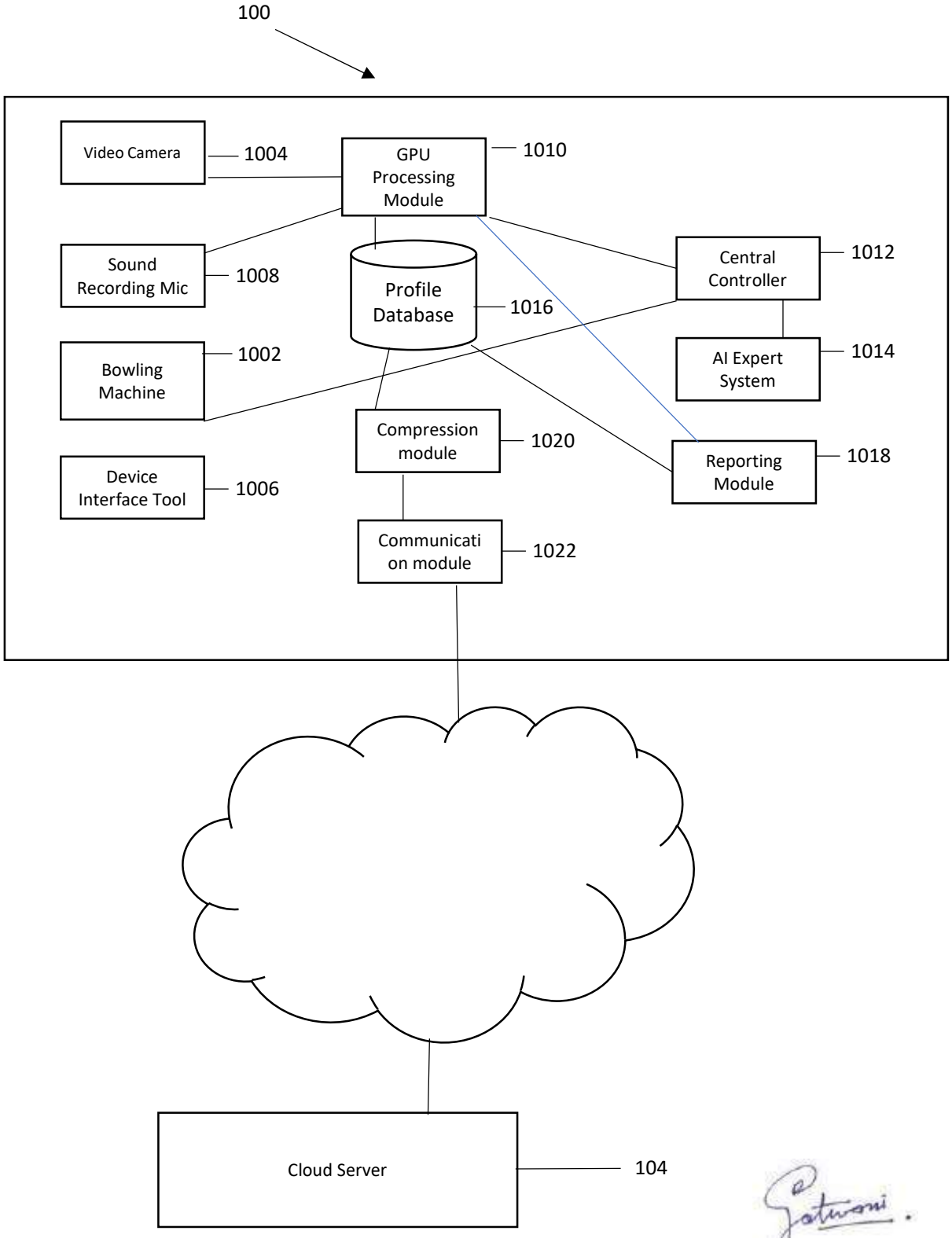


FIGURE 1

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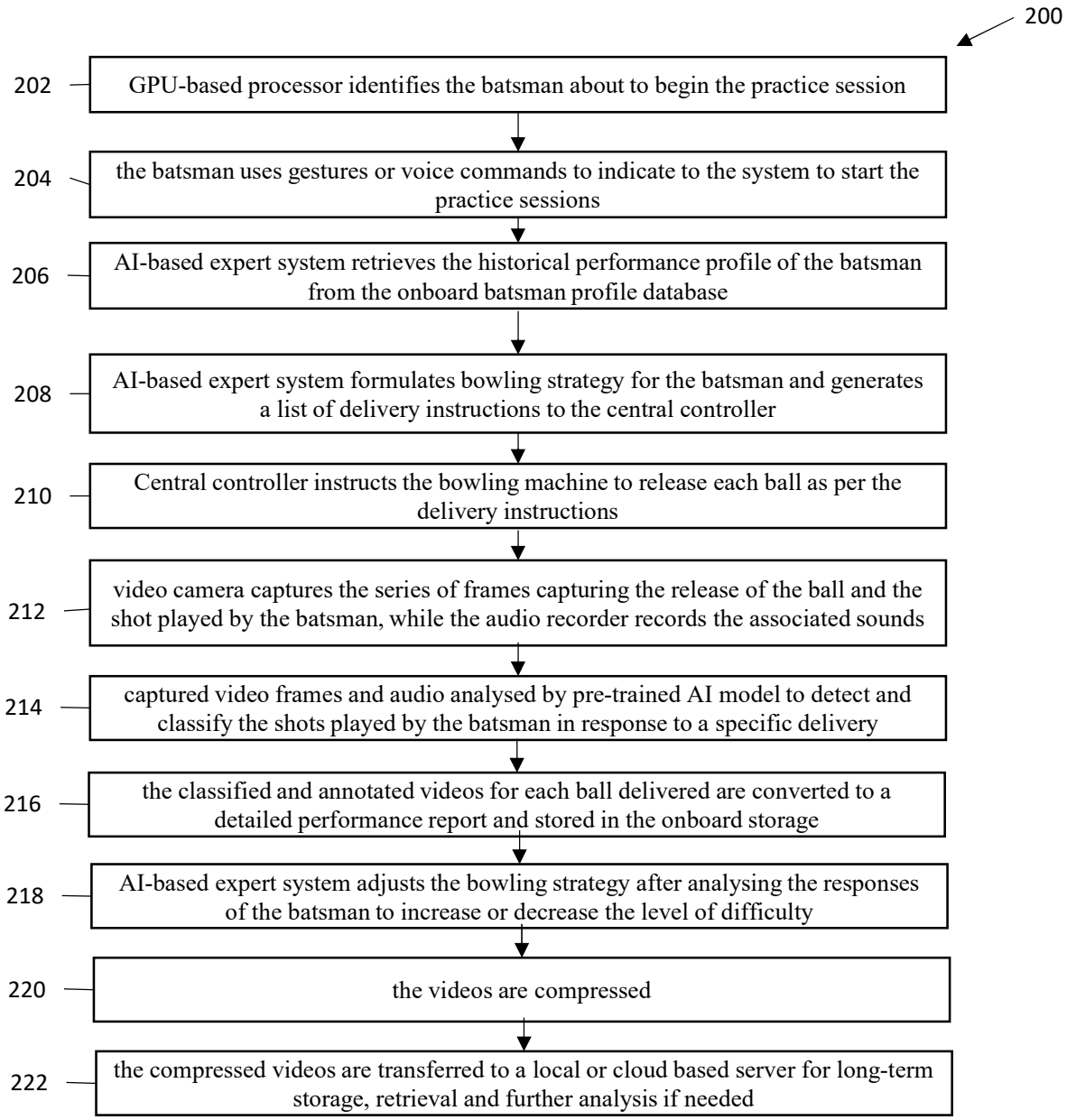


FIGURE 2

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FORM 2
THE PATENTS ACT, 1970 (39 Of 1970)
&
THE PATENTS RULES, 2003
COMPLETE SPECIFICATION
(See section 10 and rule 13)

1. **TITLE OF THE INVENTION:**

A SMART CRICKET BOWLING MACHINE WITH COMPUTER VISION BASED AI ANALYTICS

2. **APPLICANT (S)**

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3**. PREAMBLE TO THE DESCRIPTION**

COMPLETE SPECIFICATION

The following specification particularly describes the invention and the manner in which it is to be performed.

