System And Method For Controlling The Direction Of A Mobile Video Camera Moving On A Playing Field Of A Mobile Video Camera

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Abstract

System and Method to adjust the orientation of a mobile video camera suited to film a pair of athletes moving on a field of play, wherein the position of the athletes is determined relative to a coordinate system integral to the field of play by using radio transmitters, which are applied to the bodies of the athletes, and radio receivers arranged around the field of play, and fixed relative to the field of play and interfaced with a processing and control unit, the processing and control unit determines an intermediate position between the two athletes as a function of the current positions of two athletes, and a motor-driven moving device moves the mobile video camera so as to center the respective camera framing on the intermediate position.

Keywords

Control the orientation； a mobile video；camera；film athletes moving；a field of play.

1. Introduction

In fencing competitions, the decision of which fencer is to be assigned a point at the end of an action is taken by a referee who normally stands aside, and at one-half length from the fencing platform. Behind the referee a video camera is normally positioned for filming the pair of fencers moving on the field of play. The video camera lens is arranged at a height greater than that of the referee for preventing the latter from obstructing the view of the fencers. The video images recorded by the video camera can help the referee in making a decision on the point to be assigned at the end of a very rapid exchange of strikes between the fencers[1]. To this end, the video camera framing must remain constantly focused and narrowed upon the pair of fencers as they move along the competition platform. For this reason, the video camera is mounted on a mobile support which allows to adjust the orientation of the video camera relative to the competition platform while a person moves the support to keep the framing centered on the pair of fencers as they move along the competition platform. Therefore, if an exchange of strikes proves to have been too quick even for the referee, then the latter may decide who receives the point only after having looked at the recorded video images in slow motion[2, 3].

As can be understood, the filming method described above is strongly subject to the inattentiveness of the person moving the video camera. In other words, it is not uncommon for the person operating the video camera to be unable to maintain an accurate framing thus missing out one of the fencers, when, during an exchange of strikes, they quickly reach one end of the platform. In these cases, the recorded video images cannot be of any help to the referee[4, 5].

2. A System For Filming A Pair Of Athletes Moving On A Field Of Play

In FIG. 1, reference numeral 1 denotes a fencing platform, 2 denotes the two fencers that compete on the platform 1, 3 indicates the referee who is standing aside, and at the mid-length, of the platform 1 for watching the same 1 and 4 denotes a system for filming the fencers 2 moving on the platform 1. The system 4 comprises a video camera 5 for filming the pair of athletes moving on the platform 1 and a support 6 for supporting the video camera 5 with its own lens 5a facing towards the platform 1 and at a height greater than that of the referee 3. As shown in FIG. 1, the video camera 5 is normally arranged behind the referee 3 relative to the position of the platform 1.

