A sports apparatus is provided for monitoring movement of one or more projectiles associated with a sporting event. The apparatus includes a data processing system for processing sampled data signals generated in operation by one or more sensors included in the one or more projectiles. Moreover, the apparatus includes a mobile telephone coupled in wireless communication with the one or more projectiles for receiving the sampled data signals indicative of motion of the one or more projectiles. Furthermore, the mobile telephone is operable to execute one or more software products therein for analyzing the sampled data signals received at the mobile telephone for providing analysis results indicative of a nature of trajectory of the one or more projectiles.
SPORTS APPARATUS AND METHOD
CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is a continuation application of U.S. patent application Ser. No. 13/660,385 filed on 25 Oct. 2012, the disclosure of which is incorporated herein by reference in its entirety.

BACKGROUND

[0002] 1. Field
[0003] The aspects of the present disclosure generally relate to a sports apparatus, for example to sports apparatus including one or more projectiles, for example one or more balls, wherein the projectiles include one or more sensors and a wireless communication interface, and a data processing arrangement also equipped with a wireless interface, for example implemented via a smart phone and/or a personal computer and/or a remote server with data processing functionality, wherein the one or more sensors of the one or more projectiles provide sensor signals indicative of movements of the one or more projectiles, wherein the sensor signals are communicated to the data processing arrangement for analysis and recording. Moreover, the present disclosure relates to methods of operating aforesaid sports apparatus for recording movement of the one or more projectiles for subsequent analysis and reporting. Furthermore, the present disclosure relates to software products recorded on machine-readable data storage media, wherein the software products are executable upon computing hardware for implementing aforesaid methods.

[0004] 2. Brief Description of Related Developments
[0005] It is well known to track movement of one or more projectiles, for example one or more balls, utilized when playing a sports game, for example football or basketball, to determine statistical information relating to the sports game. Such statistical information can include a number of goals or points scored, and performance of one or more players of the sports game. Such tracking has often been implemented using cameras, personnel collecting statistics manually as well as using sensors included in the one or more projectiles. However, known approaches for analysing movement of the one or more projectiles are not well developed, such that inadequate analysis of sports games utilizing the one or more projectiles is not presently achievable.

[0006] In a published US patent application no. US2012/058845A1, there is described a basketball which incorporates motion sensors. The motion sensors include, for example, one or more accelerometers, one or more angular rate gyroscopic sensors and one or more magnetometers. In the application, it is elucidated that sensor signals from the motion sensors can be analyzed to generate statistical results, but the application is devoid of detail of how the statistical analysis can be performed in practice.

[0007] There arises therefore a problem that known apparatus for providing analysis of trajectories of one or more projectiles associated with sports events are not sufficiently evolved and do not provide statistical analysis to a fullest extent which is potentially feasible to achieve.

SUMMARY

[0008] The present disclosure provides an improved sports apparatus, wherein movements of one or more projectiles employed in sports activities are more fully analyzed using the sports apparatus.

[0009] The present disclosure provides an improved method of using sports apparatus, wherein the method is capable of analyzing movements of one or more projectiles employed in sports activities more fully analyzed using the sports apparatus.

[0010] In one aspect, the present disclosure provides a sports apparatus for monitoring movement of one or more projectiles associated with a sporting event. The sports apparatus includes a data processing system for processing sampled data signals generated in operation by one or more sensors included in the one or more projectiles. The apparatus includes a mobile telephone coupled in wireless communication with the one or more projectiles for receiving the sampled data signals indicative of motion of the one or more projectiles, wherein the mobile telephone is operable to execute one or more software products therein for analyzing the sampled data signals received at the mobile telephone for providing analysis results indicative of a nature of trajectory of the one or more projectiles.

[0011] The mobile telephone executing the one or more software products is capable of providing more full analysis of movements of the one or more projectiles.

[0012] In another aspect, the present disclosure provides a method of using a sports apparatus for monitoring movement of one or more projectiles associated with a sporting event. The method involves using a mobile telephone coupled in wireless communication with the one or more projectiles for receiving the sampled data signals indicative of motion of the one or more projectiles; and using the mobile telephone to execute one or more software products therein for analyzing the sampled data signals received at the mobile telephone for providing analysis results indicative of a nature of trajectory of the one or more projectiles.

[0013] In another aspect, the present disclosure provides a software product recorded on machine-readable data storage media. The software product is executable upon computing hardware for implementing a method pursuant to the method of the present disclosure.

