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(54) MONITORING SYSTEM, MONITORING METHOD, AND MONITORING DEVICE FOR RAILWAY TRAIN

(57) A monitoring system for a railway train, comprising: acquisition devices (100), configured to acquire monitoring data in the railway train, the monitoring data comprising videos; a monitoring server (200), connected to the acquisition devices (100) to receive and store the monitoring data, and transmitting the monitoring data to main computers for analysis (300); a plurality of main computers for analysis (300), respectively provided in carriages of the railway train, and configured to identify a preset target from the monitoring data and analyze same, and when a behaviour of the preset target satisfies a preset pre-alarm condition, send pre-alarm information to a pre-alarm device (400); and the pre-alarm device (400), connected to the main computers for analysis (300), and configured to give a pre-alarm upon receipt of the pre-alarm information. A monitoring method and a monitoring device are provided. The monitoring system for a railway train can analyze monitoring data and give an alarm in time.

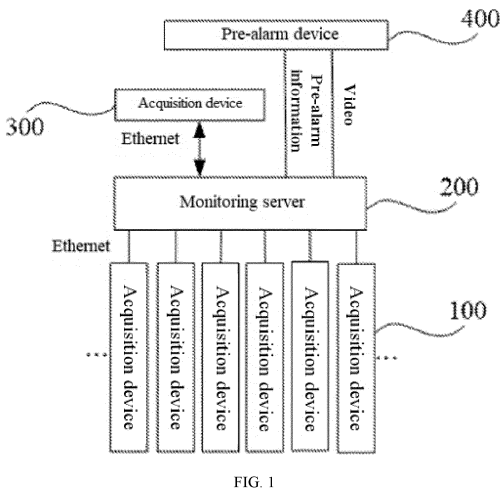

FIG. 1

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Description

TECHNICAL FIELD

[0001] The present application relates to the field of railway train technologies, and in particular, to a monitoring system, monitoring method, and monitoring device for a railway train.

BACKGROUND

[0002] At present, a high-speed rail project carriage video monitoring system is only provided with a passenger compartment camera configured to collect monitoring data, including videos and audios, and store the monitoring data in a video monitoring server to realize a driver's monitoring of a passenger compartment, which cannot analyze the data and pre-alarm emergencies.

[0003] Therefore, related monitoring systems for railway trains only collect monitoring data without analyzing the monitoring data, which is an urgent technical problem to be solved by those skilled in the art.

[0004] The above information disclosed in the background is intended only to strengthen an understanding to the background of the present application and thus may include information not forming the related art well-known to those skilled in the art.

SUMMARY

[0005] Embodiments of the present application provide a monitoring system, monitoring method, and monitoring device for a railway train, so as to solve the technical problem that related monitoring systems for railway trains only collect monitoring data without analyzing the monitoring data.

[0006] An embodiment of the present application provides a monitoring system for a railway train, including:

acquisition devices configured to acquire monitoring data in the railway train, the monitoring data including videos;

a monitoring server, connected to the acquisition devices to receive and store the monitoring data, and transmitting the monitoring data to main computers for analysis;

a plurality of main computers for analysis, respectively provided in carriages of the railway train, and configured to identify a preset target from the monitoring data and analyze same, and when a behaviour of the preset target satisfies a preset pre-alarm condition, send pre-alarm information to a pre-alarm device; and

a pre-alarm device, connected to the monitoring server, and configured to give a pre-alarm upon receipt of the pre-alarm information forwarded by the monitoring server.

[0007] An embodiment of the present application further provides the following technical solution.

[0008] A monitoring method for a railway train includes the following steps:

acquiring monitoring data in the railway train, the monitoring data including videos;

receiving and storing the monitoring data, and transmitting the monitoring data;

identifying a preset target from the monitoring data and analyzing same, and when a behaviour of the preset target satisfies a preset pre-alarm condition, sending pre-alarm information; and

receiving the pre-alarm information, and giving a pre-alarm.

[0009] An embodiment of the present application further provides the following technical solution.

[0010] A monitoring device for a railway train includes:

an acquisition module configured to acquire monitoring data in the railway train, the monitoring data including videos;

a receiving and storing module configured to receive and store the monitoring data, and transmit the monitoring data;

an analysis module configured to identify a preset target from the monitoring data and analyze same, and when a behaviour of the preset target satisfies a preset pre-alarm condition, send pre-alarm information; and

a pre-alarm module configured to receive the pre-alarm information, and give a pre-alarm.

[0011] Due to the use of the above technical solutions in the embodiments, the present application has the following technical effects.

