

(21) Application No: **2002805.6**
 (22) Date of Filing: **27.02.2020**

(51) INT CL: **A63B 71/06** (2006.01) **A63B 24/00** (2006.01)

(56) Documents Cited: **BE 001016077 A6** **BE 001015552 A6**

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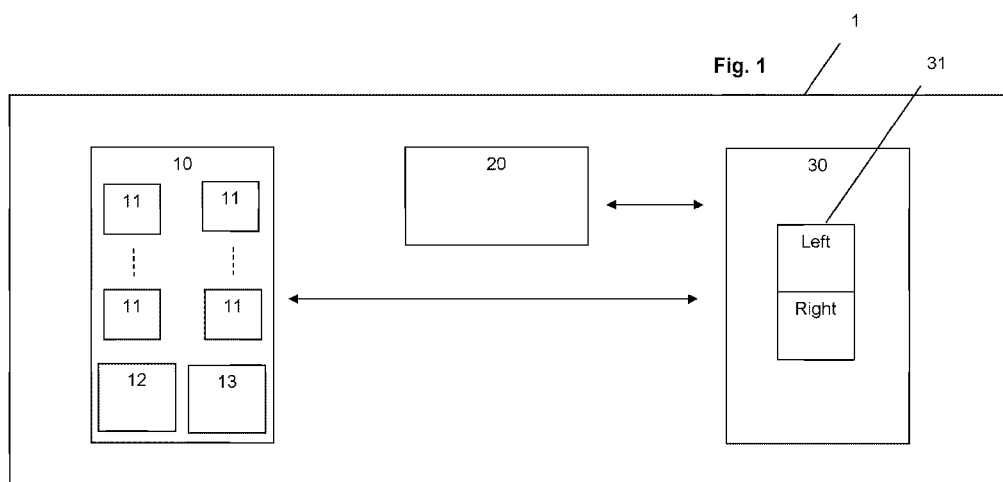
(58) Field of Search:
 INT CL **A63B**
 Other: **WPI, EPODOC, Patent Fulltext**

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(54) Title of the Invention: **Electronic apparatus**
 Abstract Title: **Electronic apparatus for signalling ball touches and offside positions**

(57) An electronic apparatus for use in a game of soccer or football comprising: a tracking system comprising tracker units carried by players or a ball, and a tracking controller to record the tracked position of the players or ball in real time; an event detection system for detecting, in real time, when the ball is played or touched, and by which player; and a signalling system for signalling and alerting a user, e.g. a referee or linesman to potential infractions by: signalling when the ball is played or touched and by which player, based on events detected by the event detection system; and by signalling when a player is in an offside position or the ball has left the playing field based on the tracked positions of the players or ball recorded by the tracking controller. The signals may be audio transmitted over different channels to binaural earpieces.