FIELD OF THE INVENTION

[002] The present invention relates to automated tracking of performance of batsmen using a smart bowling machine. More specifically it is intended to serve as an automated coaching-aid for improving batting performance.

BACKGROUND OF THE INVENTION

[003] Technology is being increasingly utilized to help improve the performance of sportspersons in different sports, including cricket. The use of Artificial Intelligence (AI) in analysing video footage of actual match performance with a view to identifying weaknesses of specific batsmen and helping devise plans to get them out is already prevalent. Video-analytics is also being already used in coaching drills including batting net sessions to help improve the performance of batsmen. However, all these setups require different specialists to operate them, which is not convenient and also cannot be utilised at all locations.

[004] The solution to the problem mentioned above is presented in the present disclosure. The invention proposes an integrated system that performs an automated batting performance analysis in conjunction with an automatic bowling machine.

[005] Any discussion of the prior art throughout the specifications should in no way be considered as an admission that such prior art is widely known or forms part of common general knowledge in the field.

[006] US8292709B2, describes a mechanism for determining the impact of the ball by the batsman for tracking performance through the

use of impact sensors. The invention does not include the use of a bowling machine or use of computer vision for the analysis. Also, it is unable to perform correlation between the type of bowler/bowling and the performance of the batsman.

[007] WO2014147444A1, encompasses a bowling machine which includes an automated pitching arm and a feeding mechanism. The pitching arm can be adjusted to simulate different types of bowlers and bowling types.

[008] Indian patent 270304, describes an electro-mechanical bowling machine with 3 different rotors to simulate a wide variety of bowling styles including spin bowling.

[009] US5868578A, describes a system including a multitude of video cameras aimed at a baseball batter for the purposes of analysis of performance and training. However, this is a purely computer vision-based method without involving automatic pitching machine and correlation between the types of baseball pitch and response from the batter.

[010] After an extensive prior art search, it is analysed that none of the existing invention provides the following claimed features of the current invention: integrated computer vision-based capture and analysis module with an automatic bowling machine, ability to devise different bowling strategies and capturing batsman's responses to those strategies, congruent operation and control of the bowling machine and computer vision-based module through AI-based controller, providing real-time performance report of the batsmen to

the coach an finally, the cloud-based integration for long-term performance analysis and on-demand analysis. The proposed invention is therefore a complete system and method for automating the performance analysis of batsmen during cricket net practice,

SUMMARY OF THE INVENTION

[011] The system in the present invention is a smart cricket bowling machine with computer vision based artificial intelligence analytics. The system captures the batsman's response to specific types of bowling styles allowing multi-dimensional performance analysis. The smart bowling machine encompasses a built-in adjustable video camera, a hi-fidelity audio mic, a Graphic Processing Unit (GPU) based processing unit, a central control unit and an AI-based expert system to capture, analyse, identify, and categorize the performance of a batsman during a particular net session. The analytics module than puts out detailed performance report of the batsman with specific suggestions for improvement.

OBJECT OF THE INVENTION

[012] One of the objects of the present invention is to provide a system and method for a smart bowling machine using computer vision and artificial intelligence to analyse batting performance during cricket practice sessions, that helps in the improvement of the performance of batsmen for varying types of bowling styles.

[013] Another object of the present disclosure is the generation of real-time performance report of each practice session for each batsman

thus creating long-term performance reports useful for coaching and performance enhancement purposes.

[014] Another aspect of the present disclosure is the real-time formulation of bowling strategies based on the past performance of the batsman and the observed performance of the batsman during the practice session with the ability to increase/decrease the challenge level for the batsman.

BRIEF DESCRIPTION OF THE DRAWINGS

[015] The numerous advantages of the present invention may be better understood by those skilled in the art by reference to the accompanying figures in which:

[016] Figure 1 is an exemplary environment of different sub-systems, modules, computing elements and interfaces etc. for a smart bowling machine, in accordance with an embodiment of the present invention.

