

A SYSTEM FOR LINE UMPIRING IN GAMES AND A METHOD TO OPERATE THE SAME

EARLIEST PRIORITY DATE

- 5 This Application claims priority from a Complete patent application filed in India having Patent Application No. 202341048657, filed on July 19, 2023, and titled “A SYSTEM FOR LINE UMPIRING IN GAMES AND A METHOD TO OPERATE THE SAME”

FIELD OF INVENTION

- 10 Embodiments of a present disclosure relate to the field of digital services and more particularly to a system for line umpiring in games and a method to operate the same.

BACKGROUND

- In competitive sports, players and judges must determine where a ball is relative to a boundary line or other location at a particular time. Umpiring decisions are common in every sport. Line umpiring involves many sports such as badminton, tennis, kabaddi, and the like. Today, all sporting games involving rules around boundaries depend on the decisions of human judges. Because of human error or the difficulty in observing a fast-moving ball the decisions may not be taken precisely. By using an automated system for video playback, players may argument the decision-making involved in the determination of a ball's status.
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- It is challenging to make an accurate determination of position of a sports instrument such as the ‘ball’, when the ball is at or near a boundary line. This is challenging, especially for recreational games that are not being televised. The existing digital systems do not precisely determine the ball's coordinates and hence are not able to provide an accurate digital image to the umpire. Currently, the
- 25

solutions are based on object position prediction algorithms to bring the line umpiring decision with a proof based on ball trajectory animation. But the currently existing system does not provide proof of the decision based in real-time. There is need of system that may provide automated decision-making and accuracy in the decision making in sports.

Hence, there is a need for to a system for line umpiring in games a method to operate the same that addresses the aforementioned issues.

10 BRIEF DESCRIPTION

In accordance with one embodiment of the disclosure, a system for line umpiring in games is provided. The system includes a housing unit and a processing subsystem. The housing includes a top unit, and a bottom unit. The top unit includes a plurality of cameras mounted on a top portion of the housing unit. The plurality of cameras is configured to capture a plurality of images of a moving object in a court pertaining to a game and an area of the court. The top unit also includes a plurality of attachments positioned on the housing unit. The plurality of attachments is configured to attach the plurality of cameras to the housing unit in a preferred orientation and position. The bottom unit is operatively coupled with the top unit for holding the top unit at a predefined height and position from a net pole of the area, wherein the bottom unit is flexible to move based on the requirement of adjustment of the plurality of cameras. The processing subsystem is operatively coupled to the plurality of cameras and hosted on a server and configured to execute on a network to control bidirectional communications among a plurality of modules. The plurality of modules includes an image processing module and a display module. The image processing module configured to analyse the captured images using artificial intelligence in response to receive a request for review from an umpire. The image processing module is also configured to determine a plurality

of lines and a region for determining a position of a game instrument by means of morphological operation, and a color image processing technique and edge with contour analysis. Further, the image processing module configured detect a moving object, a plurality of pixel coordinates corresponding to the moving object and one
5 or more border lines of the area corresponding to the trajectory of the moving object in one or more image frames pertaining to the captured images. Furthermore, the image processing module configured detect one or more decision-making image frames based on a change in the plurality of pixel coordinates that indicates the touching of the moving object on the one or more border lines of the area
10 corresponding to a recent shot in real time, and the decision is generated by analysing the decision-making image frame. The display module is operatively coupled to the image processing module wherein the display module is configured to present the decision in real time to the umpire thereby aiding the umpire to make a line assessment in the game.

15 In accordance with another embodiment, a method for operation of the system for to a system for line umpiring in games is provided. The method includes attaching, by a plurality of attachments of the top unit of the housing unit, the plurality of cameras to the housing unit in a preferred orientation and position. The method also includes providing, a bottom unit for holding the top unit at a predefined height and
20 position from a net pole of the area, wherein the bottom unit is flexible to move based on the requirement of adjustment of the plurality of cameras. Further, the method includes capturing, by a plurality of cameras of a top unit of a housing unit, a plurality of images of a moving object in a court pertaining to a game and an area of the court. Furthermore, the method includes analysing, by an image processing
25 module of a processing subsystem, the captured images using artificial intelligence in response to receive a request for review from an umpire. determining, by the image processing module of the processing subsystem, a plurality of lines and a region for determining a position of a game instrument by means of morphological operation, and a color image processing technique and edge with contour analysis.
30 Furthermore, the method includes detecting, by the image processing module of the

processing subsystem, a moving object, a plurality of pixel coordinates corresponding to the moving object and one or more border lines of the area corresponding to the trajectory of the moving object in one or more image frames pertaining to the captured images. Furthermore, the method includes detecting, by
5 the image processing module of the processing subsystem, one or more decision-making image frames based on a change in the plurality of pixel coordinates that indicates the contact of the moving object on the one or more border lines of the area corresponding to a recent shot in real time, and the decision is generated by analysing the decision-making image frame. Furthermore, the method includes
10 displaying, by a display module of the processing subsystem the decision in real time to the umpire thereby aiding the umpire to make a line assessment in the game.