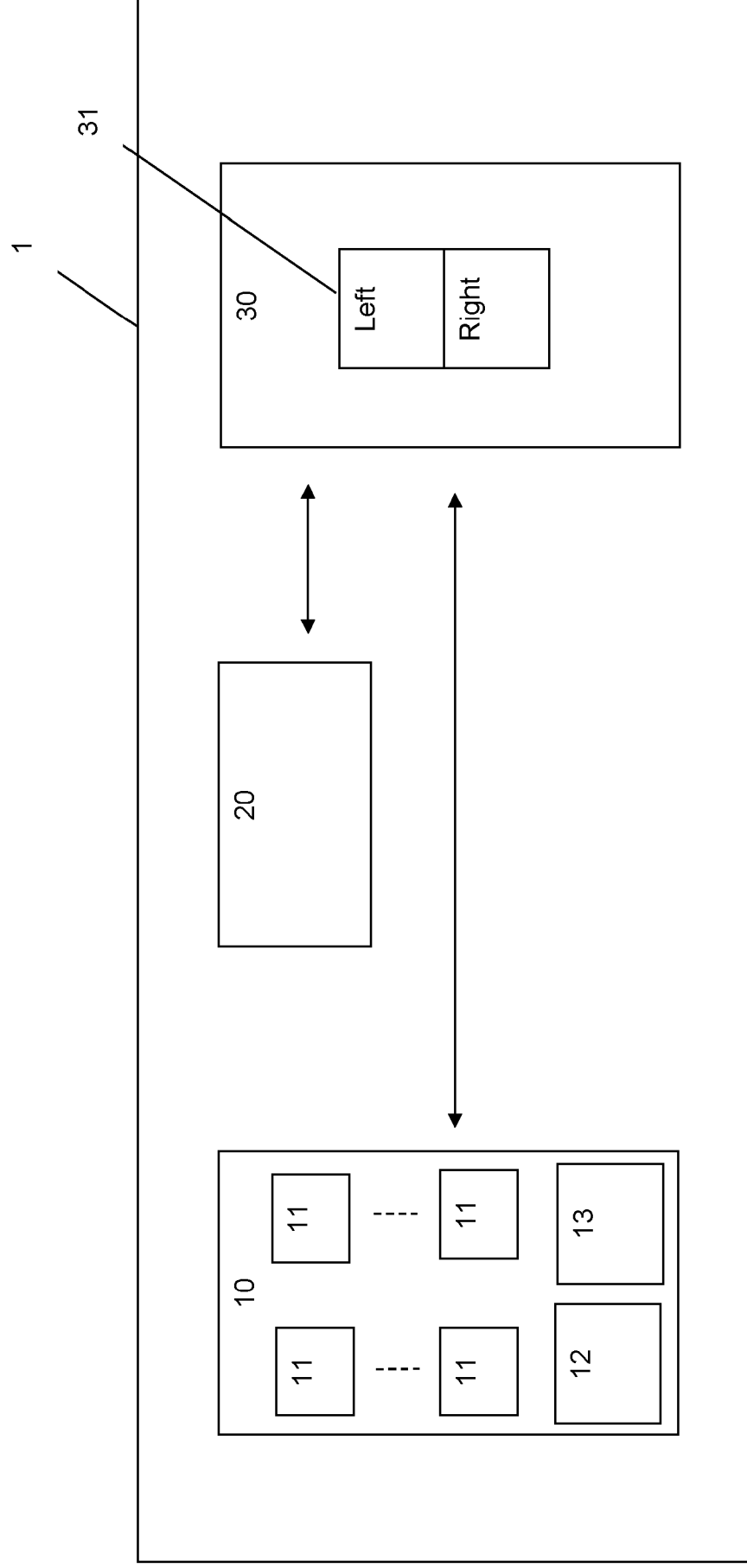


Fig. 1

30 04 21

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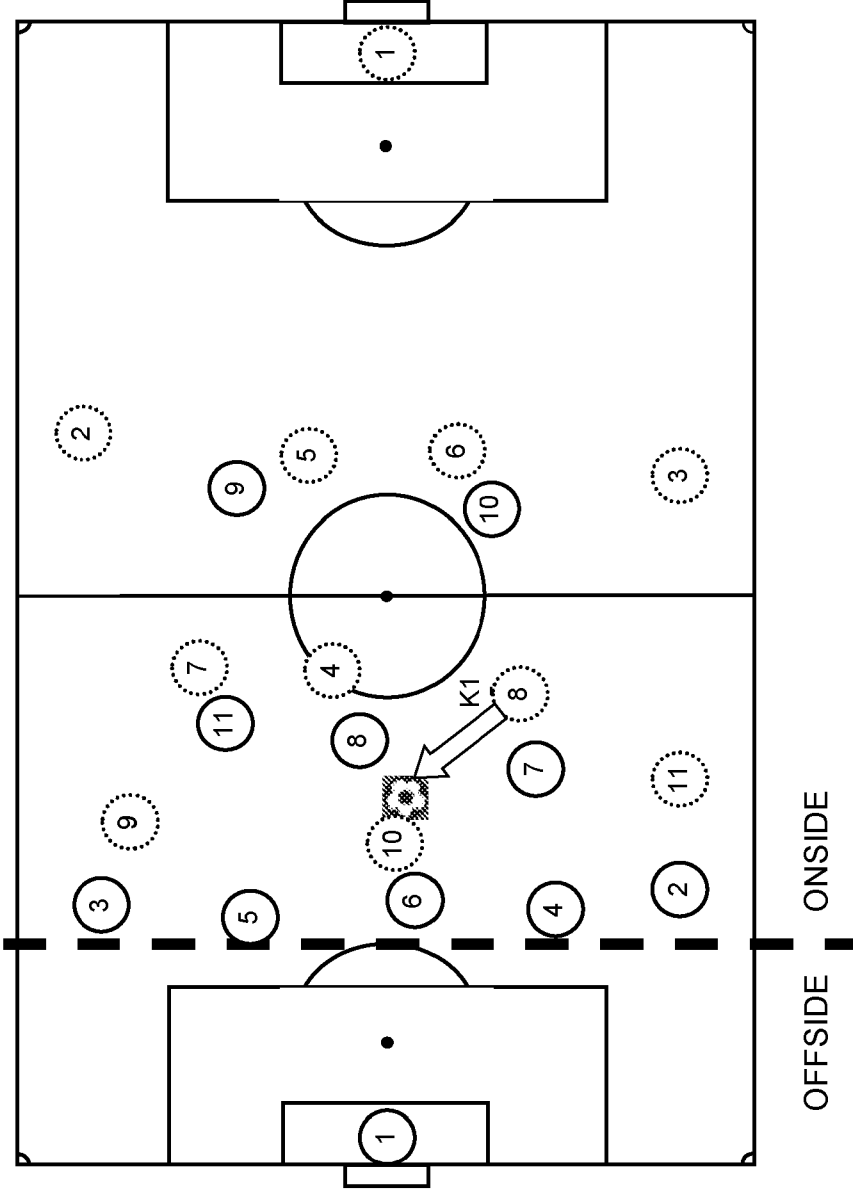