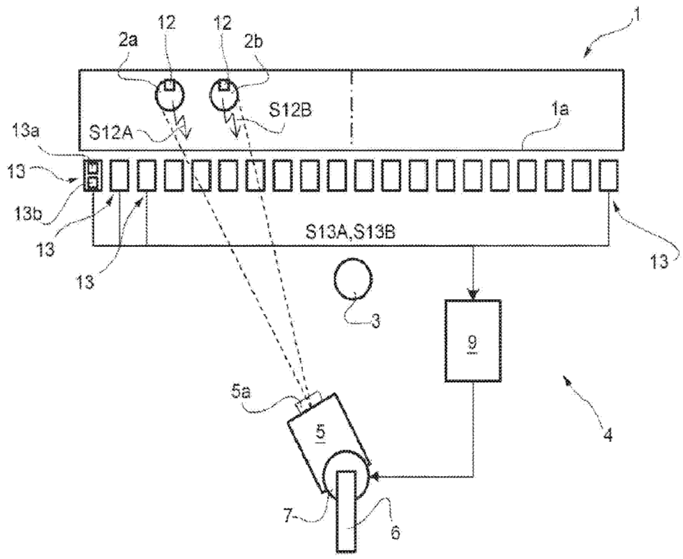

FIG. 1 a system for filming a pair of athletes moving on a field of play

With reference again to FIG. 1, according to the present topic, the system 4 comprises a motor-driven moving device 7, which is mounted on the support 6 and on which the video camera 5 is mounted to move the latter by changing its orientation relative to the platform 1, a further video camera 8, which is arranged fixed relative to the platform 1 for framing the whole platform 1 in order to acquire video images indicating the position of the fencers 2 moving on the platform 1, and a processing and control unit 9, which is interfaced with the video camera 8 to receive, from the latter, the video images in the form of a SV video signal, and is configured to determine, in real time, as a function of the SV video signal, an intermediate position between the two fencers 2 relative to a coordinate system integral with the platform 1 and to control the moving device 7 so as to center the framing of the video camera 5 on the intermediate position. As can be seen from FIG. 1, the framing 11 of the video camera 8 should be much wider than the framing 10 of the video camera 5[6.7].

The motorization device 7 is constituted by an electric motor provided with a respective encoder enabling high accuracy control of the angular position of the electric motor. The video camera 5 is mounted integral with the motor shaft of the electric motor of the moving device 7 to rotate together with the motor shaft of the electric motor. The motorization device 7 is known per se and is not described with further detail[8].

The processing and control unit 9 is configured for processing the video images provided by the video camera 8 to identify the moving fencer silhouettes, process each silhouette in order to determine the position of the respective fencer 2 relative to said coordinate system and determine the intermediate position between the two fencers as a function of the current positions of the two fencers. In detail, each silhouette is processed to determine, as the position of the respective fencer, the position of a certain point of the fencer's body, for example, the waist of the fencer's body, in the area of the framing 11.

3. The System For Filming A Pair Of Athletes Moving On A Field Of Play

According to a further embodiment of the present topic illustrated in FIG. 2, wherein the fencers are indicated with 2a and 2b and the corresponding elements are indicated with the same numbers and abbreviations of FIG. 1, the system 4 comprises, instead of the video camera 8 of FIG. 1, two radio transmitters 12, each of which is associated with a respective fencer 2a, 2b and which are applied in similar points of the body of the two fencers 2a and 2b, and a plurality of radio receivers 13, which are arranged in fixed and known positions along the platform 1 and defined relative to the coordinate system integral with the platform 1 and are interfaced with the processing and control unit 9 to communicate to the latter, in analog form, the signals received. Each transmitter 12 is, for example, fixed on the helmet of the respective fencer 2a, 2b and is of the battery-powered type. The radio receivers 13 are arranged in series and equally spaced apart along a first longer side 1a of the platform 1. Since the radio receivers 13 are distributed along the longer side 1a, the coordinate system integral with the platform 1 is a one-dimensional coordinate system which has as an origin a point of the longer side 1a, for example an end point or the middle point of the longer side 1a[9.10.11].