[017] Figure 2 is a flow chart illustrating the method for operation of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[018] The detailed description set forth below is intended as a description of various configurations of the subject technology and is not intended to represent the only configurations in which the subject technology may be practiced. The appended drawings are incorporated herein and constitute a part of the detailed description. The detailed

description includes specific details for the purpose of providing a thorough understanding of the subject technology. However, it will be apparent to those skilled in the art that the subject technology may be practiced without these specific details. Like or similar components are labelled with identical element numbers for ease of understanding. As used throughout this description, the word "may" is used in a permissive sense (i.e., meaning having the potential to), rather than the mandatory sense, (i.e. meaning must). Further, the words "a" or "an" mean "at least one" and the word "plurality" means "one or more" unless otherwise mentioned. Furthermore, the terminology and phraseology used herein is solely used for descriptive purposes and should not be construed as limiting in scope. Language such as "including," "comprising," "having," "containing," or "involving," and variations thereof, is intended to be broad and encompass the subject matter listed thereafter, equivalents, and additional subject matter not recited, and is not intended to exclude other additives, components, integers, or steps. Likewise, the term "comprising" is considered synonymous with the terms "including" or "containing" for applicable legal purposes.

[019] Figure 1 is an exemplary environment for a smart bowling machine capable of performing detailed performance analysis of a batsman's performance during a cricket practice session using integrated audio-video analysis. The system (100) is a smart bowling machine, containing an automatic bowling machine (1002), a video camera of sufficient configuration (1004) mounted on top of the bowling machine in a front-facing manner on an adjustable mechanical

arm, a camera protector (1006) which is a transparent sheet of hard plastic mounted in front of the video camera for its protection, an audio mic capable of sound recording (1008) which is sensitive enough to detect fine noises, a GPU-based processing unit (1010) capable of running computer-vision tasks using AI, a central controller (1012) which controls the operation of the bowling machine based on inputs from the GPU-based controller, an AI-based expert system capable of devising run-time bowling strategies to specific batsmen based on their past performance (1014), an onboard storage module (1016) for storing video footage along with associated data, a reporting module (1018) for generating reports based on each practice session, a speaker (1020) to announce the model of dismissal to the batsman based on real-time analysis or change in bowling strategy or even directions for improving performance, a compression module (1022) which is responsible for compressing video footage for efficient onboard storage or transfer in low bandwidth settings. Finally, a communication module (1022) capable of establishing connection with the local network or the cloud using a multitude of communication protocols including wi-fi, ethernet, LTE, NFC etc and transferring the data to a central or cloud-based server (104) is envisaged.

[020] In accordance with an embodiment of the present invention, a video camera is integrated with an automatic bowling machine and serves to capture video frames and analyse the performance of batsmen in response to the varied inputs from the bowling machine.

[021] In accordance with an embodiment of the present invention, a protective transparent shield to protect the mounted camera from

damage is envisaged in case the ball is hit back straight at the camera by the batsman.

[022] In accordance with an embodiment of the present invention A GPU-based processing unit is provisioned capable of analysing video frames from the camera and running computer vision related artificial intelligence code to detect the batsman, ball tracking, line and length of the delivered ball, point of impact (on the bat and or body), time to impact, position of impact (in relation to stumps), batsman position and posture (head, feet and hands) at impact, batsman position in case no contact is made, detecting whether batsman is out or not and the mode of dismissal etc.

[023] In accordance with an embodiment of the present invention, another processing unit/controller capable of running artificial intelligence code related to an expert system which devises bowling strategies to different batsmen based on their level (beginner, intermediate, advanced) and their historical weaknesses and variety of bowling styles including pace and spin.

[024] In accordance with an embodiment of the present invention, a hi-fidelity sound capturing mic is also provided to capture sounds of impact of the ball with either the edge of the bat, edge of the bat and then pad (double sound), middle of the bat, not the middle of the bat to classify dismissal mode and the quality of the shot played by the batsman, used in conjunction with the visual analysis module to enhance accuracy of the system.

[025] In accordance with an embodiment of the present invention, the GPU-based processing module analyses the batsman's performance and correlates it with the bowling strategy employed by the expert system, generating detailed session-wise performance reports and long-term analysis reports on each batsman.

