tool to help the user improve the characteristic(s) of interest.

For example, as shown in FIGURE 3B, the display interface 62e can display the two measured “ollies” 64a, 64b and the “ideal ollie” 64c in table form. The display interface 62e can be populated with information from one or more records, for example, the identification of the object 20 (e.g., the user of the object 20), the characteristics of interest (e.g., height 66, distance 68, and a tabulated score 70) associated with the one or more records (e.g., ollies 64a', 64b', 64c'), and other associated information (e.g., the ramp on which the trick was performed, the date on which the trick was performed).

The display interface 62e can also be configured to display multimedia content associated with a record and/or, for example, a virtual representation of the object 20 during the action in which the characteristic is determined. Thus, the display interface 62e can display, for example, a photograph or video of the particular trick or motion being performed. Alternatively or in addition, the display interface can depict a virtual snapshot or video of the object 20 as it performs, for example, a particular motion or trick. As will be appreciated by the skilled artisan, the virtual representation of the kinetic information can be generated by the portable digital data processor 60 in accord with known methods and algorithms, adapted in view of the teachings herein.

By way of non-limiting example, software can be used to render a full virtual display of an object 20 in three-dimensions based on the data generated by the measurement device 40. The display interface 62e can be configured such that the virtual display of the object 20 can be repositioned in virtual space (e.g. rotated) by user interaction. In one embodiment, the user of the primary digital data processor 60 can control the frame rate and virtual camera angle of the virtual display of the object 20 such that the user can view the object 20 as it performed a particular action to see, for example, how the object 20 moved over time. Panda – 3D, an open source three-dimensional game engine is an example of suitable software for use in accord with the teachings herein. Further, if the physical location at which the action was performed is known, software could be used to model the physical space such that the virtual

display of the can be overlaid in a virtual space representative of the physical space.

of the trick is known, it is possible to model the physical space as well so that the virtual board can be seen moving in the virtual world in a way that exactly mirrors how the real skateboard moved through the real world. It is possible to overlay two or more iterations of the trick to make it easy to see variation. Such information is useful to knowing what was done wrong.

System 10'

FIGURE 4 depicts a system 10' according to another exemplary embodiment of the invention. FIGURE 4 and the discussion below are intended to overview an example of the architecture with which the invention is practiced, other configurations of which fall within the scope thereof. The system 10' of FIGURE 4 is similar to the system 10 depicted in FIGURES 1-2 in that the system 10' includes a primary measurement device 40a' coupled to a primary object 20a' and in communication with a primary digital data processor 60a'. The system 10' can additionally include a central store 82' and/or one or more nodes 84'-92' in communication with the primary digital data processor 10' through a central server 80'. The central server 80' can be in communication with the central store 82' and the one or more nodes 84'-92' via a network 94'. The system 10' can allow for the transmission and exchange of content between any of the primary digital data processor 10', the central store 82', the nodes 84'-92', and any other device modified in accord with the teachings herein which can communicate with the system 10'. For example, the system 10' can include a secondary measurement device 40b' coupled to a secondary object 20b' and in communication with a secondary digital data processor 60b'. System 10' can also include an audio output device, as discussed above, associated with one or more of the nodes 84'-92. Alternatively, or in addition, the system 10' can include a dedicated audio output device 96'.

As discussed above in reference to system 10, the content handled by the system 10'

can include data generated by the primary and/or secondary measurement device 40a', 40b', information about a characteristic of the primary and/or secondary object 20a', associated information (e.g., identification of the primary object 20a' or its user, information about the circumstances under which the characteristic was determined such as the location and date), and multimedia content such as images, video, and audio data. The system 10' can also be configured to handle content such as text data, notifications, advertisements, events, and other information that can be distributed to the primary and secondary portable digital data processors 60a', 60b' and any of the other nodes 84'-92'.

As discussed above in reference to the digital data processor 60 of FIGURES 1 and 2, the primary digital data processor 60a' can generate information about a characteristic of an object 20a' from data generated by a measurement device 40a' coupled to that object 20a'. Alternatively, in one embodiment, the data generated by the primary measurement device 20a' and/or the primary processor 60a' can be processed locally or transmitted to the central server 80' for analysis. The primary digital data processor 60a' can be configured to communicate data and/or information about a characteristic of the object 20a' or other content with the secondary portable digital data processor 60b' and the nodes 84'-92' directly and/or through the server 80'. Information can be acquired by the nodes 84'-92' in various ways as will be appreciated by a person skilled in the art. Thus, by way of non-limiting example, (a) the primary digital data processor 60a' can acquire kinetic data regarding the motion and orientation of the object 20a'; (b) process that data to generate kinetic information about the movement of the object 20a'; (c) display the kinetic information in the form of a kinetic display (e.g., in the form of graphs, tables, scores, a virtual representation or video) on a display module of the primary digital data processor 60a'; (d) associate the kinetic information with multimedia content (e.g., an image, video, or audio clip); and/or (e) transmit the kinetic data, kinetic information, kinetic display, and/or multimedia content to the secondary digital data processor and/or nodes 84'-92' directly and/or through a central server 80'.

As depicted in FIGURE 4, the secondary portable digital data processor 60b' can also

be in communication with a second measurement device 40b' that is attached to a secondary object 20b'. The secondary portable digital data processor 60b' can be configured substantially the same as the primary portable digital data processor 60a'. That is, the secondary digital data processor 60b' can receive the data generated by the secondary measurement device 40b', process the data to obtain information about the secondary object's 20b' characteristic(s) of interest, display the information, and/or transmit the information to the server 80'. Additionally, the primary and secondary portable digital data processors 60a', 60b' can be configured to be in communication with one another such that information regarding the characteristic(s) of their respective objects 20a', 20b' can be shared directly between the portable digital data processors 60a', 60b'.

The secondary portable digital data processor 60b' can also be configured to communicate with the primary measurement device 20a'. That is, the secondary portable digital data processor 60b' can receive the data generated by the primary measurement device 20a', process the data to obtain information about the primary object's 20a' characteristic(s) of interest, and display the information, as discussed in detail above. The secondary portable digital data processor 60b' can be configured, for example, to automatically communicate with the primary measurement device 20a', or can communicate with the primary measurement device 20a' only upon being granted permission by the primary portable digital data processor 60a'. In this way, the primary and secondary portable digital data processors 60a', 60b' can each transmit and/or receive information regarding the object's 20a' characteristic(s) of interest, as well as any associated content, and process that information as discussed herein. Similarly, the primary portable digital data processor 60a' can be configured to communicate with the secondary measurement device 20b'.

Additionally, as will be appreciated by one of ordinary skill in the art, both the primary portable digital data processor 60a' and the secondary portable digital data processor 60b' can be considered nodes (as otherwise used herein) in that the portable digital data processors

60a', 60b' can also be configured to communicate with the server 80'.

The illustrated server 80' can aggregate, process, and/or serve data and/or information generated by one or more measurement devices 20a', 20b' and processed by one or more digital data processors 60a', 60b' to and/or from one or more of the nodes 84'-92'. Although the nodes 84'-92' are depicted as connected to a single server 80', it will be appreciated that the invention can be practiced with fewer or more servers, as well as without any servers. The server 80' can comprise one or more personal computers, workstations, or other digital data processing devices of the type commercially available in the marketplace as adapted in accord with the teachings herein. A plurality of servers 80' can be coupled for communications with one another over a network 94', may be collocated, distributed or otherwise.