To further clarify the advantages and features of the present disclosure, a more particular description of the disclosure will follow by reference to specific embodiments thereof, which are illustrated in the appended figures. It is to be
15 appreciated that these figures depict only typical embodiments of the disclosure and are therefore not to be considered limiting in scope. The disclosure will be described and explained with additional specificity and detail with the appended figures.

OBJECTIVE OF THE INVENTION

An objective of the present invention is to provide a system for automated line
20 umpiring in games.

Another objective of the present invention is to provide accuracy of the decision by artificial intelligence-based algorithm and high frequency video data.

Yet, another objective of the present invention is the system enables an umpire to re-evaluate the final decision by reviewing the previous decision with proof of real
25 time images and videos.

BRIEF DESCRIPTION OF THE DRAWINGS

The disclosure will be described and explained with additional specificity and detail with the accompanying figures in which:

FIG. 1 is a block diagram representing a system for line umpiring in games in accordance with an embodiment of the present disclosure;

- 5 FIG. 2 is a flow chart representing the steps involved in the communication of the system for line umpiring in games with an umpire of the games of FIG. 1 in accordance with an embodiment of the present disclosure;

FIG. 3 is a schematic representation of an exemplary embodiment of a top unit of a housing structure of FIG. 1 in accordance with an embodiment of the present
10 disclosure;

FIG. 4 is a schematic representation of a portable central processing unit with a custom-made artificial intelligence-based software of FIG. 1 in accordance with an embodiment of the present disclosure;

- FIG. 5a is a schematic representation of an exemplary embodiment of a bottom unit
15 of the housing fixed in a ground region of FIG. 1 in accordance with an embodiment of the present disclosure;

FIG. 5b is a schematic representation of an exemplary embodiment of the bottom unit of the housing unit with a portable stand of FIG. 1 in accordance with an embodiment of the present disclosure;

- 20 FIG. 5c is a schematic representation of another exemplary embodiment of the stand of the bottom unit of the housing unit of FIG. 1 in accordance with an embodiment of the present disclosure;

FIG. 6a is a schematic representation of an exemplary embodiment of illustration of endpoints of a shuttlecock near to a border line of FIG. 1 in accordance with an
25 embodiment of the present disclosure;

FIG. 6b is a schematic representation of an embodiment exemplary embodiment of illustration of endpoints of a shuttlecock on the border line of FIG. 1 in accordance with an embodiment of the present disclosure;

FIG. 6c is a schematic representation of another exemplary embodiment of illustration of endpoints of a shuttlecock in real time of FIG. 1 in accordance with an embodiment of the present disclosure;

FIG. 7 is a schematic representation of an exemplary embodiment depicting multiple regions of FIG. 1 in accordance with an embodiment of the present disclosure;

FIG. 8 is a flowchart representing steps involved in the initialization of the system for line umpiring in games of FIG. 1 in accordance with an embodiment of the present disclosure;

FIG. 9 is a flowchart representing steps involved in the initial setting of the system for line umpiring in games during the match with background recording of FIG. 1 in accordance with an embodiment of the present disclosure;

FIG. 10a is a flowchart representing steps involved in the working of the system for line umpiring in games in a fully automatic mode of FIG. 1 in accordance with an embodiment of the present disclosure;

FIG. 10b is a flowchart representing steps involved in the working of the system for line umpiring in games in a semi-automatic mode of FIG. 1 in accordance with an embodiment of the present disclosure;

FIG. 11 is a block diagram of a computer or a server for the system for line umpiring in games in games in accordance with an embodiment of the present disclosure; and

FIG. 12 is a flow chart representing steps involved in a method for the operation of the system for line umpiring in games.

Further, those skilled in the art will appreciate that elements in the figures are illustrated for simplicity and may not have necessarily been drawn to scale. Furthermore, in terms of the construction of the device, one or more components of the device may have been represented in the figures by conventional symbols, and
5 the figures may show only those specific details that are pertinent to understanding the embodiments of the present disclosure so as not to obscure the figures with details that will be readily apparent to those skilled in the art having the benefit of the description herein.