[0012] The acquisition devices acquire the monitoring data in the railway train, the monitoring data is transmitted to the main computers for analysis, and the main computers for analysis are provided in the carriages of the railway train. In this way, the main computers for analysis can analyze a large amount of monitoring data, which can speed up the analysis. When the main computers for analysis identify the preset target from the monitoring data and analyze same and the behaviour of the preset target satisfies the preset pre-alarm condition, the pre-alarm information is sent to the pre-alarm device, and the pre-alarm device gives a pre-alarm. The monitoring system for a railway train according to the embodiment of the present application stores the monitoring data for future call and viewing, also analyzes the monitoring data, and gives a pre-alarm when the preset pre-alarm condition is satisfied, which realizes automatic analysis and pre-alarm, and provides a basis for timely detection of special situations and early intervention measures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The accompanying drawings, which are included to provide a further understanding of the application, constitute a part of the present application. Illustrative embodiment(s) of the present application and together with the description serve to explain but not to limit the present application. In the drawings:

FIG. 1 is a schematic structural diagram of a monitoring system for a railway train according to an embodiment of the present application;
FIG. 2 is a schematic diagram showing that the monitoring system shown in FIG. 1 is mounted to the railway train;
FIG. 3 is a flowchart of analyzing, by main computers for analysis of the monitoring system shown in FIG. 1, whether a dangerous behaviour exists;
FIG. 4 is a flowchart of analyzing, by the main computers for analysis of the monitoring system shown in FIG. 1, whether a protected region is intruded; and
FIG. 5 is a flowchart of analyzing, by the main computers for analysis of the monitoring system shown in FIG. 1, whether people are crowded.

Reference numerals:

[0014] 100: acquisition device, 110: hemispherical camera, 120: panoramic camera, 200: monitoring server, 300: main computer for analysis, 400: pre-alarm device.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0015] In order to make the technical solution and advantages in the embodiments of the present application more clearly understood, further description of the exemplary embodiments of the present application will be made below in detail with reference to the accompanying drawings, and it is obvious that the described embodiments are only a part of the embodiments of the present application, but not exhaustive of all the embodiments. It should be noted that, in the present application, the embodiments and features of the embodiments may be combined with one another without conflict.

First Embodiment

[0016] FIG. 1 is a schematic structural diagram of a monitoring system for a railway train according to an embodiment of the present application. FIG. 2 is a schematic diagram showing that the monitoring system shown in FIG. 1 is mounted to the railway train.

[0017] As shown in FIG. 1 and FIG. 2, a monitoring system for a railway train according to the embodiment of the present application includes:

acquisition devices 100 configured to acquire monitoring data in the railway train, the monitoring data including videos;
a monitoring server 200, connected to the acquisition devices to receive and store the monitoring data, and transmitting the monitoring data to main computers for analysis;
a plurality of main computers for analysis 300, respectively provided in carriages of the railway train, and configured to identify a preset target from the monitoring data and analyze same, and when a behaviour of the preset target satisfies a preset pre-alarm condition, send pre-alarm information to a pre-alarm device; and
a pre-alarm device 400, connected to the monitoring server, and configured to give a pre-alarm upon receipt of the pre-alarm information forwarded by the monitoring server.

[0018] In the monitoring system for a railway train according to the embodiment of the present application, the acquisition devices acquire the monitoring data in the railway train, the monitoring data is transmitted to the main computers for analysis, and the main computers for analysis are provided in the carriages of the railway train. In this way, the main computers for analysis can analyze a large amount of monitoring data, which can speed up the analysis. When the main computers for analysis identify the preset target from the monitoring data and analyze same and the behaviour of the preset target satisfies the preset pre-alarm condition, the pre-alarm information is sent to the pre-alarm device, and the pre-alarm device gives a pre-alarm. The monitoring system for a railway train according to the embodiment of the present application stores the monitoring data for future call and viewing, also analyzes the monitoring data, and gives a pre-alarm when the preset pre-alarm condition is satisfied, which realizes automatic analysis and pre-alarm, and provides a basis for timely detection of special situations and early intervention measures.

[0019] During implementation, connections over Ethernet are mostly used in the railway train. In the monitoring system for a railway train according to the embodiment of the present application, the acquisition devices and the monitoring server are connected over the Ethernet. On the one hand, the Ethernet of the railway train is effectively utilized, and on the other hand, the monitoring data is large in amount and also suitable for transmission over the Ethernet. The monitoring server and the main computers for analysis are connected over the Ethernet.

[0020] The main computers for analysis analyze videos according to a hybrid algorithm of time differences and background image differences to extract information of foreground target movement by subtracting adjacent frame images. The process of video analysis (a background subtraction method) is as follows. Firstly, the system performs background learning, and the learning time varies according to lively degrees of backgrounds, during which the system automatically establishes a background model. Then, the system enters an "analysis"

state. If a moving object appears in a foreground and is within a set range and a size of a preset target meets the setting, the system may extract and track the preset target and trigger a pre-alarm according to a preset algorithm (such as intrusion, legacy, or fighting) (during which, if the acquisition devices jitter in the backgrounds, the monitoring system may enable a pre-processing function to filter out these dynamic backgrounds). Prior to triggering of the pre-alarm, the monitoring system has a preset target identification function, which is to compare the extracted preset target with established models and select the best match.

[0021] How the monitoring system pre-alarms a dangerous behaviour is described below.