Fig. 2A

30 04 21

3/8

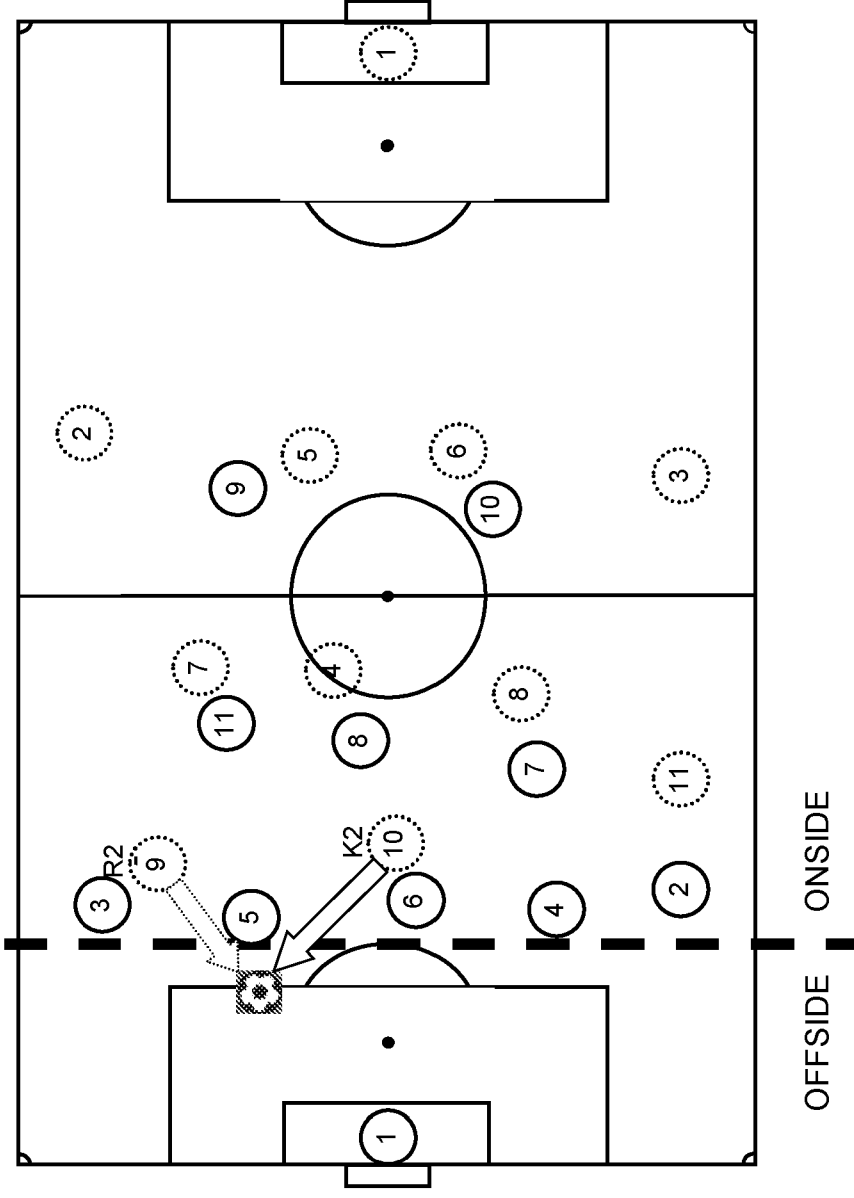


Fig. 2B

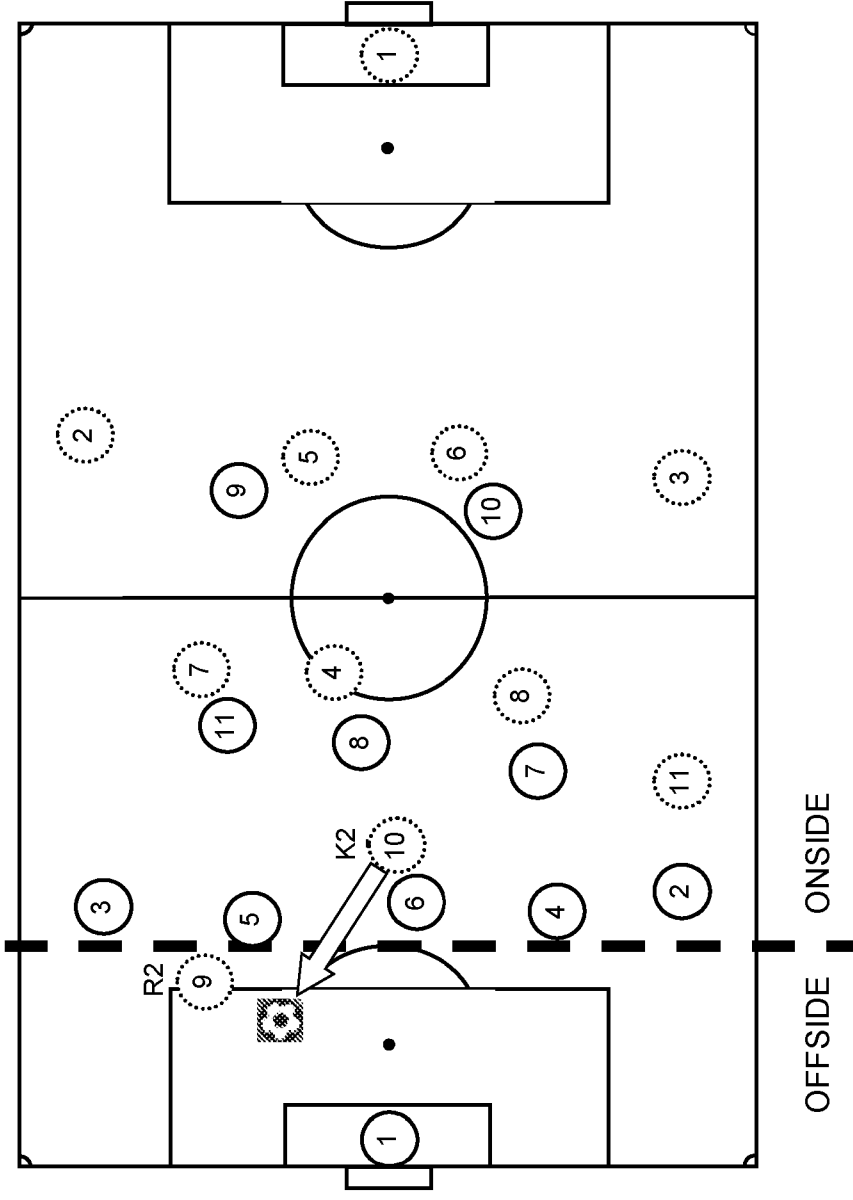


Fig. 2C

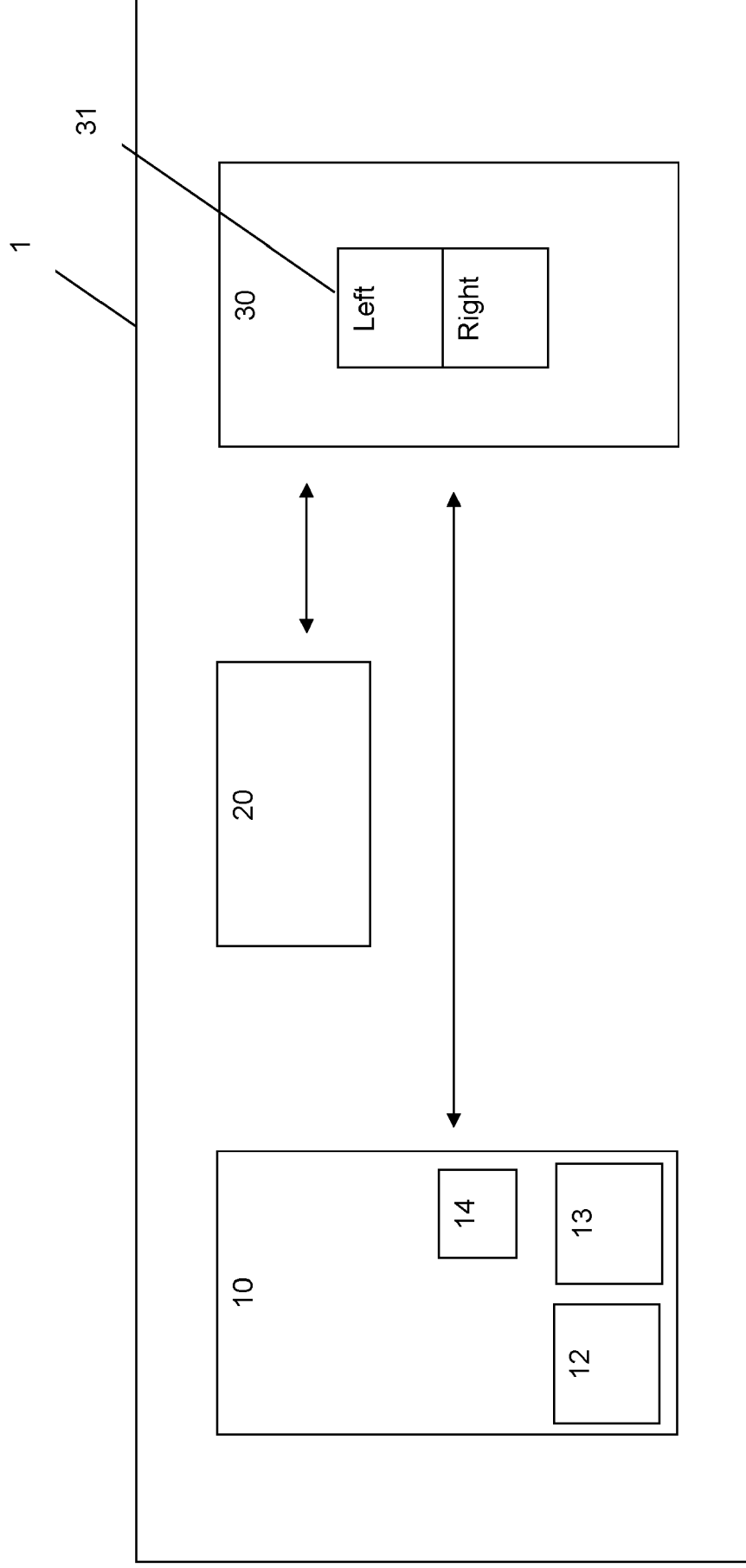


Fig. 3

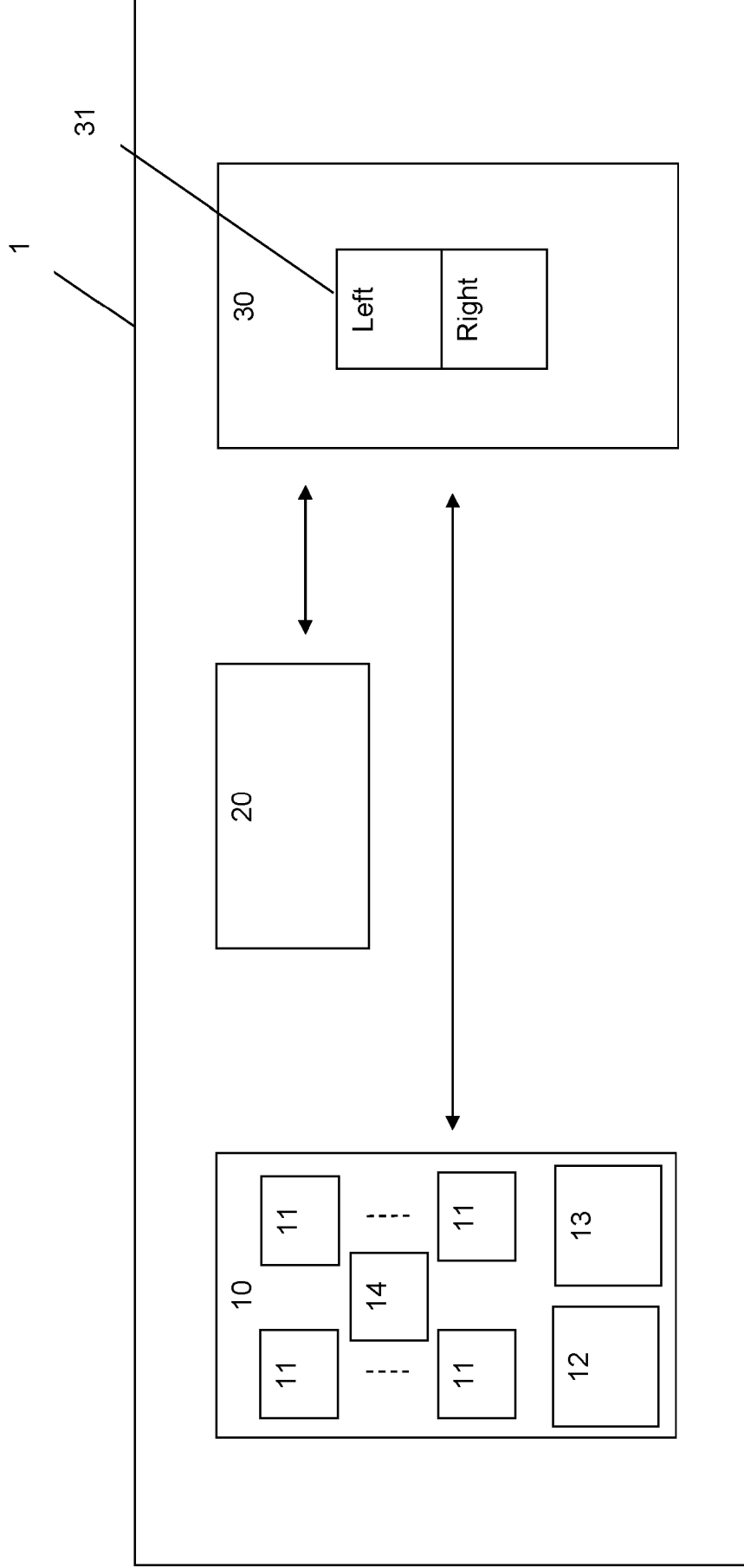


Fig. 4

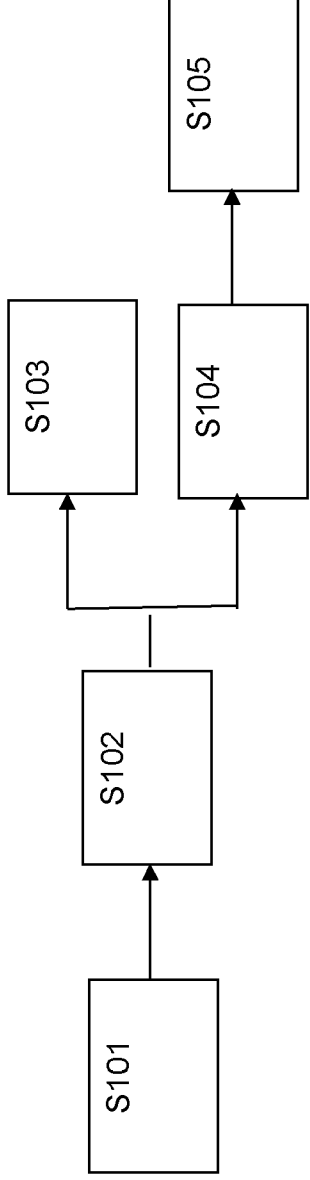


Fig. 5

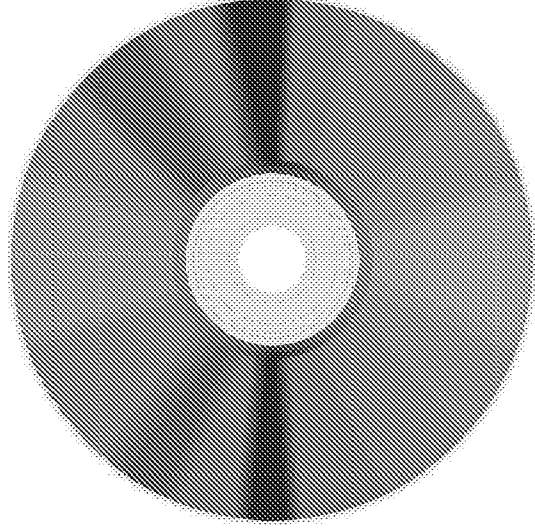


Fig. 6

Electronic Apparatus

5 [0001] Example embodiments of the present invention relate to electronic apparatus arranged to provide assistance to an assistant referee in the game of association football, also referred to as soccer.

10 [0002] In the game of association football, the duties of the assistant referees include indicating to the referee when a player may be penalised for being in an offside position. A player is in an offside position if they are nearer the opponents' goal line than both the ball and the second last opponent. A player in an offside position is to be penalised if, at the moment the ball touches or is played by their team, they are, in the opinion of the referee, involved in active play by interfering with play, or interfering with an opponent or gaining an advantage by being in that position. The elements of the offside rule mean that even with an assistant referee keeping up with play to determine when players may be in an offside position, there are considerable practical difficulties in determining the position accurately when the ball is played or touched, and whether they are involved in active play, interfering with an opponent or gaining an advantage.

20 [0003] To address this practical difficulty, a system whereby video footage is used to review plays for possible contravention of the offside rule. However, even with the benefit of such so-called Video Assistant Referee (VAR) systems, reliable and predictable decisions have not always been achieved. Furthermore, the delay while an after-the-event VAR review takes place is undesirable as it reduces the continuous excitement and flow of the game for spectators, reducing engagement and enjoyment for many fans.

25 [0004] Example embodiments aim to address at least one issue with related art systems, whether directly referenced herein, or otherwise.

[0005] In one example, there is provided an electronic apparatus comprising:

30 a tracking system for tracking the position of players in a game of soccer, the tracking system comprising player units carried by the players and a tracking controller in operative communication with the player units, the tracking controller arranged to record the tracked position of the players in real time,