DETAILED DESCRIPTION

10 For the purpose of promoting an understanding of the principles of the disclosure, reference will now be made to the embodiment illustrated in the figures and specific language will be used to describe them. It will nevertheless be understood that no limitation of the scope of the disclosure is thereby intended. Such alterations and further modifications in the illustrated system, and such further applications of the
15 principles of the disclosure as would normally occur to those skilled in the art are to be construed as being within the scope of the present disclosure.

The terms "comprises", "comprising", or any other variations thereof, are intended to cover a non-exclusive inclusion, such that a process or method that comprises a list of steps does not include only those steps but may include other steps not
20 expressly listed or inherent to such a process or method. Similarly, one or more devices or sub-systems or elements or structures or components preceded by "comprises... a" does not, without more constraints, preclude the existence of other devices, sub-systems, elements, structures, components, additional devices, additional sub-systems, additional elements, additional structures, or additional
25 components. Appearances of the phrase "in an embodiment", "in another embodiment", and similar language throughout this specification may, but not necessarily do, all refer to the same embodiment.

Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by those skilled in the art to which this

disclosure belongs. The system, methods, and examples provided herein are only illustrative and not intended to be limiting.

In the following specification and the claims, reference will be made to a number of terms, which shall be defined to have the following meanings. The singular forms
5 “a”, “an”, and “the” include plural references unless the context clearly dictates otherwise.

Embodiments of the present disclosure related to a system for line umpiring in games is provided. The system includes a housing unit and a processing subsystem. The housing includes a top unit, and a bottom unit. The top unit includes a plurality
10 of cameras mounted on a top portion of the housing unit. The plurality of cameras is configured to capture a plurality of images of a moving object in a court pertaining to a game and an area of the court. The top unit also includes a plurality of attachments positioned on the housing unit. The plurality of attachments is configured to attach the plurality of cameras to the housing unit in a preferred
15 orientation and position. The bottom unit is operatively coupled with the top unit for holding the top unit at a predefined height and position from a net pole of the area, wherein the bottom unit is flexible to move based on the requirement of adjustment of the plurality of cameras. The processing subsystem is operatively coupled to the plurality of cameras and hosted on a server and configured to execute
20 on a network to control bidirectional communications among a plurality of modules. The plurality of modules includes an image processing module and a display module. The image processing module configured to analyse the captured images using artificial intelligence in response to receive a request for review from an umpire. The image processing module is also configured to determine a plurality
25 of lines and a region for determining a position of a game instrument by means of morphological operation, and a color image processing technique and edge with contour analysis. Further, the image processing module configured detect a moving object, a plurality of pixel coordinates corresponding to the moving object and one or more border lines of the area corresponding to the trajectory of the moving object
30 in one or more image frames pertaining to the captured images. Furthermore, the

image processing module configured detect one or more decision-making image frames based on a change in the plurality of pixel coordinates that indicates the contact of the moving object on or near the one or more border lines of the area corresponding to a recent shot in real time, and the decision is generated by analysing the decision-making image frame. The display module is operatively coupled to the image processing module wherein the display module is configured to present the decision in real time to the umpire thereby aiding the umpire to make a line assessment in the game.

FIG. 1 is a block diagram representing a system (100) for line umpiring in games. The system includes a housing unit (102) and a processing subsystem (112). Further, the processing subsystem (112) includes an image processing module (118) and a display module (120).

The housing unit (102) includes a top unit (104) and a bottom unit (110). The top unit (104) includes a plurality of cameras (106) and a plurality of attachments (108). The plurality of cameras (106) is mounted on a top portion of the housing unit (102). The plurality of cameras (106) is configured to capture a plurality of images of a moving object in a court pertaining to a game and an area of the court. In one embodiment, the plurality of cameras (106) includes a visual device with custom-made applications used for high-frequency video input to the processing subsystem (112). The plurality of attachments (108) is positioned on the housing unit (102). The plurality of attachments (108) is configured to attach the plurality of cameras (106) to the housing unit (102) in a preferred orientation and position. The bottom unit (110) is operatively coupled with the top unit (104) for holding the top unit (104) at a predefined height and position from a net pole of the area. The bottom unit (110) is flexible to move based on the requirement of adjustment of the plurality of cameras (106). Further, the moving object refers to an object that is played in the game. For example, in badminton, the moving object refers to a 'shuttlecock'. Likewise, in cricket, the moving object refers to a 'ball'. It will be appreciated to those skilled in the art, that the moving object may be limited to the said examples and may include a person or an object that is referred during the game to earn points

to win. Further, in a specific embodiment, the game in the foregoing discussion is badminton. However, any other suitable indoor or outdoor games or sports may be considered.