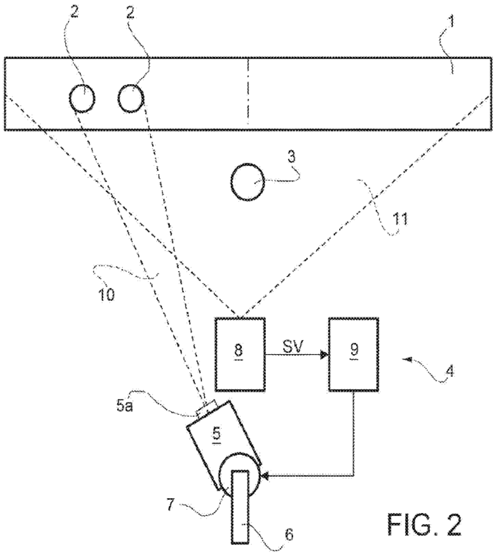

FIG. 2

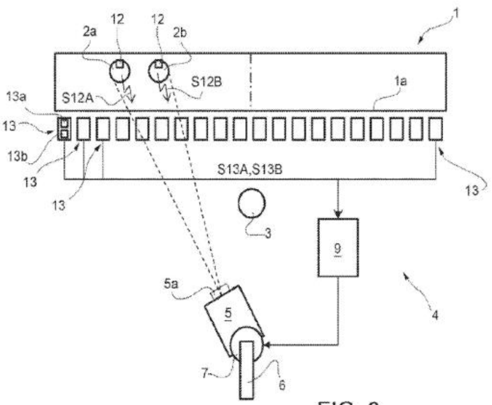

FIG. 3

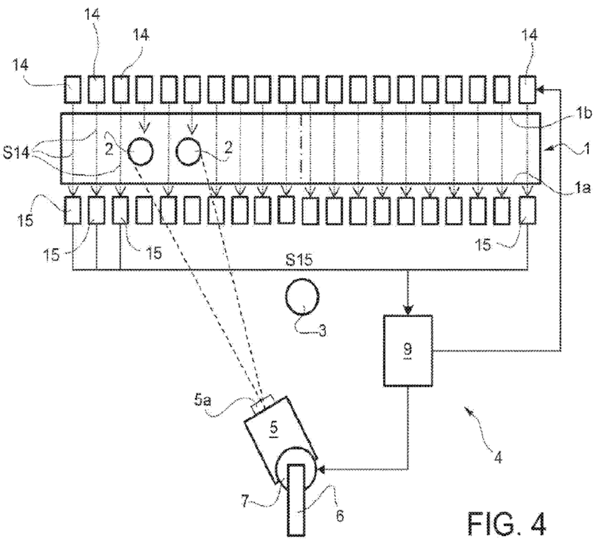

FIG. 4

FIGS. 2 to 4 illustrate the system for filming a pair of athletes moving on a field of play

The radio transmitters 12, once turned on at the beginning of the competition, transmit two respective radio signals, indicated with S12A and S12B in FIG. 2, having two different frequencies that are selected in the frequency range between 400 MHz and 2.5 GHz. Specifically, the two frequencies of the two radio signals S12A and S12B are comprised in at least one frequency band for unlicensed radio communication, for example one of the ISM bands, the LPD433 band and/or the PMR446 band. Each radio receiver 13 comprises a pair of band-pass filters 13a and 13b tuned separately on the two frequencies for simultaneously receiving the two radio signals S12A and S12B, according to known techniques of frequency division multiplexing, and to provide two electrical signals S13A and S13B corresponding to the radio signals received[12].

The embodiment of FIG. 2 differs from that of FIG. 1 also in that the processing and control unit 9 is configured to determine the position of the moving fencers 2a and 2b as a function of the known positions of the radio receivers 13 and of radio signals received by the radio receivers 13.

In particular, the processing and control unit 9 is configured to receive the signals S13A and S13B from each radio receiver 13, to measure, for each of the different frequencies of radio signals S12A and S12B, the intensity and/or the phase of the radio signals received and determine the position of each fencer 2a, 2b along the platform 1 as a function of the intensity and/or of the phases measured for the respective frequency and as a function of the known positions of the radio receivers 13. More in detail, the signals S13A are processed to measure the intensity and/or the phases of the received signals at the frequency of the signal S12A in order to determine the position of the fencer 2a while the other signals S13B are processed to measure the intensity and/or the phases of the signals received at the signal frequency S12B in order to determine the position of the fencer 2b. Therefore all the signals S13A and S13B are, in their entirety, indicative of the position of the fencers 2a and 2b.

By intensity of received radio signal, in this document, is meant the received power measured in dBm. For example, the position of each fencer 2a, 2b can be determined as an average value of the positions of said two or more radio receivers 13 whose received signals at the frequency associated with said fencer 2a, 2b have the higher intensity measured values.

4. According To A Further Embodiment Of The Topic

Not illustrated and substantially derived from that illustrated by FIG. 2, each radio receiver 13 is suitable to tune-in alternately, in time division, according to known techniques of time division multiplexing, on the two frequencies of the radio signals S12A and S12B.

According to a further embodiment of the present topic illustrated in FIG. 3, wherein the fencers are again both indicated with 2 and the corresponding elements are indicated with the same numbers and abbreviations of FIG. 2, the system 4 comprises, instead of the radio transmitters 12 and of the radio receivers 13 of FIG. 2, a plurality of optical transmitters 14, which are arranged in known positions and fixed along the platform 1 and defined relative to the coordinate system integral with the platform 1 and at a predetermined height H from the ground to transmit respective optical radiation beams S14, and a corresponding plurality of optical receivers 15, which are arranged on the opposite side of the platform 1, so that each optical receiver 15 is facing a respective optical transmitter 14 to receive the respective optical radiation beam S14 and detect the possible interception. The height H is approximately between 0.5 and 1 m.