an event detection system for detecting, in real time, when the ball is played or touched, and by which player; and

a signalling system for signalling to a user to alert the user to potential contravention of the offside rule by: signalling when the ball is played or touched and by which player, based on events detected by the event detection system; and by signalling when a player is in an offside position based on the tracked positions of the players recorded by the tracking controller.

5 **[0006]** In one example the signalling system is wirelessly coupled to the tracking system and the event detection system.

[0007] In one example, the signalling system comprises an audio signalling system for signalling to a user. In one example the signalling system comprises independent first and second audio channels. In one example the signalling system comprises a first channel for
10 signalling when the ball is played or touched. In one example the signalling system comprises a second channel for signalling when a player is in an offside position. In one example the signalling system comprises a first audio output device fed by the first channel. In one example the signalling system comprises a second audio output device fed by the second channel. In one example the first and second audio output devices are arranged to operate independently
15 of one another. In one example the first and second audio output devices are integrated into binaural headphones, respectively arranged to provide sound to the left and right ear independently.

[0008] In one example, the event detection system is arranged to detect when an attacking player plays or touches the ball, and in response the signalling system is arranged to generate
20 a signal for each such play or touch of the ball. In one example the signalling system is arranged to output the generated signal via a first channel. In one example, the event detection system is arranged to detect when an attacking player plays or touches the ball, and in response the signalling system is arranged to generate, in real time, an audible signal corresponding to each play or touch of the ball. In one example, the audible signal comprises a click or ping. In one
25 example, the audible signal is provided to the first audio output device.