The processing subsystem (112) is operatively coupled to the plurality of cameras
5 (106). The processing subsystem (112) hosted on a server (114) and configured to execute on a network (116) to control bidirectional communications among a plurality of modules. The plurality of modules includes an image processing module (118) and a display module (120). In one embodiment, the processing subsystem (112) includes a custom-made application for communication between
10 the user interface (122) and the processing subsystem (112).

The image processing module (118) is configured to analyze the captured images using artificial intelligence in response to a request for review from an umpire. The image processing module (118) is also configured to determine a plurality of lines and a region for determining a position of a game instrument by means of
15 morphological operation, and a color image processing technique and edge with contour analysis. Further, the image processing module (118) is configured to detect a moving object, a plurality of pixel coordinates corresponding to the moving object and one or more border lines of the area corresponding to the trajectory of the moving object in one or more image frames pertaining to the captured images.
20 Furthermore, the image processing module (118) is configured to detect one or more decision-making image frames based on a change in the plurality of pixel coordinates that indicates the touching of the moving object on the one or more border lines of the area corresponding to a recent shot in a real-time, and the decision is generated by analysing the decision-making image frame.

25 The display module (120) is operatively coupled to the image processing module (118) wherein the display module (120) is configured to present the decision in a real-time to the umpire thereby aiding the umpire to make a line assessment in the game.

FIG. 2 is a flow chart representing the steps involved in the communication of the system for line umpiring in games with at least one of an umpire, a system user, and an operator of the system of FIG. 1 in accordance with an embodiment of the present disclosure. Considering a non-limiting example of a badminton match where an umpire may call for a review on the last badminton shot that occurred through a display module (120). A plurality of digital devices is mounted on the bottom unit (110). In one embodiment, the plurality of digital devices may include Android operating system-based phones. The plurality of digital devices is controlled by a central processing unit (CPU) and a graphics processing unit (GPU) with a custom-made plurality of digital devices application. In one embodiment, the CPU is portable. In another embodiment, the CPU may receive high-frequency video clips from the phones after the call from the umpire. The software in the CPU processes video clips and can make decisions related to the last badminton shot held in a real-time scenario. In one embodiment, these decisions may be displayed to the umpire through the display module (120) via video, image, shuttlecock position coordinates, and other optional peripherals. In one embodiment, the display module (120) includes a user interface (122) wherein the user interface (122) is configured to display the decision to an umpire with at least one of video, an image, and an object position coordinate.

FIG. 3 is a schematic representation of an exemplary embodiment of a top unit (104) of a housing structure of FIG. 1 in accordance with an embodiment of the present disclosure. In one embodiment, a mechanical structure of the top unit (104) is fabricated with a combination of aluminium, steel, camera holders, and three-dimensional (3D) printed parts to give a position and orientation of the plurality of cameras (106). The top unit (104) hold the plurality of cameras (106) and a processing device. In one embodiment, the top unit (104) is a fixed design, which includes all camera modules and control devices. It must be noted that the system (100) can run each camera of the plurality of cameras (106) in 240 Hz frequency, which gives more accurate real-time decisions. Although the system can manage a higher frequency than 240 Hz. If the CPU receives high frequency video clips from

the phones after the call from umpire, the processing subsystem (112) in the CPU may process the video clips and able to make decisions related to last play held in real time scenario. This processing time may be reduced if the hardware specification increases. In one embodiment the system may deploy in a high specification hardware or cloud to get the maximum performance in a short period.

FIG. 4 is a schematic representation of a portable central processing unit with custom-made artificial intelligence-based software of FIG. 1 in accordance with an embodiment of the present disclosure. In one embodiment, the portable central processing unit is the system-on-module (SOM). The SOM is a core components of an embedded processing system which may include a processor core, a Graphics Processing Unit (GPU), a General-Purpose Input/Output (GPIO) pins, a communication interface, and a memory block on a single printed circuit board (PCB).