[026] In accordance with an embodiment of the present invention the captured video footage along with the graphical annotations and performance report including detailed analytics is compressed and transferred to a local or cloud-based server via the communication module for long-term storage.

[027] One aspect of the present invention is to enable automated video analysis of batting practice session for an individual or multiple batsmen.

[028] Another aspect of the present invention is the use of integrated video and audio analysis of a batsman's performance with an automatic bowling machine.

[029] Another aspect of the present invention is the automatic correlation of a batsman's performance with varying inputs and bowling strategies adopted by the bowling machine.

[030] Another aspect of the present invention is the real-time adaptive bowling strategies formulated by an expert system capable of varying the speed, direction, length, and spin of the ball based on the performance of the batsman and even exploiting the past weaknesses of a particular batsman.

[031] Another aspect of the present invention is the use of audio analysis to determine whether the batsman is out or not out, the mode of dismissal (leg-before wicket, caught behind) and the quality of shot played (sweet sound when the ball hits the middle of the bat) in conjunction with the video analysis.

[032] Another aspect of the present invention is the use of an integrated speaker to announce the mode of dismissal, directions for improvement, start and end of practice session etc. to the batsman based on the real-time audio-video analysis.

[033] Another aspect of the present invention is that the batsman can interact with the system using the audio-video interface for the purpose of controlling the operation of the bowling machine using both voice commands and gestures.

[034] Another aspect of the present invention is that the batsman can use gestures to stop the operation of the bowling machine or use voice commands to stop or resume the practice session using the audio-video module.

[035] Another aspect is that the AI-based expert system is capable of recognizing different batsman based on their gait, mannerisms, and posture etc. even with helmet and cricket gear and maintain their performance profiles in the central database;

[036] The final aspect of the present invention is the generation of real-time performance report of each practice session for each batsman

and creating long-term performance reports useful for coaching and performance enhancement purposes.

[037] Various embodiments of the present invention may now be understood with the exemplary environment 100 as a reference. The system can be setup and operated by a single individual and can track the performance of multiple batsmen sequentially. The system is setup facing the batsman and the camera can be positioned exactly overlooking the batsman from the same perspective as an umpire in a cricket match or adjusted to provide different perspective views. The automatic bowling machine 1002 is capable of delivering the pre-loaded balls down the pitch at the desired speed, direction and type of bowling and is controlled by the central controller 1012 which runs an artificial intelligence based expert system 1014 capable of devising different bowling strategies for different batsmen based on their real-time performance analysis. The responses of the batsmen and the shots played, modes of dismissal etc. being captured by the video camera 1004 and the sound recorder 1008, which are analysed by the GPU-based processing unit 1010 capable of running artificial intelligence-based computer vision models pre-trained to detect, track and classify batsmen performance in each frame. The analysis combines video analysis and audio inputs to determine the quality of the shots played by the batsman for each delivered ball. This analysis is captured in a report format by the reporting module 1018 and the annotated video footage and associated report is stored in the batsman profile database 1016 in the onboard storage module. For the purposes of data transmission, a compression module 1020 compresses the video

footage and uses the communication module 1022 to transfer the data to a local or cloud-based server 104 for long-term storage and analysis.

[038] FIG 2. is a flow chart illustrating the method encompassed by the proposed invention, in accordance with an embodiment of the present invention. The method starts at step 202 when the GPU-based processor identifies the batsman about to begin the practice session. At step 204, the batsman uses gestures or voice commands to indicate to the system to start the practice sessions. At step 206, the AI-based expert system retrieves the historical performance profile of the batsman from the onboard batsman profile database. The AI-based expert system then formulates a bowling strategy for the identified batsman at step 208 and generates a list of delivery instructions to the central controller. The central controller instructs the bowling machine to release each ball as per the delivery instructions in step 210. At step 212, the video camera captures the series of frames capturing the release of the ball and the shot played by the batsman, while the audio recorder records the associated sounds. At step 214, the captured video frames and audio inputs are analysed by the GPU-based processor which runs a pre-trained AI model to detect and classify the shots played by the batsman in response to a specific delivery. At step 216 the classified and annotated videos for each ball delivered are converted to a detailed performance report and stored in the onboard storage. At step 218, the AI-based expert system adjusts the bowling strategy after analysing the responses of the batsman to increase or decrease the level of difficulty. At step 220 the videos are compressed. Finally, at step 222

the compressed videos are transferred to a local or cloud-based server for long-term storage, retrieval and further analysis if needed.