The server 80' can also process the information and associated content, e.g., for transmission to the nodes 84'-92'. This can include generating thumbnails and/or optimized versions of the records for display or other presentation on the nodes. The server 80' can also aggregate a record with supplementary information provided by a transmitting node (e.g., the primary portable digital data processor 60a') or from other nodes 84'-92'. Supplementary information can include, by way of non-limiting example, comments from the users of one of nodes 84'-92, additional multimedia submitted by the users of nodes 84'-92', and/or communication or queries from the users of nodes 84'-92'. Processing by the server 80' can further include tagging the records, for example, in accord with the supplementary information and/or in accord with designations made by a node user. In some embodiments, tagging can also be based on record content (as determined, for example, by the location at which the characteristic was determined). In the embodiment illustrated in FIG. 4B, tagging allows categorization of the records into sets defined by one or more of the node users.

The server 80' can store the aforementioned record and other associated information in a central store 82' (e.g., database) based on database management, content management or other data storage technology known in the art, as adapted in accord with the teachings

hereof. The central store 82' can contain one or more records and/or other database structures storing or otherwise reflecting, for each record its related information – e.g., the user, information about the characteristic, the location at which the characteristic was determined, multimedia content associated with the record, etc. By way of example, the central store 82' depicted in FIGURE 4 can store information in each record related to the skater, identification of a trick, the location at which the trick was performed, the height of the object trick, average speed, number of rotations, a tabulated score, and any of an associated image, video, and/or comments. In other embodiments, other information may be contained in the central store 82', instead or in addition.

Network 94' can provide communications coupling between the server 80', the portable digital data processors 60a', 60b', and/or the nodes 84'-92'. The network 94' can include one or more cellular networks, one or more Internets, metropolitan area networks (MANs), wide area networks (WANs), local area networks, personal area networks (PANs) and other networks, wired, wireless, terrestrially-based, satellite-based, or otherwise, known in the art suitable for transport of digital content, data and commands in accord with the teachings hereof.

Generally, the nodes 84'-92' comprise electronic devices or systems that (i) can communicate with the primary digital data processor 60a', (ii) can communicate with one another and/or with the server 80', and/or (iii) display, acquire, and/or provide information regarding the characteristic(s) of the primary object 20a' and/or one or more other secondary objects 20b' and/or additional content. The nodes 84'-92' comprise, by way of non-limiting example, smart phones, mobile phones, personal digital assistants (PDAs), personal computers, real-time displays, third-party servers or server systems, all of the type commercially available in the marketplace as adapted in accord with the teachings herein. It will be appreciated that while individual examples of such electronic devices are shown in the illustrated embodiment, other embodiments can incorporate less, more, or different devices. Although the particular nodes are depicted as a smartphone 84', a third-party server 86', a computer

88', a multimedia content display 90', and a real-time display 92', it will be appreciated that other devices may be used in practice of the invention described herein, instead of or in addition to those shown in FIGURE 4. It should be further appreciated that the methods of operation and/or manners of interaction discussed below in connection with FIGURE 4 may apply to other devices and/or configurations as well. For example, although two portable digital data processors 60a', 60b' and a plurality of nodes 84'-92' are shown in the drawing, it will be appreciated that the invention can be practiced with more or fewer digital data processors in communication with more or fewer measurement devices, and more or fewer nodes which can also function as digital data processors.

Each of the nodes 84'-92' can include a display interface as discussed above in reference to the display interface 62e of the portable digital data processor 60 of FIGURES 1 and 2. As will be appreciated by the skilled artisan, the display interface of nodes 84'-92' can be configured to be an interactive interface and can display information about the characteristic(s) of interest and/or associated information and content. The interfaces can also depict the information and content on-demand, and can allow the users of the portable digital data processor 60a', 60b' or the nodes 84'-92', for example, to display information, content, and/or records received from the central server 80'. Indeed, by way of non-limiting example, one or more of the nodes 84'-92' can be dedicated display interfaces.

The nodes 84'-92' can be configured to acquire record information and/or provide content. By way of example, the users of nodes 84'-92' can associate supplementary information (e.g., comments, pictures, video, etc.) with a record generated by the user of the primary digital data processor 60a'. Access to records generated by other nodes 84'-92' can be a function of permissions and preferences. Particularly, server 80' can transmit to (or otherwise permit display on) the nodes 84'-92' only those records to which the particular node has permission (e.g., by way of hardware and/or user authentication). Such permissions may be granted, for example, by default, as a consequence of payment of a service fee, activation of a user account, action of a node user, e.g., via a user interface of the type described herein, ac-

tion of an administrator, e.g., using a web site or other interface to the server 80', and so forth.

Records received by the nodes 84'-92' from server 80' may be presented to the respective users of those nodes, for example, depending on display preferences set for those devices 84'-92', e.g., by default, user action or otherwise. Thus, for example, the node 92' (the "real-time display") can be configured to present the records in tabular form while another node 90' (the "multimedia display") can be configured to display multimedia content associated with the records. For example, if one or more measurement devices were being used at a skateboarding competition, the multimedia display 90' can be configured to display images, video, and/or virtual representations of the skateboard and skateboarders performing tricks, and the real-time display 92' can be configured to display the results of the competition, as determined by a data processor analyzing the data generated by one or more measurement devices coupled to the competitors' boards.

As discussed above with reference to the system of FIGURES 1-2, one or more of the nodes 84'-92' and/or one or more of the portable digital data processors 60a', 60b' can include an audio output device. As shown in FIGURE 4, the primary digital data processor 60a' includes a primary audio output device 96' coupled thereto. As will be appreciated by the person of ordinary skill in the art, the primary audio output device 96' can be integrated within the primary portable digital data processor 60a' in accord with the teachings herein and/or can be an external module (e.g. a speaker) physically or wirelessly coupled to the primary portable digital data processor 60a'. The primary digital data processor 60a' can control the primary audio output device 96' to generate audio output and/or manipulate the audio output in response to the determined characteristic(s) of the primary object 20a', as discussed above.

The system 10' can also include one or more secondary audio output devices 98' associated therewith. As shown in FIGURE 4, the secondary audio output device 98' can be a

dedicated audio output device (e.g., a speaker) that can generate audio output in response to the characteristic(s) of interest transmitted through the central server 80'. One or more secondary audio output devices can also be associated with the nodes 84'-92'. Though not shown, an audio output device can be associated with the multimedia display 90', for example, such that the multimedia display 90' can display images (e.g., the action of the primary object 20a') as well as audio. The audio can be generated and/or manipulated, for example, by the action of a user and/or based on the determined characteristic(s) of the object, as discussed above. In this way, the characteristic(s) of the object can be associated with a sound and/or song such that displaying of a photo, video, and/or virtual representation of the object 20a' performing the action can also "display" the associated audio output. Thus, a producer of a movie, for example, need not manually overlay particular music given action in the movie. Rather, the action of the object itself can control the associated audio output.