FIG. 5a is a schematic representation of an exemplary embodiment of a bottom unit (110) of the housing fixed in a ground region of FIG. 1 in accordance with an embodiment of the present disclosure. FIG. 5b is a schematic representation of an exemplary embodiment of the bottom unit (110) of the housing unit (102) with a portable stand (126) of FIG. 1 in accordance with an embodiment of the present disclosure. FIG. 5c is a schematic representation of another exemplary embodiment of the stand (128) of the bottom unit (110) of the housing unit (102) of FIG. 1 in accordance with an embodiment of the present disclosure. In one embodiment, the bottom is a flexible part, which holds the top unit (104) at a certain height and position from the net pole of the court. In one embodiment, three options may be available as the bottom unit (110). However, the bottom unit (110) is not limited to the three options.

FIG. 6a is a schematic representation of an exemplary embodiment of illustration of endpoints of a shuttlecock near to a border line of FIG. 1 in accordance with an embodiment of the present disclosure. FIG. 6b is a schematic representation of an embodiment exemplary embodiment of illustration of endpoints of a shuttlecock on

the border line of FIG. 1 in accordance with an embodiment of the present disclosure. FIG. 6c is a schematic representation of another exemplary embodiment of illustration of endpoints of a shuttlecock in real time of FIG. 1 in accordance with an embodiment of the present disclosure.

- 5 In one embodiment, determining the end point of a game instrument in the ground touching frame is a decision-making step. The approximate centre coordinates of the game instrument may be calculated from the artificial intelligence (AI) model response. Based on the center coordinates data and AI model response in the ground touch frame, another customized mathematical formula may give the end point
10 coordinate in the image frame. In one embodiment the endpoint coordinate of the shuttlecock (130) may be fed into contour-related image processing analysis and determine the position of the shuttlecock with respect to contour or line.

In one embodiment, computer vision algorithms may give the box and the line details of the badminton court using empty court recorded videos. The image
15 processing module (118) uses algorithms including contour detection and morphological operations and mathematical formulas.

FIG. 7 is a schematic representation of an exemplary embodiment depicting multiple regions of FIG. 1 in accordance with an embodiment of the present disclosure. As shown in the FIG. 7, different region numbers are given to different
20 regions (132). In one embodiment, these region numbers may be configured to identify the location of the shuttlecock, ball, and other sports instruments.

The process of the system includes the input taken by the system from a play area is a real-time unaltered image that is without changing the resolution and it's a part of high frequency frame.

- 25 - Process:

Each border of the play area segment is related to a region. The border is organized with a human understandable method for example, the region is labelled as number

0, 1, 2, 3, 4, 5, 6, 7, 8. Using this process, the system may define any coordinate in the image related to its region.

- Output:

Final output may be verified with the output image.

- 5 FIG. 8 is a flowchart (300) representing steps involved in the initialization of the system for line umpiring in games of FIG. 1 in accordance with an embodiment of the present disclosure. The system starts (302) when a power-on button is pressed. The power button is positioned on the housing unit (102). In one embodiment, the display module reads the wireless connectivity (304) between the CPU and the user
10 interface (122). If the connection is okay (306), then display the successful connection (308) on the user interface (122). The CPU may check the USB connectivity between the plurality of cameras (106) and the CPU. If any connectivity has failed then check for two times (310), and subsequently an error message (312) is displayed on the user interface (122).
- 15 FIG. 9 is a flowchart (400) representing steps involved in the working of the system for line umpiring in games during the match with background recording of FIG. 1 in accordance with an embodiment of the present disclosure. In one embodiment, setting (402) to the system (100) may be done before starting the match. An empty court recording (404) of 10 sec is needed before starting the match for ensuring that
20 the plurality of the camera along with the plurality of attachments is placed in the right position that and that the environment lightings are ok is all areas are covered (406) for the background detection. If all areas are not covered then check for two times (416) and ask the user to adjust the camera stand position (418). In one embodiment, a confirmation message and detected background images with
25 processed results may be displayed in the user interface. The steps mentioned here may be carried out by a user. A mode setting for operating of the system is done. The mode may be at least one of fully automatic (412) and Semi-automatic (414). In one embodiment the default mode is fully automatic and player mode which may

be singles or doubles and type of shuttlecock. In one embodiment, the type of shuttlecock is its color which may be yellow or white set by the user.

After completing the settings, the user is able to start the match recording (4108) option and players start playing. If there is a doubtful scenario arises on umpiring decision, the user may immediately click a stop button (410) in the user interface. In one embodiment, the stop button may be pressed within a short-defined period. The short defined period may be 10 sec by default, but not limited to 10 seconds. The short-defined time period varies based on the user's need. It is to be noted that if the short-time period is increased then it may increase the processing time. If the user presses the stop button after the short-defined period, the system may analyze and send the result.