[0009] In one example, the event detection system is arranged to detect touches or play of the ball based on one or more of: audio signals generated in the area of the ball; electromagnetic proximity or contact sensors in the ball and/or associated with the players or the players' clothing, including the players' boots; audio signals, pressure signals or deformation signals detected in
30 the ball by a corresponding sensor or corresponding plurality of sensors in the ball.

[0010] In one example, the tracking system comprises player units integrated into the players' clothing. In one example the tracking system comprises player units integrated into the players' shirts. In one example the tracking system comprises player units on the front of the players' shirts. In one example the tracking system comprises player units integrated into the players' footwear, including player units integrated into each boot of each player.
35

[0011] In one example, the tracking system is arranged to record the tracked position of the players in real time according to a tracked position of the player units, with reference to the player's distance up the field, i.e. the player's perpendicular distance from the half-way line.

5 **[0012]** In one example, the tracking system is arranged to record the tracked position of the players in real time according to a tracked position of the player units, by reference to the furthest distance up the field of any of a plurality of player units carried by an individual player. In one example, the tracking system is arranged to record the tracked position of the players in real time according to a tracked position of the player units, by reference to the furthest distance up the field of either of two player units respectively integrated into left boot and the right boot of an
10 individual player.

[0013] In one example, the tracking system is arranged to record the tracked position of the players in real time according to a tracked position of the player units, by reference to the furthest distance up the field of any one two player units respectively integrated into the front and rear portions of the left boot and two player units respectively integrated into the front and rear
15 portions of the right boot of an individual player.

[0014] In one example the tracking system comprises player units operable to communicate with sensors arranged to determine the position of the players using time-of-flight and/or angle-of-arrival measurements. In one example the tracking system comprises sensors arranged at the edges of the playing area, for example along the touch lines and/or goal lines that define the
20 playing area.

[0015] In one example, the tracking system is arranged to determine when a player is in an offside position based on the tracked positions of the players recorded by the tracking controller, and in response the signalling system is arranged to generate a signal while any player is in an offside position.

25 **[0016]** In one example the signalling system is arranged to output the generated signal via a second channel. In one example, tracking system is arranged to determine when a player is in an offside position based on the tracked positions of the players recorded by the tracking controller, and in response the signalling system is arranged to generate, in real time, an audible signal identifying any player in an offside position, for example, by reference to the player's shirt
30 number. In one example, the audible signal comprises a verbal signal, for example "Number N" where N represents the player's shirt number. In one example, the audible signal is provided to the second audio output device.

[0017] In one example, the event detection system is arranged to detect when a defending player plays or touches the ball, and in response the signalling system is arranged to generate

a signal for each such play or touch of the ball. In one example the signalling system is arranged to output such a generated signal via a second channel.

5 **[0018]** In one example, the event detection system is arranged to detect when a defending player plays or touches the ball, and in response the signalling system is arranged to generate, in real time, an audible signal corresponding to said play or touch of the ball.

10 **[0019]** In one example, the event detection system is arranged to detect when a defending player plays or touches the ball, and in response the signalling system is arranged to generate, in real time, an audible signal corresponding to said play or touch of the ball only when an attacking player is in an offside position based on the tracked positions of the players recorded by the tracking controller. In one example, such audible signal comprises a ping or click. In one example, the audible signal comprises a verbal signal, for example "Not offside". In one example, such audible signal is different to the audible signal generated the signalling system when the ball is played or touched by an attacking player. In one example, such the audible signal comprises a ping and the audible signal generated the signalling system when the ball is played or touched by an attacking player comprises a click, or vice versa. In one example, such an audible signal is provided to the second audio output device.

[0020] In one example the tracking system further comprises a tracking unit in the ball. In one example the tracking controller is arranged to receive information corresponding to the position of the ball, based on the position of the tracking unit.

20 **[0021]** In one example, the tracking unit in the ball is operable to communicate with sensors arranged relative to the playing area, for example at the edges of the playing area. In one example, the tracking unit in the ball is operable to communicate with electromagnetic sensors positioned at the edges of the playing area, including positioned along the touch lines and/or goal lines. In one example the tracking unit in the ball comprises a magnetic tracking unit.

25 **[0022]** In one example, the tracking system is arranged to determine, in real time, whether the ball leaves the playing area, based on the tracked position of the ball. In one example the tracking system is arranged to determine, in real time, whether the ball leaves the playing area based on the tracked position of the tracking unit in the ball. In one example, the tracking system is arranged to determine when the ball leaves the playing area, for example by crossing a touch
30 line or a goal line.

[0023] In one example, the tracking system is arranged to determine that the ball has left the playing area, and in response the signalling system is arranged to signal to a user to alert the user by: signalling that the ball has left the playing area, based on the tracked position of the ball determined by the tracking controller.

[0024] In one example, the signalling system is arranged to signal when the ball leaves the playing area by generating a signal in both first and second channels together. In one example, such audible signal comprises a verbal signal, for example "Out" or "Goal".

[0025] In another example, there is provided an electronic apparatus comprising:

5 a tracking system for tracking the position of the ball in a game of soccer, the tracking system comprising a tracking unit in the ball and a tracking controller in operative communication with the tracking unit, the tracking controller arranged to determine in real time whether the ball leaves the playing area,

10 an event detection system for detecting, in real time, when the ball is played or touched, and by which player; and

a signalling system for signalling to a user to alert the user by: signalling when the ball is played or touched and by which player, based on events detected by the event detection system; and by signalling when the ball leaves the playing area based on the tracked position of the ball determined by the tracking controller.

15 **[0026]** In one example the signalling system is wirelessly coupled to the tracking system and the event detection system.

[0027] In one example, the signalling system comprises an audio signalling system for signalling to a user. In one example the signalling system comprises independent first and second audio channels. In one example the signalling system comprises a first channel for signalling when the ball is played or touched by a player on a first team, for example an attacking player. In one example the signalling system comprises a second channel for signalling when the ball is played or touched by a player on a second team, for example an defending player. In one example the signalling system comprises a first audio output device fed by the first channel. In one example the signalling system comprises a second audio output device fed by the second channel. In one example the first and second audio output devices are arranged to operate independently of one another. In one example the first and second audio output devices are integrated into binaural headphones, respectively arranged to provide sound to the left and right ear independently.

30 **[0028]** In one example, the event detection system is arranged to detect when an attacking player plays or touches the ball, and in response the signalling system is arranged to generate a signal for each such play or touch of the ball. In one example the signalling system is arranged to output the generated signal via a first channel. In one example, the event detection system is arranged to detect when an attacking player plays or touches the ball, and in response the signalling system is arranged to generate, in real time, an audible signal corresponding to each

play or touch of the ball. In one example, the audible signal comprises a click or ping. In one example, the audible signal is provided to the first audio output device.

5 [0029] In one example, the event detection system is arranged to detect when a defending player plays or touches the ball, and in response the signalling system is arranged to generate a signal for each such play or touch of the ball. In one example the signalling system is arranged to output the generated signal via a second channel. In one example, the event detection system is arranged to detect when a defending player plays or touches the ball, and in response the signalling system is arranged to generate, in real time, an audible signal corresponding to each play or touch of the ball. In one example, the audible signal comprises a click or ping. In one example, the audible signal is provided to the second audio output device.

15 [0030] In one example, the event detection system is arranged to detect touches or play of the ball based on one or more of: audio signals generated in the area of the ball; electromagnetic proximity or contact sensors in the ball and/or associated with the players or the players' clothing, including the players' boots; audio signals, pressure signals or deformation signals detected in the ball by a corresponding sensor or corresponding plurality of sensors in the ball.

