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— *of inventorship (Rule 4.17(iv))*

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(54) **Title**: EQUIPMENT USING CAMERAS FOR RECORDING AND DISPLAYING IMPACT OF THE BALL AROUND THE LINES OF THE PLAYING AREA

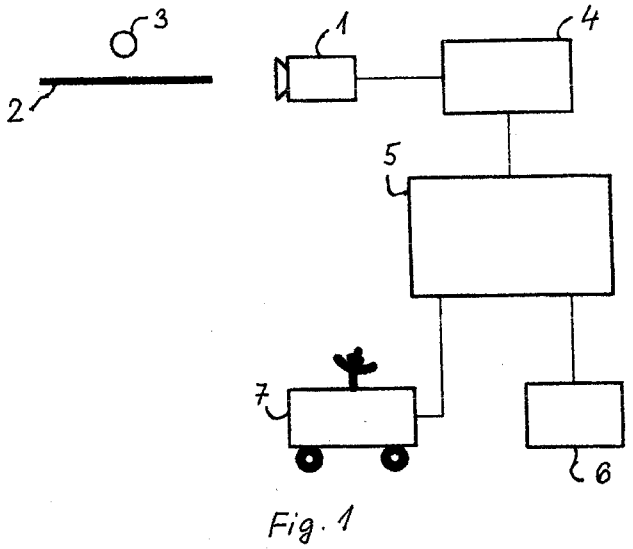


Fig. 1

(57) **Abstract**: This solution involves equipment which uses cameras for recording and displaying impact of the ball around the lines of the playing area. Its substance lies in the equipment consisting of at least two high-speed cameras (1) with a recording rate of at least 500 frames per second for scanning lines of the court (2) and flying ball (3), while camera output (1) is connected with at least one computer (4), equipped with a memory for video recording and an algorithm for image evaluation, while the computers (4) are connected, by wire or wirelessly, with at least one central server (5) for data evaluation, equipped with a memory for video and image storage from the entire playing time from all the computers (4), while the central server's output (5) is connected wirelessly with the display (6) of the umpire, and, by wire or wirelessly, with an outside-broadcasting vehicle (7). Computer (4) is also equipped with an interface for video recording from the camera. The equipment, which serves as a point of reference for tennis chair umpires, can also be used for TV broadcasts.

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Equipment using cameras for recording and displaying impact of the ball around the lines of the playing area

Technology Area

Equipment for recording and displaying impact of the ball to determine whether the ball was on the line, in or out. This equipment serves as a point of reference, for instance for tennis chair umpires and also for television broadcasts.

Current Technology Status

At the moment, a ball trajectory is estimated and visualized by means of a system of cameras placed around the playing area, and a computer calculating the coordinates of the ball along the axis X, Y, Z in time is employed. These coordinates later serve for approximate determination of the ball's impact in the playing area. The equipment subsequently processes all the information, visualizing to the chair umpire graphic representation but not a physical recording of the actual impact of the ball.

Several problems may occur in this equipment:

a) proceeding from the acquired data, the equipment may not precisely determine the ball's coordinates and, therefore, may display to the umpire graphic representation involving an erroneously determined impact of the ball. The equipment estimates the coordinates of the ball's trajectory from the frames separated from one another by a

certain time interval. If, for instance, there comes a gush of wind between two recorded intervals coinciding precisely with the ball's impact, the equipment may not be able to calculate the ball's coordinates absolutely accurately and, thus, display an erroneous visualization to the umpire;

b) the line of the playing area may not be completely straight, and once again, the system will display an incorrect result;
c) there can be an unintended movement of the camera, thus distorting the results of the algorithm for the calculation of coordinates, without detecting any error of the system,
d) toughness of balls may change with prevailing temperature and ball manufacturer; as a result, the ball tends to flatten on impact differently, which may make it impossible for the calculation to determine whether the ball was in or out.

Use of this equipment may result in disagreement and umpiring mistakes because e.g. the ball was out, which was evident from its imprint in the playing area, but the equipment evaluated the ball as in.