[0014] It will be appreciated that features of the invention are susceptible to being combined in various combinations without departing from the scope of the invention as defined by the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Embodiments of the present disclosure will now be described, by way of example only, with reference to the following diagrams wherein:

[0016] FIG. 1 is a schematic illustration of an example embodiment of a sports apparatus in accordance with the present disclosure;

[0017] FIG. 2 is a schematic illustration of an implementation of a projectile of the sports apparatus of FIG. 1;

[0018] FIG. 3 is an illustration of a projectile path associated with the system of FIG. 1; and

[0019] FIG. 4 is an illustration of example movement signals associated with a projectile of the system of FIG. 1.

[0020] In the accompanying diagrams, an underlined number is employed to represent an item over which the underlined number is positioned or an item to which the underlined number is adjacent. A non-underlined number relates to an item identified by a line linking the non-underlined number to the item. When a number is non-underlined and accompanied by an associated arrow, the non-underlined number is used to identify a general item at which the arrow is pointing.
DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

[0021] The following detailed description discloses aspects of the claimed invention and the ways it can be implemented. However, the description is not intended to define or limit the invention, such definition or limitation being solely contained in the claims appended thereto. Although the best mode of carrying out the invention has been disclosed comprehensively, those in the art would recognize that other embodiments for carrying out or practicing the invention are also possible.

[0022] In overview, the present disclosure relates to a sports apparatus for use at a sporting event, wherein the sports apparatus comprises one or more projectiles, for example balls, discs, shuttlecocks, and similar, and a data processing arrangement for receiving wireless transmissions from the one or more projectiles indicative of movement of the one or more projectiles, wherein the data processing arrangement is operable to receive the wireless transmissions from the one or more projectiles and generate various types of statistical analysis results which enable performance at the sporting event to be assessed and/or recorded.

[0023] The sports apparatus, indicated generally by 100 in FIG. 1, will now be described. Referring to FIG. 1, the apparatus 100 includes at least one projectile 200, for example a ball. During the sporting event, the projectile 200 is acted upon by one or more human participants at the sporting event, as well as bouncing on a ground surface and one or more sports structure, for example basketball nets and associated back walls. The projectile 200 includes within its outer protective layer one or more sensors 204, for example one or more accelerometers, one or more gyroscopes, sensors, one or more magnetometers, for recording motion, rotation, spin, and acceleration experienced by the projectile 200 in use. Optionally, the projectile 200, for example a ball, includes location transducers 202, for example a radio beacon arrangement, for sending signals to base stations for position measurement purposes, for example by triangulation based on received wireless signal strength at the radio beacon arrangement; alternatively, or additionally, time-of-flight of transmitted pulse radio signals from the projectile 200 is employed by the apparatus 100 for determining an instantaneous spatial position of the projectile 200 within a given playing area associated with the sporting event. Optionally, the location transducers 202 also include a GPS receiver for determining a spatial position of the projectile from Earth-orbiting position reference satellites; such position determination is, for example, beneficial when the projectile 200 is implemented as a golf ball, wherein the sporting event is a golf tournament being executed over a spatially extensive golfing range. The projectile 200 also includes a wireless interface 206 for communicating sampled sensor signals from the one or more sensors 204, and optionally the location transducers 202 to a wireless receiving location remote from the projectile 200. Optionally, the projectile 200 includes a miniaturized server arrangement, for enabling the projectile 200 to be accessed conveniently using hypertext transport protocol (HTTP) communications.

[0024] The sports apparatus 100 further includes a mobile telephone 220, also known as a cell phone. Beneficially, the mobile telephone 220 is a smart phone with sufficient computational power in its central processing unit 226 to perform analysis of movements of the projectile 200 and determine its spatial location. The mobile telephone 220 includes a user interface 224 for presenting statistical analysis results from processing data communicated from the projectile 200 to the mobile telephone 220 via a wireless interface 222 of the mobile telephone 220. Moreover, the smart telephone 220 includes a smart wireless interface 228 for enabling the mobile telephone 220 to communicate via the Internet or similar data communication network to a server system 234 and/or to a remote database 232. Optionally, the apparatus 100 is operable to function with data exchanges occurring directly between the server system 234 and the remote database 232 when performing statistical analysis of sensor signals generated during motion of the projectile 200.

[0025] Examples of methods of use of the apparatus 100 will now be described. In a first example, the mobile telephone 220 sends information after each sports practice session, for example to Facebook (“Facebook” is a registered trade mark), namely an athlete using the apparatus 100 is able to share statistical analysis results generated by the apparatus 100 within a social network, for example for competitively improving individual sports performance. Optionally, the mobile telephone 220 is beneficially configurable to send a tweet every time the athlete makes a successful shot of the projectile 200.