The third-party server 86' can allow users to access information regarding the characteristic(s) of one or more objects 20a', 20b' and other associated information and/or content. The third-party server 86' can comprise, for example, a website and/or other repository of information. The third-party server 86' can communicate with the server 80', transmit information about a characteristic of one or more object 20a', 20b', provide images and other multimedia content to the central server 80' automatically (on action of the third-party server 86'), at the request of the server 80', and/or at the request or behest of a user of the third-party server 86'.

Communication between the nodes 84'-92' and the one or more portable digital data processors 60a', 60b' enables a variety of competitions and interaction between the users of the system 10'. By way of example, FIGURE 5 depicts the user interface 62e' for an exemplary competition between two or more users of the system 10', an explanation of which will aid in an understanding of the operation of the systems and methods described herein.

The user of a first portable digital data processor 60a' can communicate to the central

server 80' an invitation to other users in the system 10' to a competition. The invitation can be targeted to a specific user, or can be communicated generally to any user. The user of a second digital data processor 60b' can be alerted by the central server 80' via e-mail, text, or otherwise as described herein, and can communicate his acceptance through the central server 80'. Accordingly, the user of the first portable digital data processor 60a' and the user of a second digital data processor 60b' can initiate a competition. Other users of the system 10' (e.g., node 84') can observe the competition as a spectator through the central server 80'.

As depicted in FIGURE 5, each of the portable digital data processors 60a', 60b' can generate a display interface 62e' displaying actions to be performed and the associated characteristic(s) of interest. The user of the primary portable digital data processors 60a' can then perform the listed actions, in proximity or remote to the other user, such that the measurement device 40a' coupled to the object 20a' generates data regarding the characteristic(s) of interest. The primary digital data processor 60a' can receive the data generated by the primary measurement device 40a' and process the data locally (or alternatively transmit the data to the central server 80' for processing). Processing of the data can generate information about the characteristic(s) of interest of the primary object 20a' (e.g. height and speed) and can calculate a rating 64 (e.g., score) for the characteristic(s) of interest. The central server 80' can be configured to receive the information from the primary digital data processor 60a' and can be configured to transmit the information to the secondary digital data processor 60b' for display on the display interface of the secondary digital data processor 60b'.

Similarly, the user of the secondary digital data processor 60b' can perform the listed actions such that measurement device 40b' generates data regarding the characteristic(s) of interest. The secondary digital data processor 60b' can receive the data generated by the secondary measurement device 40b' and can process the data locally (or alternatively transmit the data to the central server 80' for processing). Processing of the data can generate information about the characteristic(s) of interest of the secondary object 20b' (e.g. height and speed) and can calculate a rating 66 (e.g., score) for the characteristic(s) of interest. The cen-

tral server 80' can be configured to receive the information from the secondary digital data processor 60b' and can be configured to transmit the information to the primary digital data processor 60a' for display on the display interface of the primary digital data processor 60a'. After the list of actions has been performed, a winner can be determined, for example, according to the highest total score.

In one embodiment, the primary digital data processor 60a' and display interface 62e' can be configured to allow for the playing of a single- or multi-player game. The display interface 62e' be a part of a "widget," "wizard," dedicated application or other special-purpose program that can be executed by a user of the portable digital data processor 60a'. Operationally, the primary portable digital data processor 60a' can process the data and/or information relating to the characteristic(s) of the objects 20a', 20b' to provide, for example, tables, graphs, scores, virtual images (or a series of images), video, plots, or other graphic or textual representations of the characteristic(s) of the object 20a', 20b' to the display interface 62e'. The display interface 62e' can be configured to allow the user of the portable digital data processor 60a' to interact with (e.g., view, manipulate, control) the display interface 62e'.

In a single player format, for example, the user of the primary digital data processor 60a' can prompt the display interface 62e' to generate a trick or a sequence of tricks to be performed by the user of the primary object 20a'. The trick or sequence of tricks can be, for example, selected by the user, inputted by the user, or generated by the primary digital data processor 60a' or display interface 62e' based on an input from the user (e.g., by shaking the primary portable digital device 60a' to have the display interface 62e' display a new trick to be performed). The primary digital data processor 60a' can command the primary measurement device 40a' to monitor for this particular trick or sequence of tricks. As discussed above, the primary digital data processor 60a' can determine by way of the data generated by the measurement device 40a' if the trick or sequence of tricks were successfully completed. Alternatively, or in addition, the primary digital data processor 60a' can receive information regarding the successful completion of the trick through the display interface 62e' by way of input

from the user of the primary digital data processor 60a' (e.g., by the trick's performer or an observer). Alternatively, the primary digital data processor 60a' can receive information regarding the successful completion of the trick by way of input from a user without receiving, generating, and/or processing data from the measurement device 40a'. In one embodiment, the primary digital data processor 60a' can receive input regarding the successful completion of the trick by way of input of a third-party user of a secondary digital data processor 60b' connected (e.g., directly, wirelessly, through the central server 80', or otherwise) to the primary digital data processor 60a'. The results (e.g., the successful or unsuccessful completion and characteristic(s) related to the action of interest) can be displayed on the user interface 62e' as discussed herein.

In a multi-player format, for example, the primary digital data processor 60a' can also be in wireless communication with a second measurement device 40b' that is attached to a secondary object 20b'. The primary digital data processor 60a' can thus receive data generated by both the primary and secondary measurement devices 40a', 40b', process the data to obtain information about the primary and secondary object's 20a', 20b' characteristic(s) of interest, display, and/or compare the information. By way of example, the primary digital data processor 60a' can prompt the display interface 62e' to generate a trick or a sequence of tricks to be performed by the users of the object 20a', 20b'. As discussed herein, the users of the objects 20a', 20b' can then attempt to perform the listed actions, such that the measurement devices 40a', 40b' generate data regarding the characteristic(s)/action(s) of interest. The primary digital data processor 60a' can receive the data generated by the primary and secondary measurement devices 40a', 40b' for the tricks or sequence of tricks and process the data locally (or alternatively transmit the data to the central server 80' for processing). Processing of the data can generate information about the characteristic(s) of interest of the objects 20a', 20b' (e.g. successful completion of a trick, height, speed) and/or can calculate a rating (e.g., score) for each trick that can be displayed on the display interface 62e' of the primary digital data processor 60a', as depicted in FIGURE 5. As discussed above, the primary digital data processor 60a' can receive information regarding the successful completion of the trick by

way of input from a user of the primary digital data processor 60a' or from a third-party user of a secondary digital data processor. The results (e.g., the successful or unsuccessful completion and characteristic(s) related to the action of interest) can be displayed on the user interface 62e' as discussed herein and as depicted in FIGURE 5, for example. After the list of actions has been performed, a winner can be determined, for example, according to the highest total score or the successful completion of the most tricks.

In an alternative embodiment, the user of a secondary portable digital data processor 60b' can access previous records from the central server 80'. The user of the secondary portable digital data processor can send the owner of the object which generated a particular record a notification alerting the owner that the user of the secondary portable digital data processor 60b' will attempt to surpass the characteristic associated with the particular record. Performing the steps described herein for generating, processing, and transmitting data, the secondary digital data processor 60b' can determine the characteristic(s) of interest and transmit the information to the central server 80'. Accordingly, users of the system 10' can serially attempt to best the characteristic(s) of interest.

A further understanding of the invention can be attained with reference to the appendix attached hereto.