Substance of Technical Design

The above problems are eliminated by the equipment which uses cameras for recording and displaying impact of the ball around the lines of the playing area – a camera linesman, capturing the picture or video of the ball's impact in the playing area in real time and displaying it to chair umpire or outside-broadcasting vehicle.

The equipment consists of a system of at least 2 high-speed cameras, equipped with a lens providing a minimum rate of 500 frames per second (500 FPS) and covering the individual lines of the playing area. Output of each of the high-speed cameras is connected with at least one computer, which evaluates in real time the movement of the ball in the vicinity of the line, determining whether it was in, out or on the line. The computer is equipped with a memory for video recording and an algorithm for image evaluation. Each computer is connected, by wire or wirelessly, with at least one central server which receives in real time pictorial data; the central server evaluates in real time the distance of the ball from the line and determines whether it was in our out. Furthermore, it can insert into the video all the necessary visualizations (distance of the ball from the line, speed of the ball on impact, highlighting the ball, inserting advertisement etc.) Pictures thus evaluated are being sent, on an ongoing basis, to chair umpire or outside-broadcasting vehicle, which is wirelessly connected with the output of the central server. Chair umpire can subsequently view on his/her display any undistorted picture, thus avoiding disputes and umpiring mistakes since the video makes it abundantly clear where the ball precisely landed.

Overview of Pictures in the Drawing

The equipment pursuant to the given technical design is schematically depicted in the drawing attached.

Example of Implementation

The equipment consists of at least 2 high-speed cameras for tennis singles matches. Each camera 1 captures the appropriate line of the court 2 and the trajectory of the ball 3. Output of each high-speed camera 1 with a lens is connected with computer 4, equipped with a memory for video recording from camera 1 and an algorithm for image evaluation. Computer 4 is connected, by wire or wirelessly, with central server 5, equipped with memory for storing video and pictures from the entire playing time from all computers 4. Subsequently processed picture is sent from central server 5 to chair umpire's display 6 and to outside-broadcasting vehicle 7.

Industrial Application

The given technical design can be used for sports matches, such as tennis, volleyball, soccer, hockey, badminton and similar ball games, where it is necessary to watch high-speed impact of a ball/balls on the line and determine whether the ball was in our out. These slowed-down pictures can also be used for television broadcasts, where various parameters of the ball's impact interesting for viewers, complete with advertisements, may be inserted into the picture. This equipment eliminates human error of linesmen in determining the precise spot of the ball's impact in the playing area.

CLAIMS

1. The equipment using cameras for recording and displaying impact of the ball around the lines of the playing area, **distinguishing itself** by the fact that it consists of a system of at least 2 high-speed cameras (1) with the rate of frames per second amounting to at least 500 for capturing the line of the court (2) and flying ball (3), while output of the camera (1) is connected with at least one computer (4), equipped with a memory for video recording and an algorithm for image evaluation, while computers (4) are connected, by wire or wirelessly, with at least one central server (5) for evaluating data, which is equipped with a memory for storing video and pictures from the entire playing time from all the computers (4), while output of the central server (5) is connected wirelessly with the display of chair umpire (6) and, by wire or wirelessly, with an outside-broadcasting vehicle (7).

2. The equipment pursuant to claim 1, **distinguishing itself** by the fact that computer (4) is further equipped with an interface for video recording from the camera.