20 [0031] In one example the tracking system comprises a tracking unit operable to communicate with sensors arranged to determine the position of the ball using time-of-flight and/or angle-of-arrival measurements. In one example the tracking system comprises sensors arranged at the edges of the playing area, for example along the touch lines and/or goal lines that define the playing area.

[0032] In one example the tracking controller is arranged to receive information corresponding to the position of the ball, based on the position of the tracking unit.

25 [0033] In one example, the tracking unit in the ball is operable to communicate with sensors arranged relative to the playing area, for example at the edges of the playing area. In one example, the tracking unit in the ball is operable to communicate with electromagnetic sensors positioned at the edges of the playing area, including positioned along the touch lines and/or goal lines. In one example the tracking unit in the ball comprises a magnetic tracking unit.

30 [0034] In one example, the tracking system is arranged to determine, in real time, whether the ball leaves the playing area, based on the tracked position of the ball. In one example the tracking system is arranged to determine, in real time, whether the ball leaves the playing area based on the tracked position of the tracking unit in the ball. In one example, the tracking system is arranged to determine when the ball leaves the playing area, for example by crossing a touch line or a goal line.

[0035] In one example, the tracking system is arranged to determine that the ball has left the playing area, and in response the signalling system is arranged to signal to a user to alert the user by: signalling that the ball has left the playing area, based on the tracked position of the ball determined by the tracking controller.

- 5 **[0036]** In one example, the signalling system is arranged to signal when the ball leaves the playing area by generating a signal in both first and second channels together. In one example, such audible signal comprises a verbal signal, for example "Out" or "Goal".

[0037] In another example embodiment there is provided a signalling method performed using a system as described above.

- 10 **[0038]** In another example embodiment there is provided a computer program product/computer readable medium comprising instructions which when executed cause the system as described above to perform the method as described above.

[0039] Other features of the invention will be apparent from the dependent claims, and the description which follows.

- 15 **[0040]** For a better understanding of the invention, and to show how embodiments of the same may be carried into effect, reference will now be made, by way of example only, to the accompanying diagrammatic drawings in which:

[0041] Figure 1 shows an electronic apparatus according to a first example embodiment;

- 20 **[0042]** Figures 2A-2D show scenarios to explain operation of the electronic apparatus of Figure 1;

[0043] Figure 3 shows an electronic apparatus according to a second example embodiment;

[0044] Figure 4 shows an electronic apparatus according to a third example embodiment;

[0045] Figure 5 shows methods according to example embodiments; and

[0046] Figure 6 shows a computer readable medium according to an example embodiment.

- 25 **[0047]** Referring now to Figure 1 there is shown an electronic apparatus for providing assistance to an assistant referee in the game of association football, also referred to as soccer. In particular the electronic apparatus is configured to help in determining whether an offside offence has taken place. The apparatus comprises a number of components which cooperate with one another in a system to be used by assistant referees when officiating a game of soccer.

[0048] The apparatus comprises a tracking system 10 for tracking the position of the players in a game of soccer. In order to track individual players with a high degree of accuracy the tracking system 10 comprises player units 11 carried by the players, the player units 11 being in communication with a tracking controller 12. The tracking controller 12 records the tracked position of the players in real time,

In addition, the apparatus comprises an event detection system 20. The event detection system 20 is arranged to detect, in real time, when the ball is played or touched, and by which player.

The final main component of the electronic apparatus is a signalling system 30 for signalling to a user, i.e. an assistant referee, to alert them to potential contravention of the offside rule. The signalling system 30 is arranged to signal when the ball is played or touched and by which player, based on events detected by the event detection system 20. The signalling system 30 is arranged to signal when a player is in an offside position, based on the tracked positions of the players recorded by the tracking controller 10.

[0049] In order for the apparatus to be used as the assistant referee moves along the touch line of the playing area, and elsewhere on and around the playing area, the signalling system 30 is wirelessly coupled to the tracking system 10 and the event detection system 20, and comprises an audio signalling system having independent first and second audio channels which respectively feed into the left and right speakers of a pair of binaural headphones 31. In this way the assistant referee can receive signals from the signalling system 30 while keeping a close watch on play. In particular, the assistant referee can focus attention on players which are potentially in an offside position, and concentrate whether such players are involved in active play by interfering with play, or interfering with an opponent or gaining an advantage by being in that position.

[0050] As will be described in more detail, the operations of the signalling system 30 based on the output of the tracking system 10 and event detection system 20 allow the assistant referee to be positioned away from the offside line, ideally ahead of play. This is because the electronic apparatus of Figure 1 is providing signals that confirm to the assistant referee which player last played or touched the ball, and whether any attacking player is in an offside position. In this way assistant referees can concentrate on attacking players in an offside position and judging their potential for being involved in active play etc. This reduces burden on the assistant referees, leading to better, more predictable outcomes for offside decision without the need for an after-the-event video review such as may be performed with a VAR system.

[0051] The first channel of the signalling system 30, which goes to the assistant referee's left headphone speaker, is used to signal when the ball is played or touched by an attacking player. The event detection system 20 detects when an attacking player plays or touches the ball, and

in response causes the signalling system to generate a particular first audio signal for each such play or touch of the ball. In the example embodiment shown, the first audio signal is a click.

5 **[0052]** The second channel of the signalling system 30, which goes to the assistant referee's right headphone speaker, is also used to signal when the ball is played or touched by a defending player. The event detection system 20 detects when a defending player plays or touches the ball, and in response causes the signalling system to generate a particular second audio signal for each such play or touch of the ball. In the example embodiment shown, the second audio signal is a ping. In this way the assistant referee is provided with a signal corresponding to each touch, and is able to differentiate between touches made by attacking players and defending
10 players according to the sound, and the ear in which it is heard.

[0053] The event detection system 20 detects touches or play of the ball in any suitable manner, for example based on one or more of: audio signals generated in the area of the ball; electromagnetic proximity or contact sensors in the ball and/or associated with the players or the players' clothing, including the players' boots; audio signals, pressure signals or deformation
15 signals detected in the ball by a corresponding sensor or corresponding plurality of sensors in the ball.

[0054] The second channel of the signalling system 30, which goes to the assistant referee's right headphone speaker is additionally used to signal when a player is in an offside position, based on the tracked positions of the players recorded by the tracking controller 10. Based on
20 the tracked positions of the players recorded by the tracking controller 10 the signalling system 30 generates a signal for the assistant referee while any player is in an offside position.

[0055] While it is determined any player is in an offside position, based on the tracked positions of the players recorded by the tracking controller 10, the signalling system 30 generates, in real time, an audible signal identifying any player or players in an offside position, by reference to
25 the players' shirt number. In the example embodiment shown the audible signal is a verbal sign for example "Number N" where N represents the offside player's shirt number.

[0056] As described above, the tracking system 10 comprises player units 11 carried by players. In the example embodiment of Figure 1 the player units 11 are integrated into the players' clothing. In order for the position of all players to be determined in a consistent manner,
30 the positioning of the player units 11 with respect to the players' bodies should be consistent between players. In the example embodiment of Figure 1 the apparatus includes player units 11 that are integrated into front of the players' shirts and into the front and rear portions of each boot of each player. The payer units 11 are uniquely identifiable to the tracking controller 12.