FIG. 10a is a flowchart (500) representing steps involved in the working of the system for decision-making in games in a fully automatic mode (412) of FIG. 1 in accordance with an embodiment of the present disclosure. In one embodiment, in the fully automatic mode, the user doesn't need to give any input to the system, the system may automatically decide the camera region (502) in which the ground touch detection scenario occurred. The system (100) then automatically filters the last ground touch shot (504), then the ground touching scenario frame. The system then makes the decision based on shuttlecock's position in the ground touching frame. In one embodiment, the image processing module uses Artificial intelligence (AI) and digital image processing techniques.

In one embodiment, the AI model trained with custom data is used with a deep learning model for object detection and segmentation. The model will give the position of the shuttlecock. These positions will be fed into different mathematical formulas and programming conditions in order to do the automation steps and ground frame detection. Then display the decision (506) on user interface. The final result is displayed based on the position (coordinate) of the shuttlecock endpoint in the image. In one embodiment, the result may be displayed on the user interface with the proof of final ground touch image and a short video of the ground touch

scene. The recording is started (508) for taking images and videos. This real-time images & videos will give more clarity to the users on decisions made by the system.

In one embodiment, if there is a failure in fully automatic mode (412), the user is
5 able to switch to semi-automatic mode (414).

FIG. 10b is a flowchart (500) representing steps involved in the working of the system for line umpiring in games in a semi-automatic mode (414) of FIG. 1 in accordance with an embodiment of the present disclosure. In one embodiment, in the semi-auto mode, the camera region (510) of the ground touch is selected and
10 the last shot in which ground touch is determined. This determination may be done by user that is manually using the user interface display. Further steps are done automatically by the system (100). After determination, based on the ground-touch video shot, the ground touching image frame is determined by the system (100) automatically using pre-defined algorithms. The system may use the specific
15 algorithms such as ground region 1, ground region 2, ground region 3, ground region 4 (514) based on the camera region selection from user input. The end point coordinate ~~and~~ of the shuttlecock from the ground touching ~~the~~ image frame is calculated. Then the contour or line position related to the shuttlecock coordinate is calculated. The final decision-making and displaying the decision (516) with proofs
20 such as recording (520) the ground touch image and short video.

In one embodiment the system may provide the result in 25 sec to 45 sec in full auto mode and 25 sec to 35 sec in semi-auto mode (414) at the moment with ordinary specific hardware.

FIG. 11 is a block diagram of a computer or a server for the system for line umpiring
25 in games in games in accordance with an embodiment of the present disclosure. The server (600) includes a processor(s) (602), and memory (606) operatively coupled to the bus (604).

The processor(s) (602), as used herein, means any type of computational circuit, such as, but not limited to, a microprocessor, a microcontroller, a complex instruction set computing microprocessor, a reduced instruction set computing microprocessor, a very long instruction word microprocessor, an explicitly parallel instruction computing microprocessor, a digital signal processor, or any other type of processing circuit, or a combination thereof.

The bus (604) as used herein refers to be internal memory channels or computer network that is used to connect computer components and transfer data between them. The bus (604) includes a serial bus or a parallel bus, wherein the serial bus transmits data in a bit-serial format and the parallel bus transmits data across multiple wires. The bus (604) as used herein, may include but not limited to, a system bus, an internal bus, an external bus, an expansion bus, a frontside bus, a backside bus, and the like.

The memory (606) includes a plurality of subsystems and a plurality of modules stored in the form of an executable program which instructs the processor (602) to perform the method steps illustrated in FIG. 1. The memory (606) is substantially similar to the system (100) of FIG.1. The memory (606) has submodules: an image processing module (118) and display module (120).

The image processing module (118) is configured to analyze the captured images using artificial intelligence in response to a request for review from an umpire. The image processing module (118) is also configured to determine a plurality of lines and a region for determining a position of a game instrument by means of morphological operation, and a color image processing technique and edge with contour analysis. Further, the image processing module (118) is configured to detect a moving object, a plurality of pixel coordinates corresponding to the moving object, and one or more border lines of the area corresponding to the trajectory of the moving object in one or more image frames pertaining to the captured images. Furthermore, the image processing module (118) is configured to detect one or more decision-making image frames based on a change in the plurality of pixel

coordinates that indicates the touching of the moving object on the one or more border lines of the area corresponding to a recent shot in real time, and the decision is generated by analysing the decision-making image frame.

The display module (120) operatively coupled to the image processing module
5 (118) wherein the display module (120) is configured to present the decision in real time to the umpire thereby aiding the umpire to make a line assessment in the game.