Described above are methods and system meeting the objects and goals set therefor. Those skilled in the art will appreciate that the embodiments shown in the drawings and described in the accompanying text are merely examples and that other embodiments, incorporating modifications and changes therein and including combinations of foregoing embodiments, fall within the scope of the invention.

Thus, by way of non-limiting example, it will be appreciated that the steps depicted in the figures may be performed in any suitable order, the ordinal numbering of those steps therein notwithstanding, as it is provided only for explicative purposes. The use of known

data processing techniques, known hardware configurations, and known programming constructs, including web-related programming, known data storage or database principles, are contemplated herein to effect the novel methods and systems disclosed herein. Therefore, it is intended that the invention not be limited to the particular embodiments disclosed herein, but that the invention includes all embodiments falling within the scope of the appended claims.

In view of the foregoing, what is claimed is:

Appendix

1. Introduction

Despite the multitude of advanced technology found in the components of modern skateboards, there is very little technology dedicated to measuring the tricks that skateboarders perform. The old adage due to Lord Kelvin, “if you can’t measure it, you can’t improve it” applies to skateboarders. The skate-hub universal sensor system (shuss) consists of hardware and software that measures the tricks that skateboarders perform.

There are several uses of this shuss . The shuss can be use to “score” or “rate” a particular trick. Unlike the current situation where tricks are based on the opinion of judges, shuss provides an unbiased, objective measure. In addition, the trajectory and motion of the skateboard through space can be visualized, replayed, and compared any number of times on a computer or even a smartphone. This can be used to improve the skaters performance.

The shuss helps to engage a community of skaters with the extended shuss system. Using geolocation and a database, it is possible for individuals to declare themselves “king of the park”. Yet another use of shuss is as a way of engaging a set of visitors to a festival. For example, contestants that can jump higher than a certain amount will win a T-shirt.

Skateboarders, as well as other social sporting activities, like to perform tricks using their skateboards. They practice the tricks over and over, either alone or in groups. They may perform these tricks in a skatepark, playground, or other spaces that have not been designed for skateboarding. They share their tricks, have similar musical interests, and are always in search of new places to try out their tricks. Moreover, skateboarders often buy their equipment from local skateboard shops. Skateboarders usually listen to music while they skate.

Our invention leverages these different and unique characteristics of skateboarders. There are other groups that share these characteristics and so our invention is not limited to skateboarders. The invention involves hardware, mobile devices, and computer services, although we believe that not all components are necessary.

2. The Hardware

There are many different IMU (Inertial Measurement Unit) chips and boards on the market. We assembled an IMU board with the following components:

- a 3D accelerometer (x, y, and z) – triple axis Analog Devices ADXL335
- a single-axis and dual-axis gyroscopes – such as an LY530AL and LPR530AL
- a triple-axis magnetometer – such as the HMC5843
- a bluetooth SMD module
- a rechargeable, LiPo, battery.

Nearly all the surface of a skateboard gets stepped on, grinded, or slammed against some hard

physical object. The wheels of a skateboard are attached to the board by something called a truck. A truck has a flat square metal piece that screws to the board. It also has a piece that holds the axel connecting two wheels. There are two trucks to the board. Some boards have a riser or spacer between the truck and the board to give the board more height. The shuss hardware device is placed in this riser and is protected from collisions because it is protected by the truck and hte board.

There are several ways to recharge the battery of the device. We use a very long and thin barrel plug. A small cap covers the hole on the riser to keep out dirt and dust.

Two devices can be placed on each board, between each truck. One device is sufficient for most, but not all tricks. Better precision is gotten when using two devices.

The device can transmit the data of all 9 axis using the bluetooth radio, although the magnetometer often gives distorted results due to the metal in teh truck. There are times when its results are meaningful and does improve the precision of the measurements.

It communicates with a computer to process the data. In the current system, a laptop running windows 7 os is used. The computer, however, can be either a desktop, laptop, or smart mobile phone. The only requirement is bluetooth support.

The micro-controller on the device is set to transmit either all 9 readings or just 6 (3 accelerometer and 3 gyroscope) all at 100 Hz. Our experiments show that this gives the best precision without exceeding the bluetooth radio's bandwidth.

The next version will allow the computer/smartphone to set the sampling rate.

2.1 Sleep Mode

In order to extend the internal battery of the device, it is important for the device to enter and exit sleep mode. Assume the The device is sleep mode. When the board is moved, the accelerometer generates an interrupt which wakes up the device. The bluetooth turns on and begins to listen. If the computer does not connect to the device within 5 min, the device goes back into sleep mode. At least 1 minute must pass during which there are no interrupts from the accelerometer. After that point, interrupts from the accelerometer will once again wake up the device.

In other words, to get the device to connect to the computer, the device must be quiet for 1 min. Then when the device is moved, the computer establishes contact with the device.

There are many other ways to enter and exit sleep mode. It is easy for some connected bluetooth machine or smartphone to put the device into sleep mode via a bluetooth command. It is more difficult to have it wakeup. The accelerometer wakes up on movement, and so various patterns can be used to place device into active mode. The bluetooth radio consumes the most power, so that is the component that should stay asleep the longest. It can be awakened when a pattern is detected, such as three taps, two taps, three taps. Or a small switch can be in the device that can be turned on or off by pressing it, maybe with a small sharp stick.

2.2 The controller

The controller on the device performs several functions in its control of the various modules in the device.

Bluetooth is the most complex. Upon master reset and when it is first powered on, the bluetooth module is setup to pair with any other bluetooth device, using a fixed passkey. We use 12345. After its initial pairing, it will always recognize and pair with that device. That first paired device can tell it to pair with others. The first paired device is referred to as its “mother duck” using the analogy of how baby ducklings will assume the first living creature they see is their mother. The mother duck can tell the device to accept new pairings. Otherwise, no other bluetooth pairing request will be acknowledged by the controller. The bluetooth module is set to low power mode requiring the smartphone or computer to be closer than the maximum 10 meters.

The controller also sets and configures each module depending on the firmware. It can compress the data and do other initial analysis to reduce the number of bytes transmitted. For example, it could be programmed to recognize the start of a trick and not transmit until that happens.

2.3 Less precise measurements

Our first version uses a bluetooth chip to communicate with a computer or smartphone. It is also possible to use a wifi radio. A cheaper solution would use a different radio, one that only implements a simple data stream but then another radio would have to be attached to the smartphone or computer.

In our second version, the data will be compressed in order to reduce the number of bytes communicated and thereby reducing the power consumption.

Modern smartphones, such as the iPhone, come with an IMU. These values can be collected on the phone and processed locally or sent to a computer. But since the smartphone is on the person and not the board, the results only measure a portion of the action of the board. Nevertheless, some scoring is possible. In particular, the airtime can be measured as well as the height of a jump. While the rider is on the board that is riding on the ground, there are lots of vibrations caused by the wheels rolling over the uneven surface of the ground. When the board and rider is in the air, these vibrations are reduced. Comparing the raw readings with those of a low pass filter over the data reveal these differences.

3. The Software

Whereas the hardware's role is to gather and transmit the output of the IMU, the software has many more tasks. (1) collect the output values from the IMU, (2) analyze them (3) score them, (4) output summaries (5) interact with user, (6) interact with backend subsystems, (7) handle geolocation, video, pictures, and other smartphone sensor values.