[0026] In a second example, the mobile telephone 220 is operable to send one or more status updates to a social network each time the athlete is able to make a three-point shot of the projectile 200, namely able to score from a long distance behind a three-point line during the sporting event. In addition to third-party services such as Facebook and Twitter (“Twitter” is a registered trade mark, associated with the “Twittersphere”), analytical statistical results generated by the system 100 can be sent to any specified service hosted on the Internet. Optionally, the results can be public or restricted, for example for personal use or for use by a dedicated group, for example a sports coach or other members of a specified team of athletes.

[0027] Referring next to FIG. 2, an example implementation of the projectile 200 is shown. The projectile 200 has an outer region 300, for example fabricated from an elastically deformable material, and a central armoured core 310 for accommodating the one or more sensors 204, the wireless interface 206, and optionally the location transducers 202. Beneficially, the wireless interface 206 is implemented as three sets of dipoles A-A, B-B, C-C which are individually excitable by the wireless interface 206; the dipoles are beneficially implemented in an orthogonal manner along three Cartesian x, y, z axes as shown. When communicating data, the wireless interface 206 sends data via the three dipoles which are excited at mutually different carrier-signal frequencies, such that the projectile 200 is capable of providing a pseudo-omni directional wireless transmission polar pattern which avoids data dropout as the projectile 200 moves in use, for example rotates, and thus allows for more accurate position determination based upon received wireless signal strength from wireless emission from the projectile 200. Optionally, batteries of the projectile 200 are recharged by wireless inductive charging when the projectile 200 is not in use, for example in a storage unit overnight, thereby enabling the outer region 300 of the projectile 200 to be hermetically sealed, for example to avoid water ingress into the central armoured core 310 when the projectile 200 is in use in adverse weather conditions. Sensors might be charged also by using internal power generator taking energy from the movement of the ball. Example of such power generator can be kinetic.
power generator. Additional examples of power generation for the sensors might include solar cells etc. . . . Sensor(s) in
sporting equipment can be installed in the cover or inside of the sporting event. For example in golf ball the sensor can be
in the middle of the golf ball i.e. embedded in the structure. If sporting event is for example football (used in American
football) there might be more than one sensor for example two i.e. one in each ends. This would enable more accurate
analysis.

[0028] Software products recorded on machine-readable
data storage media and executable upon computing hardware
of the apparatus 100 are employed for analyzing movements
of the projectile 200. Such analysis is optionally based upon
classical physics, for example according to Newtonian Laws
of motion. Alternatively, such analysis is based upon other
computational techniques that will be described later.

[0029] A problem encountered when analyzing trajectories
of the projectile 200 based upon classical physics is that such
analysis requires a considerable number of data samples
recording movements of the projectile 200 to be communi-
cated; this is especially pertinent when the projectile 200 is
subject to rapid movements, for example bouncing within a
confined space wherein the projectile 200 rapidly changes its
direction of motion.

[0030] Optionally, a volume of data needing to be commu-
nicated from the projectile 200 via its wireless interface 206
is susceptible to being reduced by computing hardware, for example a PIC microcontroller or similar, included in the core 210 collecting sensor data at a high rate, for example at a 1 kHz sampling rate or higher, and then
processing the sampled sensor data to determine whether or
not changes in the sampled sensor data are greater than a
defined threshold for at least M samples, wherein M is an
integer greater than unity; in an event that changes in sensor
data are less than the threshold during the M samples, no data
is communicated from the projectile 200 to the mobile tele-
phone 220. Optionally, the projectile 200 includes a data
buffer for storing sampled sensor data for coping with a
situation where the projectile 200 is subject to a long sus-
tained period of rapid changes in motion.

[0031] Additionally in order to save power the sending of
data can be tricked to take place only when there is movement
of the sporting equipment. In general the sending of data from
the sporting equipment sensors can be continuous, burst
mode (i.e. sending buffered data) pull based (i.e. mobile
phone requests the data) or push based i.e. sensor sends as
unicast, multicast or broadcast the data to one or more receiv-
ing mobile phones or other stations. In some embodiments
the sensors can perform calculations in the sporting event and
send all or some of the data in analysed format to receivers and
the service.

[0032] Referring to FIG. 3, a set of example trajectories of
the projectile 200, for example a basketball ball, is illustrated.
A first trajectory 400 of the projectile 200 follows an ideal
path to pass centrally past a basketball net rim 410 and down
through its associated net 420, without the projectile 200
being rapidly laterally displaced or its rotation characteristic
being temporally abruptly altered. A second trajectory 450 of
the projectile 200 follows a more complex path to a back wall
460 wherein the projectile 200 impacts and bounces back to
hit the basketball net rim 410 to bounce subsequently there-
from away from the net 420. Motions of the projectile 200 as
sensed by the projectile 200 for the first and second trajec-
tories 400, 450 are radically different and are susceptible; for
example, to being each recognized by a neural network algo-