Computer memory elements may include any suitable memory device(s) for storing data and executable program, such as read-only memory, random access memory, erasable programmable read-only memory, electrically erasable programmable
10 read-only memory, hard drive, removable media drive for handling memory cards and the like. Embodiments of the present subject matter may be implemented in conjunction with program modules, including functions, procedures, data structures, and application programs, for performing tasks, or defining abstract data types or low-level hardware contexts. An executable program stored on any of the
15 above-mentioned storage media may be executable by the processor(s) (602). In one embodiment, the executable program may be executable by the graphics processing unit (GPU) as the system facilitates the GPU accelerated AI deployment.

FIG. 12 is a flow chart representing steps involved in a method (200) for the operation of the system for line umpiring in games. The method (200) also includes
20 attaching, by a plurality of attachments of the top unit of the housing unit, the plurality of cameras to the housing unit in a preferred orientation and position in step (202).

Furthermore, the method (200) includes providing, a bottom unit for holding the top unit at a predefined height and position from a net pole of the area, wherein the
25 bottom unit is flexible to move based on the requirement of adjustment of the plurality of cameras in step (204).

The method (200) includes capturing, by a plurality of cameras of a top unit of a housing unit, capturing a plurality of images of a moving object in a court pertaining

to a game and an area of the court in step (206). The method also includes fabricating, the housing unit with a combination of an aluminium, steel, and three-dimensional printed parts to provide a position and orientation of the plurality of cameras.

- 5 Furthermore, the method (200) includes analysing, by an image processing module of a processing subsystem, the captured images using artificial intelligence in response to receive a request for review from an umpire in step (208). The method also includes receiving, by a receiving module, the review request from the umpire.

- 10 Furthermore, the method (200) includes determining, by the image processing module of the processing subsystem, a plurality of lines and a region for determining a position of a game instrument by means of morphological operation, and a color image processing technique and edge with contour analysis in step (210).

- 15 Furthermore, the method (200) includes detecting, by the image processing module of the processing subsystem, a moving object, a plurality of pixel coordinates corresponding to the moving object and one or more border lines of the area corresponding to the trajectory of the moving object in one or more image frames pertaining to the captured images in step (212).

- 20 Furthermore, the method (200) includes detecting, by the image processing module of the processing subsystem, one or more decision-making image frames based on a change in the plurality of pixel coordinates that indicates the touching of the moving object on the one or more border lines of the area corresponding to a recent shot in real time, and the decision is generated by analysing the decision-making image frame in step (214) .

- 25 Furthermore, the method (200) includes displaying, by a display module of the processing subsystem, the decision in real time to the umpire thereby aiding the umpire to make a line assessment in the game in step (216). The method includes providing, a user interface wherein the user interface is configured to display the

decision to an umpire with at least one of a video, an image, and an object position coordinate. Furthermore, the method includes communicating, by using a custom-made application, between the user interface and the processing subsystem.

Furthermore, the method includes providing, a visual device with custom-made applications used for high-frequency video input to the processing subsystem. Furthermore, the method includes providing, a portable central processing unit and a Graphics processing unit (GPU) with a custom-made artificial intelligence-based application used for video and image processing and decision-making. In one embodiment, the central processing unit and the graphics processing unit may be a system-on module. In one embodiment, the system is a physical electronic unit controlled by Artificial intelligence-based software. In another embodiment, the system operated automatically.

Various embodiments of the present disclosure enable decision-making in games. The system disclosed in the present disclosure provides an automated decision-making in sports. The system may be used in tennis courts, badminton courts, and the like. The system in the present disclosure, enables the umpire to review his/her decision by using the display panel. The system disclosed in the present disclosure provides fast results with proof.

While specific language has been used to describe the disclosure, any limitations arising on account of the same are not intended. As would be apparent to a person skilled in the art, various working modifications may be made to the method in order to implement the inventive concept as taught herein.

The figures and the foregoing description give examples of embodiments. Those skilled in the art will appreciate that one or more of the described elements may well be combined into a single functional element. Alternatively, certain elements may be split into multiple functional elements. Elements from one embodiment may be added to another embodiment. For example, order of processes described herein may be changed and are not limited to the manner described herein. Moreover, the actions of any flow diagram need not be implemented in the order shown; nor do

all of the acts need to be necessarily performed. Also, those acts that are not dependent on other acts may be performed in parallel with the other acts. The scope of embodiments is by no means limited by these specific examples.