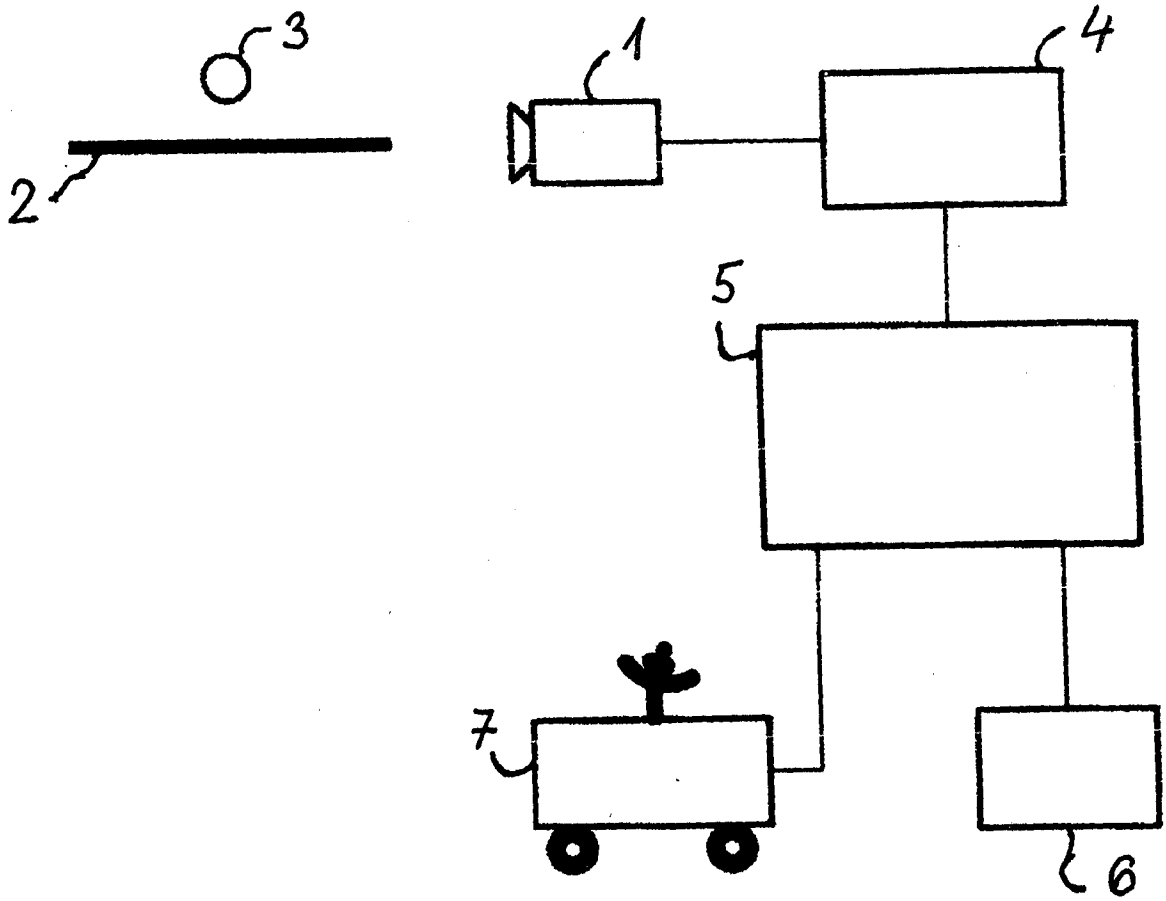


Fig. 1

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International application No
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A. CLASSIFICATION OF SUBJECT MATTER
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ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A63B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 2003/142210 A1 (CARLBOM INGRID BIRGITTA [US] ET AL) 31 July 2003 (2003-07-31) paragraph [0007]	1,2
X	EP 2 455 911 A1 (VICOMTECH VISUAL INTERACTION AND COMM TECHNOLOGIES CT [ES] FUNDACION C) 23 May 2012 (2012-05-23) sentences 1-8, paragraph 5 paragraphs [0009], [0012]	1,2
X	US 8 199 199 B1 (SHLYAK YURIY [US] ET AL) 12 June 2012 (2012-06-12) column 1, line 64 - column 2, line 25	1,2

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
2 October 2013	18/10/2013

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International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 868 578 A (BAUM CHARLES S [US]) 9 February 1999 (1999-02-09) column 1, line 36 - line 45 column 3, line 53 - line 59 -----	1,2

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/CZ2013/000080

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