The gyroscope measures rotation and accelerometers measure acceleration. While riding on the ground, the rotational sensors hardly change while the accelerometers are constantly

changing due to the vibrations of the wheels on the ground. It is difficult to means position for accelerometers although they can be used to measure the time in free fall (including time going up). Many tricks involve “air” which can be measured as free fall. Nearly all tricks, however, involve the board rotating. For example, an “Ollie” involves an initial flip of the board with the front edge rising and the back edge on the ground. The top edge then bumps into the skaters foot, causing the back edge to rise up. There are two distinct rotations. When the front edge hits the foot, there is a significant change in acceleration (the opposite direction of gravity) and when at the apex, there is another change in acceleration.

High and low pass filters are applied to smooth out the data and Kalman filters are used to smooth out the trajectories. A trick is defined by a sequence of transitions and overlaps of the different gyroscope and accelerometer axis values.

3.1 Skateboard Version of HORSE

Scoring a known trick is easier than identifying and scoring a trick. One engaging game is for the smartphone to randomly generate a series of tricks that the skateboarder must perform. The winner is the skateboarder that gets the highest total score.

3.2 Visualize and learn

We use Panda-3D, an open source 3D game engine written in python to render a display of a skateboard in 3D. Each frame of the game engine allows the board to be repositioned in space before being rendered on the screen. The gyroscope data provides input to the the position of the board in the virtual world of the game.

he user can control the virtual camera angle as well as the frame rate. The user can select to play starting at any particular frame. Thus, the user can see how his or her board was moving while doing a trick. Such information is useful to knowing what was done wrong.

If the location of the trick is known, it is possible to model the physical space as well so that the virtual board can be seen moving in the virtual world in a way that exactly mirrors how the real skateboard moved through the real world. It is possible to overlay two or more iterations of the trick to make it easy to see variations.

4. The Mobile Application

A skateboarder may cover a large area while doing his or her trick. When the shuss is attached to the board, it can accumulate the data but it is also very useful to have the data streamed to some other device in real time.

The shuss needs to conserve power as it is awkward to recharge it's battery. Our approach is to reduce the communication power by having a receiver nearby that can get the data and process it. A smartphone, PDA, or other handheld computer in the riders pocket is the solution.

This mobile device communicates with the device on the skateboard and well as with the user. It may power down the shuss , or indicate which trick is about to be performed. The mo-

mobile device collects geolocation information. It uploads the data to a server. Moreover, it interacts with the user telling the score and other status information. It can also show a simulation of the trick in nearly real time.

Two or more riders each with a shuss and mobile can interact and invent two games and competitions.

Accessing a database of tricks by professionals can be used in a variety of ways. It can be used as a teaching tool.

Claims

In view of the foregoing, what I/we claim is:

1. A digital data processing system, comprising:

a measurement device attached to an object and comprising a sensor for measuring the motion, position, and/or orientation of the object over time;

a portable digital data processor communicatively coupled with the first digital data processor via a wireless communications link;

the measurement device operable to wirelessly transmit information about the motion, position, and/or orientation of the object over time (“spatial information”) to the digital data processor;

the portable digital data processor operable to wirelessly receive that spatial information from the measurement device, to display the motion, position, and/or orientation of the object over time, and to compare the motion, position, and/or orientation of the object over time with that of another object whose spatial information has been obtained via a measurement device attached thereto and transmitted to the portable digital data processor.
2. The system of claim 1, wherein the portable digital data processor comprises a smart phone, personal digital assistant, handheld device
3. The system of claim 1, wherein the sensor comprises an accelerometer, gyroscope, magnetometer
4. The system of claim 1, wherein the wireless link operates in accord with Bluetooth,

wireless Ethernet, etc.

5. The system of claim 1, wherein the object comprises sports equipment
6. The system of claim 1, wherein the object comprises a skateboard
7. The system of claim 1, wherein the motion, position, and/or orientation of the object over time is controlled by a user.
8. The system of claim 1, wherein the portable digital data processor comprises a imaging device that photographs and/or films the object.
9. The system of claim 1, wherein any of the measurement device and the portable digital data processor comprises a location sensor that records a location of the object and associates that location with the spatial information.
10. The system of claim 1, wherein the portable digital data processor analyzes the spatial information so as to calculate a rating associated therewith.
11. The system of claim 1, wherein the portable digital data processor analyzes the spatial information to detect the presence of one or more predetermined values for motion, position, and/or orientation.
12. The system of claim 1, wherein the portable digital data processor analyzes the spatial information to detect the presence of a sequence of predetermined values for motion, position, and/or orientation of the object.
13. A digital data processing system, comprising:

a measurement device attached to an object and comprising a sensor for measuring a

value of at least one physical characteristic of the object over time;

a portable digital data processor communicatively coupled with the first digital data processor via a wireless communications link and communicatively coupled with a server digital data processor;

the measurement device operable to wirelessly transmit information about the value of the at least one physical characteristic of the object over time (“physical characteristic information”) to the digital data processor;

the portable digital data processor operable to wirelessly receive the physical characteristic information of the object from the measurement device, to display the physical characteristic information of the object, and to transmit the physical characteristic information of the object to the server digital data processor for storage and/or comparison with physical characteristic information of other objects.

14. The system of claim 13, wherein the physical characteristic comprises any of motion, position, and orientation of the object.
15. The system of claim 13, wherein the server digital processor is operable to collect physical characteristic information from a plurality of portable digital data processors and/or measurement devices associated with other objects.
16. The system of claim 13, wherein the server digital data processor is operable to transmit the physical characteristic information of the object to at least other portable digital data processor.
17. The system of claim 13, wherein the server digital data processor ranks the physical characteristic information of objects according to a scoring system.

18. The system of claim 13, wherein the server digital data processor ranks users based on the physical characteristic information of objects associated therewith.
19. The system of claim 13, wherein the portable digital data processor comprises a smart phone, personal digital assistant, handheld device
20. The system of claim 13, wherein the sensor comprises an accelerometer, gyroscope, magnetometer
21. The system of claim 13, wherein the wireless link operates in accord with Bluetooth, wireless Ethernet, etc.
22. The system of claim 13, wherein the object comprises sports equipment
23. The system of claim 13, wherein the object comprises a skateboard
24. The system of claim 13, wherein the motion, position, and/or orientation of the object over time is controlled by a user.
25. The system of claim 13, wherein the portable digital data processor comprises a imaging device that photographs and/or films the object.
26. The system of claim 13, wherein any of the measurement device and the portable digital data processor comprises a location sensor that records a location of the object and associates that location with the spatial information.
27. The system of claim 13, wherein the portable digital data processor analyzes the spatial information so as to calculate a rating associated therewith.
28. The system of claim 13, wherein the portable digital data processor analyzes the spa-

tial information to detect the presence of one or more predetermined values for motion, position, and/or orientation.

29. The system of claim 13, wherein the portable digital data processor analyzes the spatial information to detect the presence of a sequence of predetermined values for motion, position, and/or orientation of the object.

30. A method comprising:

with a sensor attached to an object, sensing any of the motion, position, and/or orientation of the object over time;

wirelessly transmitting information about the motion, position, and/or orientation of the object over time from the sensor to a portable digital data processor;

at least one of displaying and comparing with like data received from another measurement device information about the motion, position, and/or orientation of the object.