The optical transmitters 14 are arranged in series and equally spaced apart along a longer side lb of the platform 1. The optical transmitters 14 are turned on by the processing and control unit 9. The optical transmitters 14 are arranged to emit laser beams of infrared radiation. The optical receivers 15 are arranged in series and equally spaced apart along the other longer side la of the platform 1. The optical receivers 15 are suited to detect which optical radiation beams S14 are intercepted by the fencers 2 moving on the platform 1. Therefore, the optical receivers 15 provide the processing and control unit 9 with electrical signals S15 of on/off type that are indicative of the possible interception of the corresponding optical radiation beam S14, and which therefore, once combined with the position information of the respective optical receivers 15 along the platform 1, are indicative of the position of the fencers 2.

The embodiment of FIG. 3 differs from that of FIG. 2, also in that the processing and control unit 9 is configured to determine the position of the moving fencers 2 as a function of the signals S15 and of the position of the optical receivers 15, i.e., in other words, the position of said optical receivers 15 which detect the interception of the corresponding optical radiation beam S14.

FIG. 4 illustrates a further embodiment of the present topic which is essentially an evolution of the embodiment of FIG. 2.

With reference again to FIG. 4, the system 4 comprises, instead of the two radio transmitters 12, two respective active RFID tags 16, which are applied to the bodies of the respective fencers 2a and 2b in the same way as the radio transmitters 12 and are suited to transmit respective UWB (Ultra Wide Band) radio signals, indicated with S16A and A16B in FIG. 4, and, in place of the radio receivers 13, two receiver devices 17, which are arranged in two respective positions around the platform 1 and each comprises a respective antenna array and a respective plurality of UWB receivers to receive both signals S16A and S16B.

In the example of FIG. 4 the two receiver devices 17 are arranged facing one another from opposite sides of the platform 1, at the mid-length of the same. In particular, one of the two receiver devices 17 is fixed to the support 6. According to an alternative not illustrated, the two receiver devices 17 are arranged on the side of a same long side of the platform 1 and are preferably aligned parallel to the platform 1.

The frequency band used by the signals S16A and S16B is a non-licensed type and is allocated on frequencies higher than 3 GHz. For example, the bandwidth of the signals S16A and S16B is allocated in the frequency range between 3 GHz and 11 GHz.

The processing and control unit 9 is interfaced with the receiver devices 17 to acquire from the latter data and/or electrical signals S17 indicative of the signals S16A and S16B received and is configured to determine the position of the moving fencers 2a and 2b as a function of the signals provided by the receiver devices 17. In particular, the position of each fencer 2a and 2b is determined by a multi-lateration algorithm based on the calculation of the “Time Difference Of Arrival” (TDOA) of the signals received from two receiver devices 17 for each of the transmitted signals S16A and A16B.

According to further embodiments not illustrated of the present topic, the system 4 comprises more than two receiver devices 17 arranged at respective points around the platform 1. A greater number of receiver devices 17 allows to improve the accuracy with which the multi-lateration algorithm determines the positions of the fencers 2a and 2.

It is worth noting that the methodology implemented by the system 4 described above is suited to film any pair of athletes in any sport as they move on a respective field of play. In the most generic case, the field of play is not one-dimensional, as the platform 1, but is two-dimensional, as for example a football field.

5. Conclusions And Implications

The embodiment wherein the means for detecting the position of the athletes comprise radio transmitters and receivers is well suitable for use in two-dimensional fields of play within which more than two athletes to be filmed are moving, however, in pairs, for example for following and filming a defender intent to thwart an attacker during a football game. In this case, the system 4 comprises a number of radio transmitters equal to the number of athletes in the field of play to transmit respective radio signals having different frequencies from one another, and a plurality of radio receivers arranged along at least one portion of the perimeter of the field of play, for example, a shorter side and a longer side of a football field. The pair of athletes to be filmed is easily selectable by selecting the two frequencies on which each radio receiver must tune-in, by frequency division or by time division.

In the case of use of the frequency division technique, each radio receiver comprises a number of band-pass filters equal to the number of frequencies transmitted by radio transmitters.

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