[039] The previous description is provided to enable any person skilled in the art to practice the various aspects described herein. The previous description provides various examples of the subject technology, and the subject technology is not limited to these examples. Various modifications to these aspects will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other aspects. For example, while the foregoing was described in the context of automating performance analysis of batsmen during practice session by enhancing the functionality of an automatic bowling machine by incorporating innovative equipment, modules, and processing elements, it will be understood that other applications may use aspects of the proposed system and method to address related use cases/scenarios. Thus, the claims are not intended to be limited to the aspects shown herein but is to be accorded the full scope consistent with the language claims.

We claim:

1. A system (100) of smart cricket bowling machine, comprising of:

an automatic bowling machine (1002);

a front-mounted video camera (1004) to capture video frames;

a hi-fidelity sound recorder (1008) to record associated sounds;

a transparent video camera protector shield (1006);

characterized by;

the front-mounted video camera (1004) and the high-fidelity sound recorder (1008) are integrated with the automatic bowling machine (1002);

a GPU-based processing module (1010);

an AI-based expert system (1014) to retrieve historical performance of the batsman;

a compression module (1020) to compress a captured and annotated video;

a communication module (1022) for transferring the compressed video to a cloud-based server (104).

a central controller (1012) comprising a processing unit;

an onboard storage module (1016) to store the batsman profiles; and

a reporting module (1018) to generate the performance report of the batsman for a particular practice session.

2. The system as claimed in claim 1, wherein the AI-based expert system (1014) formulates bowling strategy for the batsman.

3. The system as claimed in claim 1, wherein the AI-based expert system (1014) classifies generates a list of delivery instructions to the central controller (1012).

4. The system as claimed in claim 2, wherein the central controller instructs the automatic bowling machine (1002) to release a ball as per the list of delivery instructions.

5. The system as claimed in claim 1, wherein the video frames captured include the frames capturing release of the ball and shots played by the batsman.

6. The system as claimed in claim 1, wherein the batsman uses voice commands and gestures to control the operation of the smart cricket bowling machine (100).

7. A method of operation of a smart cricket bowling machine (100), comprising of:

identifying a batsman by a GPU-based processing module (1010);

retrieving historical performance profile of the batsman by an AI-based expert system (1014);

formulating a bowling strategy for the batsman by the AI-based expert system (1014);

generating a list of delivery instructions to a central controller (1012);

capturing video frames by the video camera (1004);

recording associated sounds by high-fidelity sound recorder (1008);

classifying the video frames into different categories;

converting classified videos to a performance report; and

storing the performance report to a server for long-term storage and analysis;

8. The method as claimed in Claim 7, wherein the AI-based expert system adjusts the bowling strategy after analysing the performance report of the batsman.

9. The method as claimed in Claim 7, wherein the AI-based expert system recognizes different batsman based on their gait, mannerisms, and posture etc. even with helmet and cricket gear.



Date: New Delhi **Dinesh Jotwani IN/PA 359**
Place: 31st May 2022 **Jotwani Associates**

ABSTRACT

A SMART CRICKET BOWLING MACHINE WITH COMPUTER VISION BASED AI ANALYTICS

A smart cricket bowling machine (100) with integrated video and audio analytics is proposed for the purposes of automatic analysis of the performance of a batsman during a cricket practice session for the purposes of coaching and performance enhancement. An AI-based expert system (1024) dynamically formulates bowling strategies for a particular batsman based on a past performance profile and adapts the strategy in real-time based on the performance of the batsman. Audio and video analysis is fed to an AI-based expert system (1024), which classifies the performance of the batsman, quality of the shots plated, mode of dismissals etc. and generates a detailed performance profile for the batsman. The batsman can use voice commands and gestures to control the operation of the smart bowling machine. The system provides an integrated coaching and performance enhancement mechanism.

Representative FIG 1