31. The system of claim 30, wherein the portable digital data processor comprises a smart phone, personal digital assistant, handheld device

32. The system of claim 30, wherein the sensor comprises an accelerometer, gyroscope, magnetometer

33. The system of claim 30, wherein the wireless link operates in accord with Bluetooth, wireless Ethernet, etc.

34. The system of claim 30, wherein the object comprises sports equipment

35. The system of claim 30, wherein the object comprises a skateboard
36. The system of claim 30, wherein the motion, position, and/or orientation of the object over time is controlled by a user.
37. The system of claim 30, wherein the portable digital data processor comprises a imaging device that photographs and/or films the object.
38. The system of claim 30, wherein any of the measurement device and the portable digital data processor comprises a location sensor that records a location of the object and associates that location with the spatial information.
39. A method comprising:
- with a sensor attached to an object, sensing a physical characteristic of the object over time;
- wirelessly transmitting information about the physical characteristic that varies over time from the sensor to a portable digital data processor;
- collecting with the portable digital data processor any of location, still images and video images in a locale of the object;
- sending, from the portable digital data processor to a server digital data processor, information about the physical characteristic that varies over time and, optionally, at least one of said location, still images and video images;
- from the server digital data processor, causing information about the physical characteristic that varies over time and, optionally, at least one of said location, still images

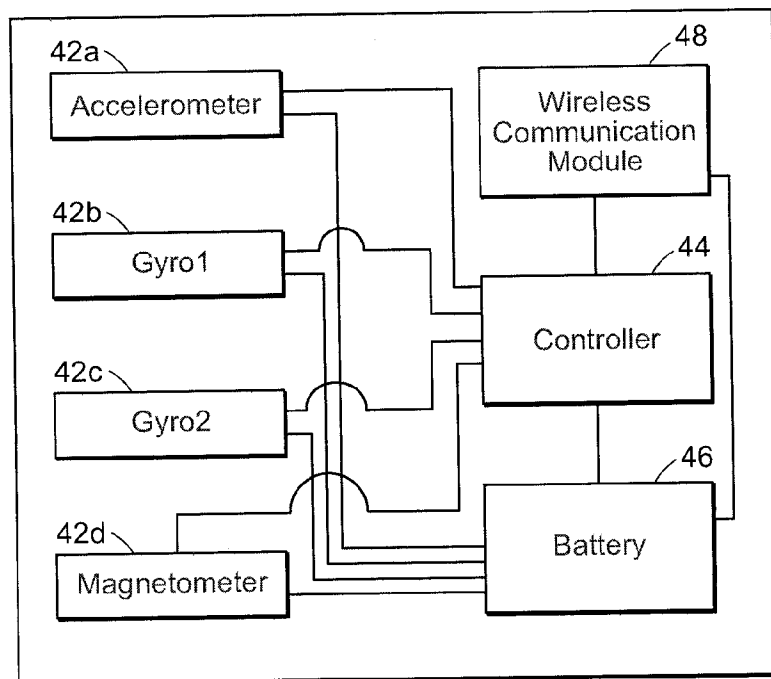
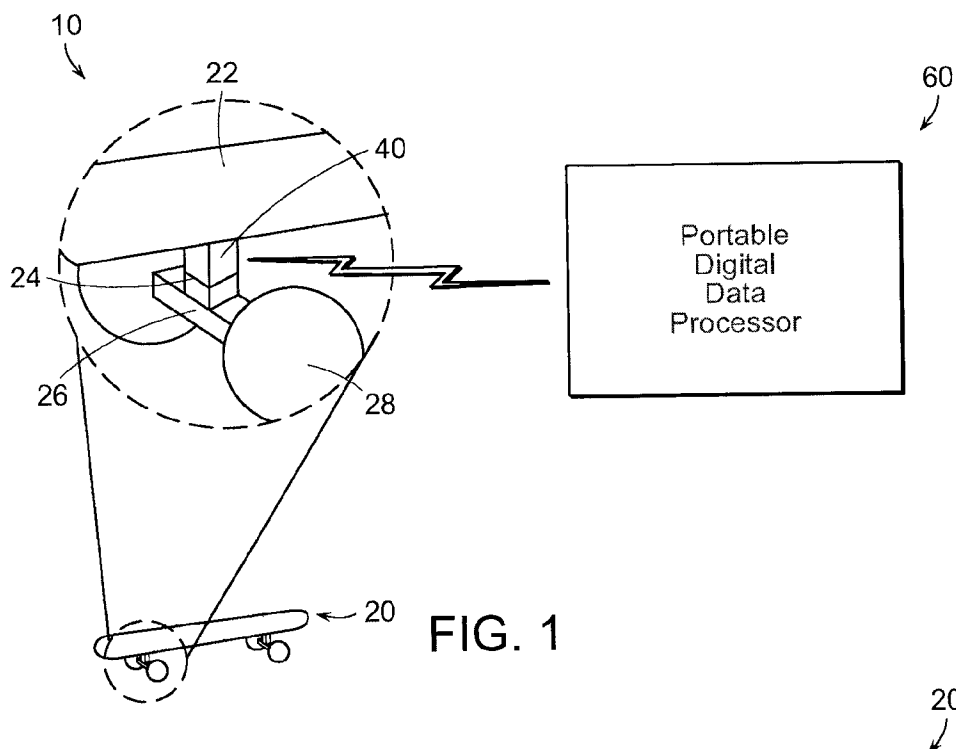
and video images, to be communicated to others.

40. The method of claim 39, comprising the step of comparing, with the server digital data processor, information information about the physical characteristic that varies over time with like information generated with respect to another object.
41. The method of claim 39, further comprising causing an audio signal to be generated based on the physical characteristic.
42. The system of claim 1, wherein the portable digital data processor further comprises an audio output device.
43. The system of claim 42, wherein the audio output generated by the audio output device is associated with the motion, position, and/or orientation of the object over time.
44. The system of claim 1, wherein the portable digital data processor is communicatively coupled with at least a second measurement device via a wireless communications link.
45. The system of claim 44, wherein the second measurement device is coupled to a second object.
46. The system of claim 45, wherein the portable digital data processor generates an action to be performed by the first and second objects, and wherein the portable digital data processor compares the results of the performance of the action.
47. The system of claim 1, wherein the portable digital data processor generates an action to be performed object.
48. The system of claim 47, wherein the portable digital data processor determines if the

action was successfully completed.

49. The system of claim 47, wherein the primary digital data processor receives information regarding successful completion of the action from a user of a second digital data processor.
50. The method of claim 39, further comprising generating an action to be performed by the object and determining if the action was completed successfully.
51. The method of claim 50, further comprising generating an action to be performed by a second object and determining if the action was completed successfully by the second object.
52. The method of claim 50, wherein the action to be performed is displayed based on a prompt by the user.