WE CLAIM:

1. A system (100) for line umpiring in games comprises:

a housing unit (102) comprises:

a top unit (104) comprising:

5 a plurality of cameras (106) mounted on a top portion of the housing unit (102) wherein the plurality of cameras (106) is configured to capture a plurality of images of a moving object in a court pertaining to a game and an area of the court;

10 a plurality of attachments (108) positioned on the housing unit (102) wherein the plurality of attachments (108) is configured to attach the plurality of cameras (106) to the housing unit (102) in a preferred orientation and position; and

15 a bottom unit (110) operatively coupled with the top unit (104) for holding the top unit (104) at a predefined height and position from a net pole of the area, wherein the bottom unit (110) is flexible to move based on the requirement of adjustment of the plurality of cameras (106); and

20 a processing subsystem (112) operatively coupled to the plurality of cameras (106) and hosted on a server (114), and configured to execute on a network (116) to control bidirectional communications among a plurality of modules comprising:

an image processing module (118) configured to:

analyse the captured images using artificial intelligence in response to receive a request for review from an umpire;

25 determine a plurality of lines and a region for determining a position of a game instrument by means of morphological operation,

and a color image processing technique and edge with contour analysis;

5 detect a moving object, a plurality of pixel coordinates corresponding to the moving object and one or more border lines of the area corresponding to the trajectory of the moving object in one or more image frames pertaining to the captured images; and

10 detect one or more decision-making image frames based on a change in the plurality of pixel coordinates that indicates the touching of the moving object on the one or more border lines of the area corresponding to a recent shot in real time, and the decision is generated by analysing the decision-making image frame; and

15 a display module (120) operatively coupled to the image processing module (118) wherein the display module (120) is configured to present the decision in real time to the umpire thereby aiding the umpire to make a line assessment in the game.

2. The system (100) as claimed in claim 1, wherein the housing unit (102) is fabricated with at least one of an aluminium, steel, fibre, carbon foil, and three-dimensional printed parts to provide a position and orientation of the plurality of cameras (106).
- 20 3. The system (100) as claimed in claim 1, wherein the plurality of cameras (106) comprises a visual device with custom-made applications used for high-frequency video input to the processing subsystem (112).
4. The system (100) as claimed in claim 1, is a physical electronic unit controlled by Artificial intelligence-based software.
- 25 5. The system (100) as claimed in claim 1, wherein the display module (120) comprises a user interface (122) wherein the user interface (122) is configured to

display the decision to an umpire with at least one of a video, an image, and an object position coordinate.

6. The system (100) as claimed in claim 5, wherein the processing subsystem (112) comprises a custom-made application for communication between the user interface (122) and the processing subsystem (112).

7. The system (100) as claimed in claim 1, comprises a portable central processing unit and a graphics processing unit with a custom-made artificial intelligence-based application used for video and image processing and decision-making.

8. The system (100) as claimed in claim 1, wherein the processing subsystem (112) comprises a receiving module (124) configured to receive the review request from the umpire.

9. The system (100) as claimed in claim 1, is operated automatically.

10. A method (200) for operation of the system for decision-making in sports comprises:

attaching, by a plurality of attachments of the top unit of the housing unit, the plurality of cameras to the housing unit in a preferred orientation and position; (202)

providing, a bottom unit for holding the top unit at a predefined height and position from a net pole of the area, wherein the bottom unit is flexible to move based on the requirement of adjustment of the plurality of cameras; (204)

capturing, by a plurality of cameras of a top unit of a housing unit, a plurality of images of a moving object in a court pertaining to a game and an area of the court; (206)

analysing, by an image processing module of a processing subsystem, the captured images using artificial intelligence in response to receive a request for review from an umpire; (208)

5 determining, by the image processing module of the processing subsystem, a plurality of lines and a region for determining a position of a game instrument by means of morphological operation, and a color image processing technique and edge with contour analysis; (210)

10 detecting, by the image processing module of the processing subsystem, a moving object, a plurality of pixel coordinates corresponding to the moving object and one or more border lines of the area corresponding to the trajectory of the moving object in one or more image frames pertaining to the captured images; (212)

15 detecting, by the image processing module of the processing subsystem, one or more decision-making image frames based on a change in the plurality of pixel coordinates that indicates the touching of the moving object on the one or more border lines of the area corresponding to a recent shot in real time, and the decision is generated by analysing the decision-making image frame; (214) and

20 displaying, by a display module of the processing subsystem, the decision in real time to the umpire thereby aiding the umpire to make a line assessment in the game. (216)