[0057] To aid in assessment of offside, the tracking system 10 records the tracked position of
35 the players in real time according to a tracked position of the player units 11, with reference to

the players' distance up the field, i.e. the players' perpendicular distance from the half-way line. The position distance up the field is determined by reference to the furthest distance up the field of any one of the player units 11 carried by each individual player.

5 **[0058]** The tracking system 10 comprises player units 11 operable to communicate with sensors 13 that determine the position of the players using time-of-flight and/or angle-of-arrival measurements. The sensors 13 are arranged at the edges of the playing area, along the touch lines and/or goal lines that define the playing area and are in communication with the tracking controller 12.

10 **[0059]** Operation of the apparatus of Figure 1 will now be described, with reference to the scenarios of Figures 2A-2D. Figures 2A-2D show a schematic playing area for a game of soccer, the ball, an attacking team of players playing from right to left, and a defending team of players playing from left to right. The position of the offside line is indicated, in line with the second last defending player.

15 **[0060]** In the scenario of Figure 2A, the attacking player "8" passes the ball to attacking player "10", indicated by kick K1 and reception R1 respectively. The ball is in play and there is no attacking player in an offside position. The signalling system 10 signals such that the assistant referee hears only the clicks in their left ear as the ball is played/touched by the attacking players.

LEFT EARPIECE	RIGHT EARPIECE
Kicker 1 Blue - click	(no one offside)
Receiver 1 Blue - click	Kicker 1 'silence'
	Receiver 1 'silence'

20 **[0061]** In the scenario of Figure 2B, the attacking player "10" passes the ball to beyond the last defender, with the attacking player "9" advancing from an onside position to receive the ball. This is indicated by kick K2 and reception R2 respectively. The ball is in play and there is no attacking player in an offside position. The signalling system 10 signals such that the assistant referee hears only the clicks in their left ear as the ball is played/touched by the attacking players.

25 **[0062]** When the ball was played no player was offside and any further play is allowed. If the attacking player "9" does not shoot for goal, then the whole process continues with the highest defender setting the offside line. In this scenario the assistant referee only hears clicks in their left ear, and silence in their right ear.

LEFT EARPIECE	RIGHT EARPIECE
Kicker 2 Blue - 'click'	(no one offside)
Receiver 2 Blue - 'click'	Kicker 2 'silence'
	Receiver 2 'silence'

[0063] In the scenario of Figure 2C, a straightforward offside offence is committed. The attacking player "10" passes the ball to beyond the last defender, to an attacking player "9" standing in an offside position. This is indicated by kick K2 and reception R2 respectively. The ball is in play and there is no attacking player in an offside position. The signalling system 10 signals such that the assistant referee hears the clicks in their left ear as the ball is played/touched by the attacking players, and also signals such that in their right ear they hear the number of the offside player while in the offside position and when the ball is received.

LEFT EARPIECE	RIGHT EARPIECE
Kicker 2 Blue - 'click'	(player offside)
Receiver 2 Blue - 'click'	'No 9' - 'No 9'
	Receiver 2 'No 9' - 'No 9'

[0064] Figure 2D corresponds to a more complex scenario. In Figure 2D the initial setup is similar to that of Figure 2C. However, in the scenario of Figure 2D, the event detection system 20 detects that a defending player touches the ball after it has been played forward by attacking player "10". This means that even through the attacking player "9", who would otherwise have received the ball in an offside position and commit an offside offence, does not commit an offside offence. The signalling system 30 generates a signal for the touch of the ball by the defending player "5". The signalling system 10 outputs such a generated signal via the second channel for delivery to the assistant referee's right ear as a ping, and a verbal confirmation that the player that was standing in an offside position when the attacking player "10" played the ball is in fact not committing an offside offence.

LEFT EARPIECE	RIGHT EARPIECE
Kicker 2 Blue - 'click'	(no one offside)
	'No 9' - 'No 9'
	Contact 1 'C1 Red - ping' not offside

[0065] As set out above in relation to Figure 2D, the event detection system 20 is arranged to detect when a defending player plays or touches the ball, and in response the signalling system 30 generates, in real time, an audible signal corresponding to said play or touch of the ball only when an attacking player is in an offside position, based on the tracked positions of the players recorded by the tracking controller 10. As will be appreciated, the apparatus can be configured

with additional functions, so as to not signal offside for throw ins, corners, when players are in their own half of the playing area, or when players are outside of the playing area.

5 **[0066]** Figure 3 shows an embodiment in which the tracking system comprises a tracking unit 14 in the ball. Components that correspond to those of the embodiment of Figure 1 are shown with corresponding reference numerals.

10 **[0067]** The tracking controller 12 is arranged to receive information corresponding to the position of the ball, based on the position of the tracking unit 14 in the ball. The tracking unit 14 in the ball is operable to communicate with sensors 13. The sensors 13 are at the edges of the playing area and in this way may determine when the ball has left the playing area by crossing the touchlines or goal lines that define the sides and end of the playing area respectively. The tracking unit 14 in the ball comprises a magnetic tracking unit.

15 **[0068]** The tracking controller 12 of the tracking system 10 determines when the ball leaves the playing area according to information received from the sensors 13. In response the signalling system 30 signals to a user, again ideally to the assistant referee, to alert the user. The signal is generated, for example, in both first and second channels together for delivery to the left and right ears of the user as an audible signal. The audible signal comprises a verbal signal, for example "Out" or "Goal" according to whether the ball has left the playing area, or a goal has been scored.

20 **[0069]** The event detection system 20 in this embodiment signals when the ball is played or touched by an attacking player or by a defending player, i.e. by a player on one team or the other. The event detection system 20 detects when a player on one team plays or touches the ball, and in response causes the signalling system to generate a particular first audio signal for each such play or touch of the ball, and correspondingly detects when a player on the other team plays or touches the ball, and in response causes the signalling system to generate a particular second audio signal for each such play or touch of the ball. In the example embodiment shown, the first audio signal is a click and the second audio signal is a ping. In this way the assistant referee is provided with a signal corresponding to each touch, and is able to differentiate between touches made by players from each team according to the sound. It is furthermore envisaged that the first and second audio signals are provided independently into left and right channels of headphones 31. In this way the assistant referee is provided with information about whether the ball has left the playing area or not, and which team touched it last. This facilitates the awarding of throw ins, and goal kicks/corners to the appropriate team based on which player last touched the ball.

35 **[0070]** Figure 4 shows an embodiment which combines the features and functionality of the embodiments described above.

[0071] Figure 5 shows steps in an example method carried out using an electronic apparatus as set out above. At step S101, a tracking system tracks the position of players in a game of soccer, according to the detected position of player units carried by the players, and records the tracked position of the players in real time. At step S102 an event detection system detects, in real time, when the ball is played or touched, and by which player. As will be understood, the operations of steps S101 and S102 are performed continuously while the method is being performed, so that continuous real time information about the position of players and plays or touches of the ball are generated.

[0072] At step S103 a signalling system signals to a user to alert the user to potential contravention of the offside rule. The step S103 comprises signalling when the ball is played or touched and by which player, based on events detected at step S102; and by signalling when a player is in an offside position based on the tracked positions of the players recorded at step S101. The tracking of the players, detection of events and signalling operations are performed in the manner described above for the first example embodiment of the electronic apparatus.