1/5



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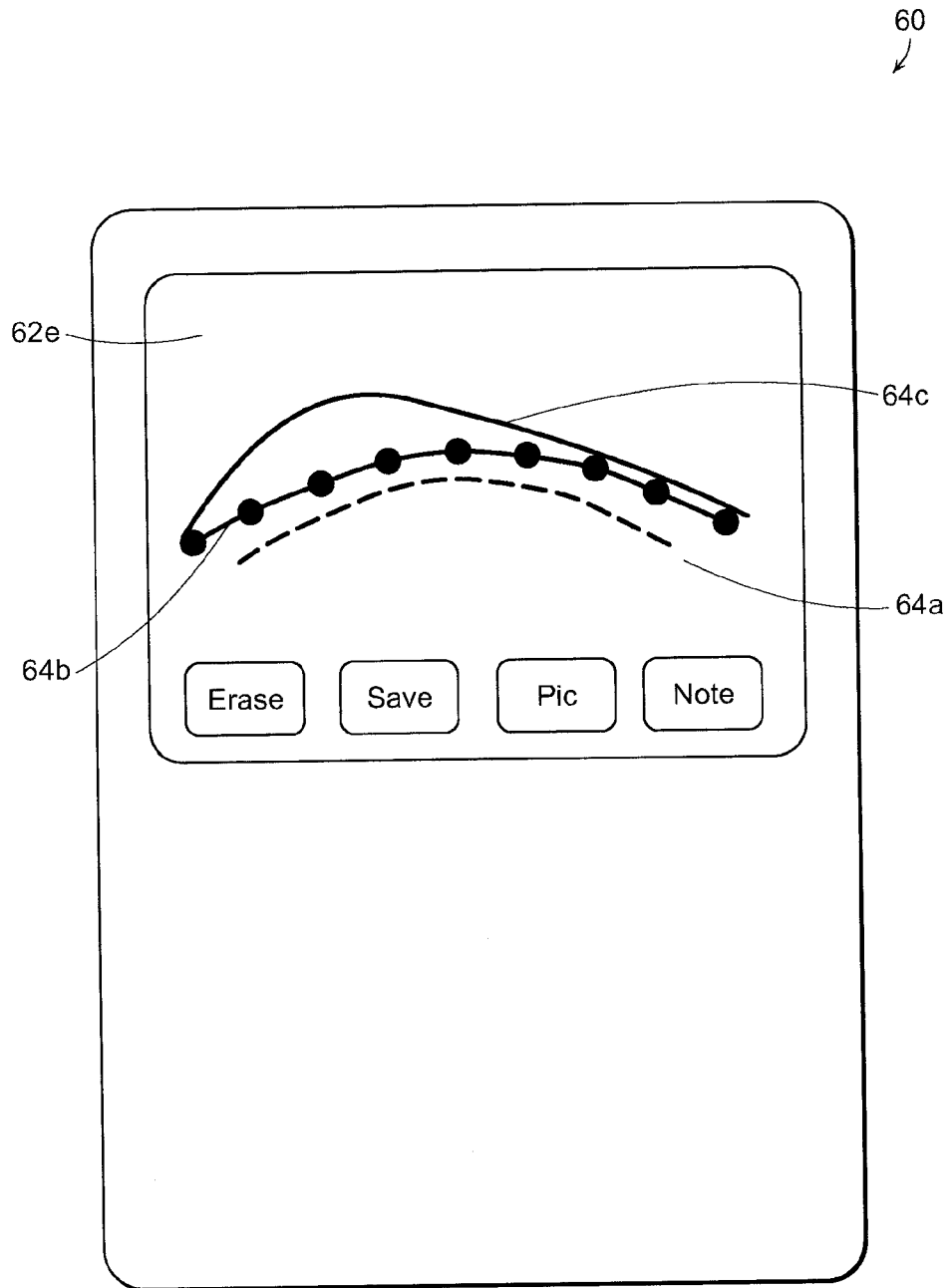


FIG. 3A

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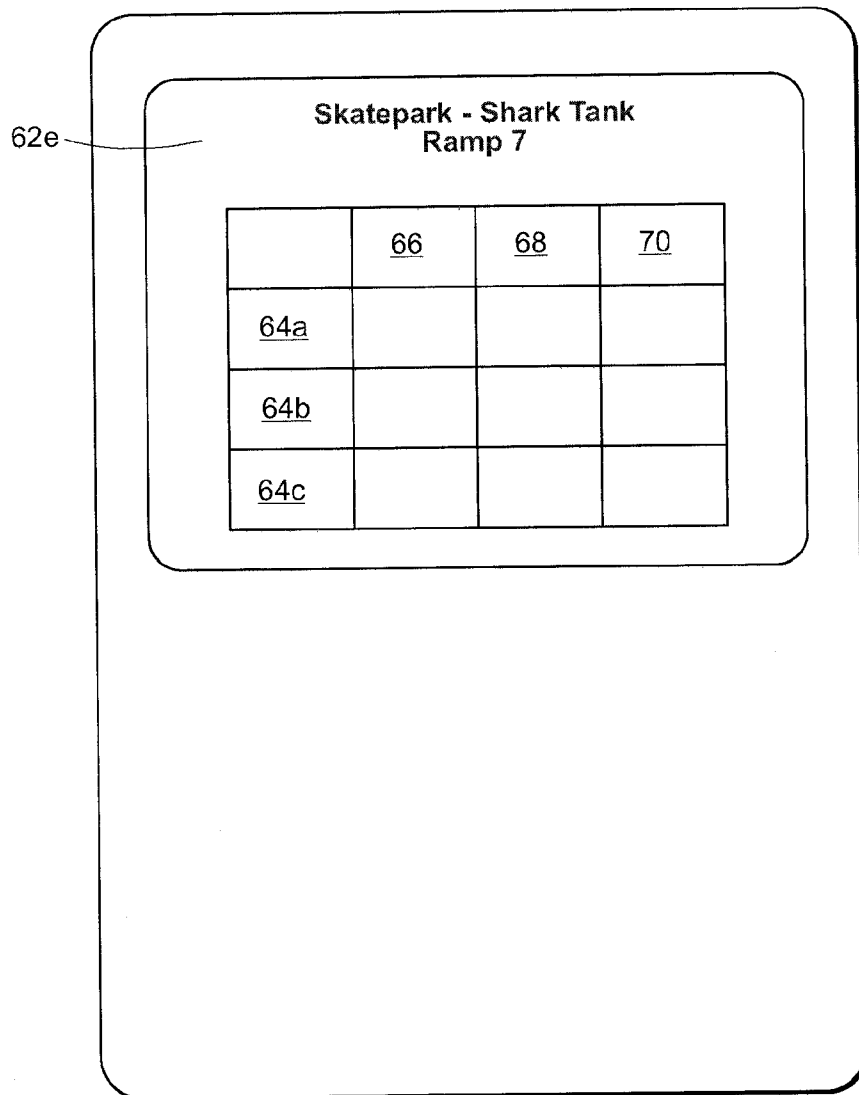