[0033] Referring to FIG. 4, sampled sensors signals cor-
responding to the aforesaid second trajectory 450 are shown.
In FIG. 4, an abscissa axis 500 denotes a passage of time from
left to right, and an ordinate axis 510 denotes samples sensor
signal value. A first portion 520 of the trajectory 450 has
relatively small changes in sampled sensor data, whereas
bouncing from the back wall 460 results in rapidly changing
data in a second portion 530. A third portion 540 of the
trajectory 450 between the back wall 460 and basketball net
rim 410 has associated therewith relatively little change in
sampled sensor data from the projectile 200, whereas the
bounce outward from the basketball net rim 410 results in a
fourth portion 550 of the trajectory 450 with rapid changes.
Finally, a fifth portion 560 of the trajectory 450 where the
projectile 200 is bouncing outwardly away from the basket-
ball net rim 410 has relatively slowly changing sampled sen-
sor data associated therewith.

[0034] The aforementioned neural network software, for
downloadable to the mobile telephone 220 as a soft-
ware application, for example from an “App Store”, is
beneficially trained to recognize different patterns of movement
of the projectile 200 during the sporting event. For example,
the projectile 200, for example a basketball ball, is shot
towards a central opening of the basketball net rim 410 for N
times, and a user interface (UI), for example a touch screen, of
the mobile telephone 220 is used to inform the neural network
software whether or not the shot was successful, namely
passed correctly through the net 420. Moreover, the neural
network software is also informed via the user interface (UI)
if the shot were a normal shot or three-point shot. After a
series of such learning exercises, the neural network software
is capable of resulting in the mobile telephone 220 being able
to recognize immediately what type of shot has been executed
for the projectile 200. Optionally, learning parameters for the
neural network software can be pre-loaded into the mobile
telephone 220, thereby avoiding a need for aforesaid training,
for example in an event that sensor characteristics of the
projectile 200 are known beforehand, for example the projec-
tile 200 is a mass-produced proprietary product. Optionally,
users are able to share their neural network software training
parameters with other users of the apparatus 100.

[0035] The apparatus 100 is capable of being employed in
a wide range of sports, for example bowling, tennis, football,
rugby, basketball, baseball, cricket, water polo, but not limi-
thed thereto. By the mobile telephone 220, it is meant one or
more of communication devices such as: telephones, personal
data assistants (PDA’s) provided with wireless interfaces,
tablet computers provided wireless interfaces, but not limited
thereto.

[0036] Modifications to embodiments of the invention
described in the foregoing are possible without departing
from the scope of the invention as defined by the accompa-
nying claims. Expressions such as “including”, “compris-
9. A method of using a sports apparatus for monitoring movement of one or more projectiles associated with a sporting event, wherein the apparatus includes a data processing system for processing sampled data signals generated in operation by one or more sensors included in the one or more projectiles, the method comprising:

- using a mobile telephone coupled in wireless communication with the one or more projectiles for receiving the sampled data signals indicative of motion of the one or more projectiles; and
- using the mobile telephone to execute one or more software products therein for analyzing the sampled data signals received at the mobile telephone for providing analysis results indicative of a nature of trajectory of the one or more projectiles.

10. The method as claimed in claim 9, further comprising using a server arrangement which is remote from the mobile telephone, wherein the mobile telephone is coupled in communication with the server arrangement for communicating analysis data thereto and/or receiving analysis parameters therefrom.

11. The method as claimed in claim 9, further comprising using the mobile telephone to provide a user interface via which the one or more software products are user programmable to identify from the sample data signals a nature of trajectory of the one or more projectiles.

12. The method as claimed in claim 9, further comprising operating one or more of the software products to implement a neural network algorithm upon computing hardware of the mobile telephone for performing trajectory analysis.

13. The method as claimed in claim 9, further comprising using a wireless beacon detection arrangement for determining one or more spatial locations of the one or more projectiles when in use.

14. The method as claimed in claim 13, further comprising arranging for one or more projectiles to include a pseudo-omnidirectional antenna arrangement for emitting wireless radiation therefrom for receipt at the mobile telephone.

15. The method as claimed in claim 9, further comprising arranging for the apparatus to support multiple users for providing sharing between the users of at least one of: analysis results pertaining to trajectories of the one or more projectiles, neural network learning parameters for recognizing types of trajectory of the one or more projectiles.

16. The method as claimed in claim 9, further comprising arranging for the one or more projectiles to include a data processing arrangement for analyzing the sampled data signals and for sending the sampled data signals when an amplitude of change in the sample data signals exceeds a predefined threshold for more than a predefined period.

17. A software product recorded on machine-readable data storage media, wherein the software product is executable upon computing hardware for implementing the method as claimed in claim 9.

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