[0073] In addition to the operation of S103, or in the alternative, steps S104 and S105 may be performed to indicate that the ball leaves the playing area, and by which team it was last touched. Step S104 comprises signalling when the ball is played or touched and by which player, based on events detected at step S102. At step S105 a signal is generated when the ball leaves the playing area based on the tracked position of the ball determined by the tracking controller. The tracking of the players, detection of events and signalling operations are performed in the manner described above in relation to the second or third example embodiments of the electronic apparatus.

[0074] In order to perform the event detection, ball and player tracking, data storage, analysis, communication between components and signalling, various known technologies may be used, according to the required degree of accuracy, response speed, size, weight or other restrictions. Suitable technologies include those proposed for goal-line decision assistance, such as GoalRef, or the Caros Technologies/Adidas systems tested by FIFA in 2012, and the Fraunhofer RedFIR real time high precision wireless tracking system. The method steps and control functionality may be implemented in computer software, i.e. instructions which when executed by a processor control the electronic apparatus to perform the stated method/implement the stated functional units. Figure 6 shows a computer readable medium comprising such instructions recorded there, in a non-transient/tangible form.

[0075] That is, at least some of the example embodiments described herein may be constructed, partially or wholly, using dedicated special-purpose hardware. Terms such as 'component', 'module' or 'unit' used herein may include, but are not limited to, a hardware device, such as circuitry in the form of discrete or integrated components, a Field Programmable Gate

Array (FPGA) or Application Specific Integrated Circuit (ASIC), which performs certain tasks or provides the associated functionality. In some embodiments, the described elements may be configured to reside on a tangible, persistent, addressable storage medium and may be configured to execute on one or more processors. These functional elements may in some

5 embodiments include, by way of example, components, such as software components, object-oriented software components, class components and task components, processes, functions, attributes, procedures, subroutines, segments of program code, drivers, firmware, microcode, circuitry, data, databases, data structures, tables, arrays, and variables. Although the example

10 embodiments have been described with reference to the components, modules and units discussed herein, such functional elements may be combined into fewer elements or separated into additional elements. Various combinations of optional features have been described herein, and it will be appreciated that described features may be combined in any suitable combination. In particular, the features of any one example embodiment may be combined with features of any other embodiment, as appropriate, except where such combinations are mutually exclusive.

15 Throughout this specification, the term “comprising” or “comprises” means including the component(s) specified but not to the exclusion of the presence of others.

[0076] Attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are

20 incorporated herein by reference.

[0077] All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

25 **[0078]** Each feature disclosed in this specification (including any accompanying claims, abstract and drawings) may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

[0079] The invention is not restricted to the details of the foregoing embodiment(s). The

30 invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. An electronic apparatus comprising:

5 a tracking system for tracking the position of players in a game of soccer, the tracking system comprising player units carried by the players and a tracking controller in operative communication with the player units, the tracking controller arranged to record the tracked position of the players in real time,

an event detection system for detecting, in real time, when the ball is played or touched, and by which player; and

10 a signalling system for signalling to a user to alert the user to potential contravention of the offside rule by: signalling when the ball is played or touched and by which player, based on events detected by the event detection system; and by signalling when a player is in an offside position based on the tracked positions of the players recorded by the tracking controller.

15 2. The electronic apparatus of claim 1, wherein the signalling system is wirelessly coupled to the tracking system and the event detection system, and comprises an audio signalling system for signalling to a user over independent first and second audio channels, with a first channel for signalling when the ball is played or touched and a second channel for signalling when a player is in an offside position.

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3. The electronic apparatus of any preceding claim, wherein the event detection system is arranged to detect touches or play of the ball based on one or more of: audio signals generated in the area of the ball; electromagnetic proximity or contact sensors in the ball and/or associated with the players or the players' clothing, including the players' boots; audio signals, pressure signals or deformation signals detected in the ball by a corresponding sensor or corresponding plurality of sensors in the ball.

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4. The electronic apparatus of any preceding claim, wherein the tracking system comprises player units integrated into the players' clothing, including one or more of: player units integrated into the players' shirts; player units on the front of the players' shirts; player units integrated into the players' footwear; player units integrated into each boot of each player.

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5. The electronic apparatus of any preceding claim, wherein the tracking system is arranged to record the tracked position of the players in real time according to a tracked position of the player units, with reference to the player's distance up the field, i.e. the player's perpendicular distance from the half-way line, by reference to the furthest distance up the field of any of a plurality of player units carried by an individual player.

5

6. The electronic apparatus of any preceding claim, wherein the tracking system comprises player units operable to communicate with sensors arranged to determine the position of the players using time-of-flight and/or angle-of-arrival measurements.

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7. The electronic apparatus of any preceding claim, wherein the tracking system is arranged to determine when a player is in an offside position based on the tracked positions of the players recorded by the tracking controller, and in response the signalling system is arranged to generate a signal while any player is in an offside position.

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8. The electronic apparatus of any preceding claim, wherein the tracking system is arranged to determine when a player is in an offside position based on the tracked positions of the players recorded by the tracking controller, and in response the signalling system is arranged to generate, in real time, an audible signal identifying any player in an offside position.

20

9. The electronic apparatus of claim 2, or of any one of claims 3 to 8 as dependent on claim 2, wherein the event detection system is arranged to detect when a defending player plays or touches the ball, and in response the signalling system is arranged to generate a signal for each such play or touch of the ball via the second channel.

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10. The electronic apparatus of any preceding claim, wherein the event detection system is arranged to detect when a defending player plays or touches the ball, and in response the signalling system is arranged to generate, in real time, an audible signal corresponding to said play or touch of the ball.

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11. The electronic apparatus of any preceding claim, wherein the event detection system is arranged to detect when a defending player plays or touches the ball, and in response the signalling system is arranged to generate, in real time, an audible signal corresponding to said play or touch of the ball only when an attacking player is in an offside position based on the tracked positions of the players recorded by the tracking controller.

12. The electronic apparatus of any preceding claim, wherein the tracking system further comprises a tracking unit in the ball, and the tracking controller is arranged to receive information corresponding to the position of the ball, based on the position of the tracking unit, the tracking unit in the ball is operable to communicate with sensors arranged relative to the playing area to determine, in real time, whether the ball leaves the playing area, based on the tracked position of the ball.

13. An electronic apparatus comprising:

a tracking system for tracking the position of the ball in a game of soccer, the tracking system comprising a tracking unit in the ball and a tracking controller in operative communication with the tracking unit, the tracking controller arranged to determine in real time whether the ball leaves the playing area,

an event detection system for detecting, in real time, when the ball is played or touched, and by which player; and

a signalling system for signalling to a user to alert the user by: signalling when the ball is played or touched and by which player, based on events detected by the event detection system; and by signalling when the ball leaves the playing area based on the tracked position of the ball determined by the tracking controller.

14. A signalling method performed using an electronic apparatus or system as set out in any preceding claim.

15. A computer program product/computer readable medium comprising instructions which when executed cause the electronic apparatus or system as set out in any preceding claim to perform the operations described in any preceding claim.



Application No: GB2002805.6

Examiner: Dr Niall Deakin

Claims searched: 1-15

Date of search: 23 August 2021

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
Y	1-15	BE 1016077 A6 (HAJJAB) See whole document
Y	1-15	BE 1015552 A6 (PENEZY) See whole document

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X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^X :

Worldwide search of patent documents classified in the following areas of the IPC

A63B

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC, Patent Fulltext

International Classification:

Subclass	Subgroup	Valid From
A63B	0071/06	01/01/2006
A63B	0024/00	01/01/2006