FIG. 3B

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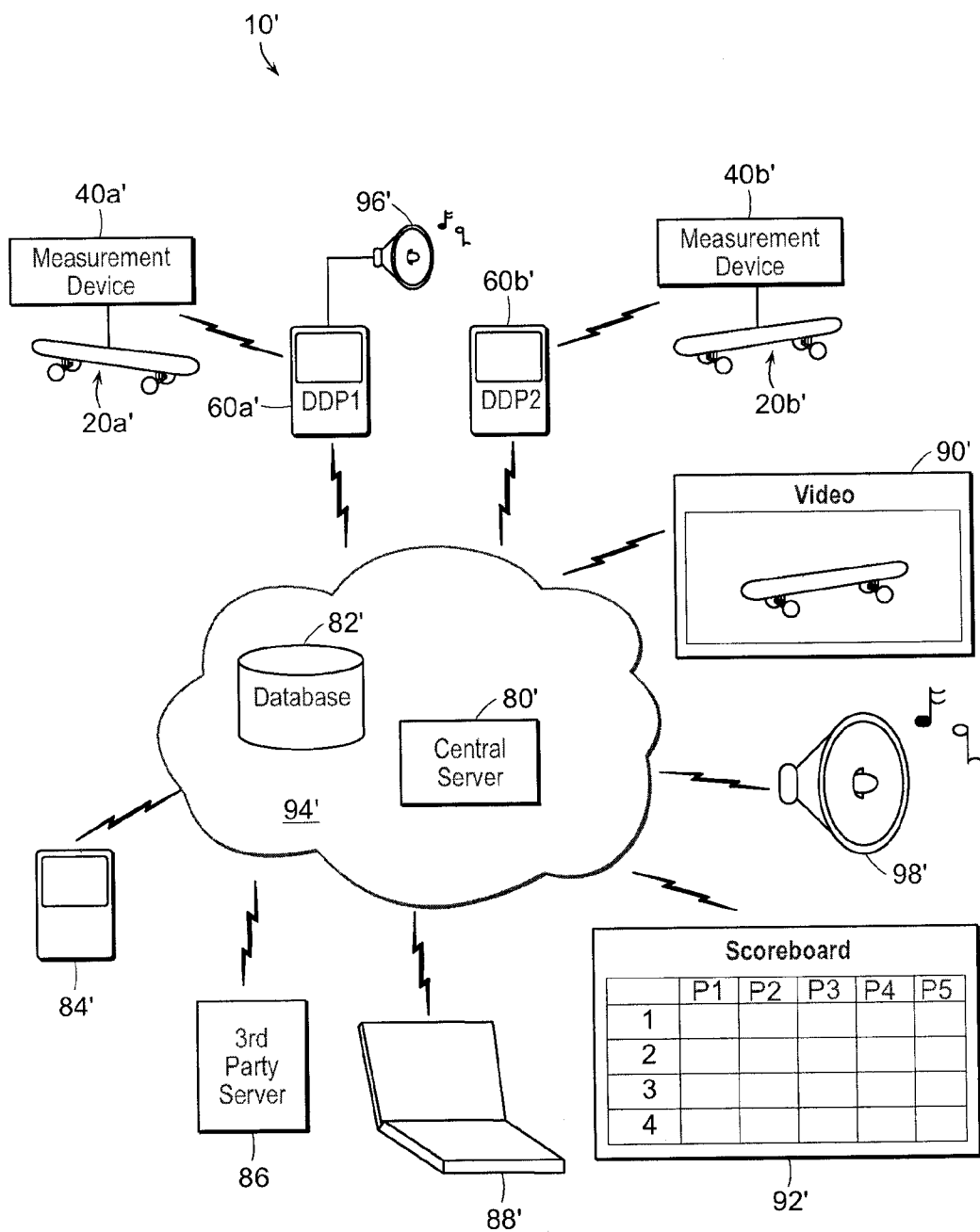


FIG. 4

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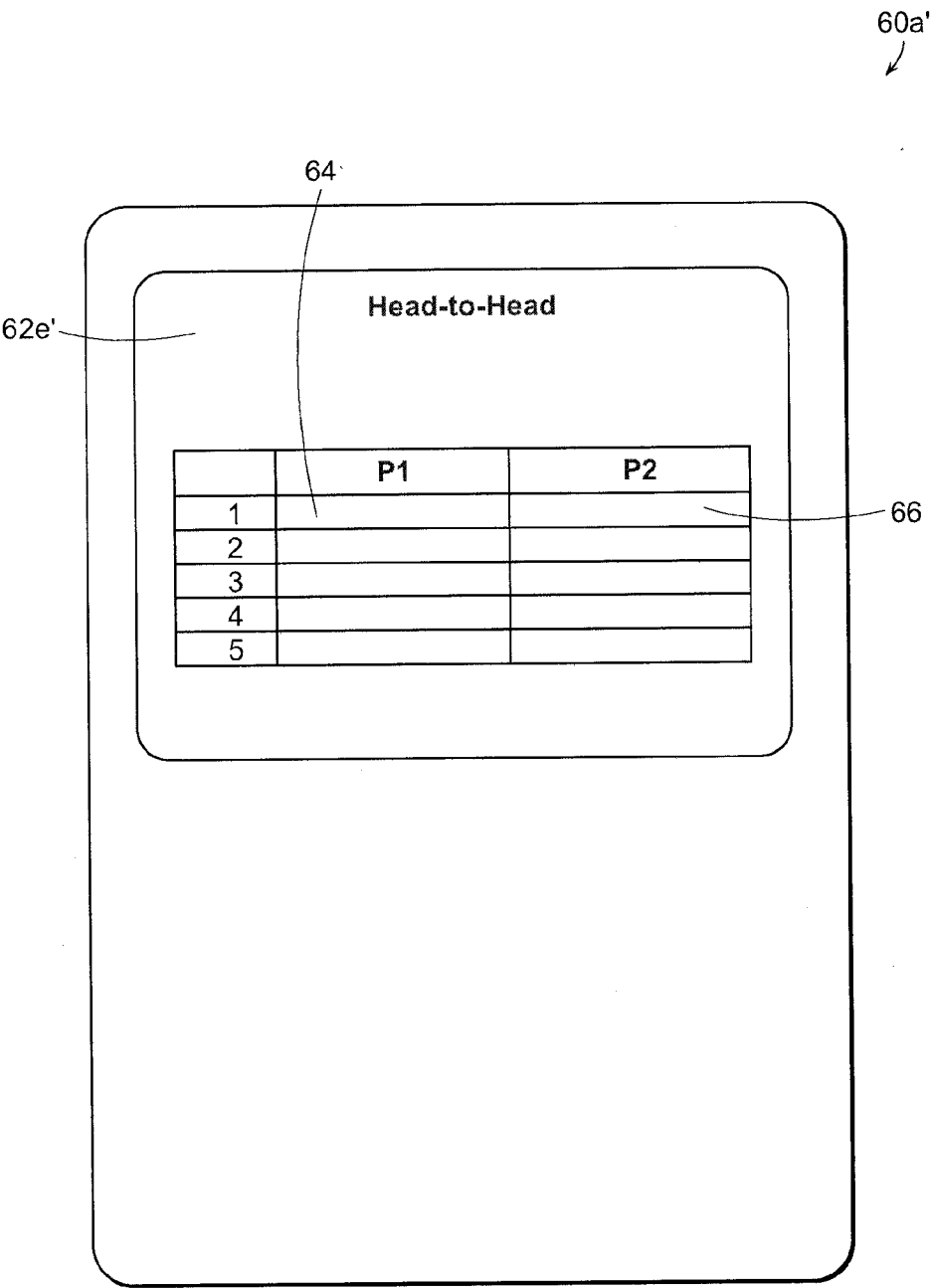


FIG. 5