[0022] FIG. 3 is a flowchart of analyzing, by main computers for analysis of the monitoring system shown in FIG. 1, whether a dangerous behaviour exists. During implementation, the preset pre-alarm condition includes reaching or exceeding a motion amplitude threshold.

[0023] As shown in FIG. 3, the main computers for analysis are specifically configured to analyze whether a dangerous behaviour exists, including step S300: identifying the preset target from a preset dangerous behaviour monitoring range in a video of a passenger compartment region of the railway train and analyzing whether a behaviour motion amplitude of the preset target in the dangerous behaviour monitoring range reaches or exceeds the motion amplitude threshold:

step S310: sending pre-alarm information of the dangerous behaviour to the pre-alarm device when the motion amplitude threshold is reached or exceeded; and

step S320: not sending the pre-alarm information of the dangerous behaviour when the behaviour motion amplitude of the preset target in the dangerous behaviour monitoring range does not reach or exceed the motion amplitude threshold.

[0024] The pre-alarm device is specifically configured to pre-alarm the dangerous behaviour according to the pre-alarm information of the dangerous behaviour.

[0025] Whether a dangerous behaviour exists in the preset dangerous behaviour monitoring range in the video of the passenger compartment region of the railway train is analyzed based on whether the motion amplitude threshold is reached or exceeded. When a behaviour motion amplitude of a person as the preset target in the preset dangerous behaviour monitoring range reaches or exceeds the motion amplitude threshold, the main computers for analysis judge that a dangerous behaviour exists and give a pre-alarm. When the behaviour motion amplitude of the person as the preset target does not reach or exceed the motion amplitude threshold, the main computers for analysis judge that the dangerous behaviour does not exist. Dangerous behaviours may be set according to situations, and various dangerous behaviors such as fighting and the like which need manual intervention by staff of the railway train are included through setting, so that the pre-alarmed of the dangerous behaviors is realized.

[0026] The preset dangerous behaviour monitoring range is set according to motions required by passengers in the passenger compartment region of the railway train. For example, the preset dangerous behaviour monitoring range should not include where passengers are required to make a large motion, such as picking up and putting down luggage. Otherwise, it is easy to lead to misjudgment. Specifically, any polygon range is set to the dangerous behaviour monitoring range. For each dangerous behaviour monitoring range, one of "an audio detection mode", "a video detection mode", and "an audio and video detection mode" is set. For analysis on dangerous behaviours in the dangerous behaviour monitoring range in the passenger compartment, a minimum detection size under CIF resolution is 64x32 pixels; a minimum response time is less than 2 seconds, and a detection success rate is higher than 80%.

[0027] Analysis only on whether a dangerous behaviour exists in the preset dangerous behaviour monitoring range is targeted analysis on whether the dangerous behaviour exists, which reduces the possibility of misjudgment, increases the accuracy of pre-alarming of the dangerous behaviour, and also reduces the amount of data analyzed by the main computers for analysis.

[0028] The monitoring server sends real-time videos of the acquisition devices in the passenger compartment region of the railway train to the main computers for analysis by multicast, and the main computers for analysis analyze the videos. Once someone behaves in a dangerous way, a corresponding pre-alarm is generated.

[0029] The main computers for analysis analyze whether a dangerous behaviour exists by acquiring a series of unique static and dynamic characteristics of video images to achieve description and discrimination of specific events. In order to analyze the dangerous behaviour, optical flow, cluster analysis, image feature description, a classifier, and other computer vision and pattern recognition technologies are used.

[0030] How the monitoring system pre-alarms intrusion into a protected region is described below.

[0031] FIG. 4 is a flowchart of analyzing, by the main computers for analysis of the monitoring system shown in FIG. 1, whether a protected region is intruded. During implementation, the preset pre-alarm condition further includes the preset target existing in the protected region.

[0032] As shown in FIG. 4, the main computers for analysis are specifically configured to analyze whether the protected region is intruded, including step S400: identifying, from a preset intrusion behaviour monitoring range in a video of the protected region, whether the preset target exists:

step S410: sending pre-alarm information of intrusion into the protected region to the pre-alarm device when the preset target exists; and

step S420: not sending the pre-alarm information of intrusion into the protected region to the pre-alarm device when the preset target does not exist.

[0033] The pre-alarm device is specifically configured to pre-alarm intrusion into the protected region according to the pre-alarm information of intrusion into the protected region.

[0034] A region that requires special protection and is not allowed to be entered by non-working personnel, such as a driver's cab or mechanic's cabs of the railway train, is designated as a protected region, and an intrusion behaviour monitoring range is preset in a video of the protected region, such as surroundings of a doorway. For the video of the protected region, whether the protected region is intruded is analyzed based on whether a person is within the intrusion behaviour monitoring range in the protected region.

[0035] Pre-alarm information of intrusion into the protected region is sent to the pre-alarm device when the preset target is identified in the intrusion behaviour monitoring range.

[0036] The pre-alarm information of intrusion into the protected region is not sent when the preset target is not identified in the intrusion behaviour monitoring range.

[0037] The pre-alarm device is specifically configured to pre-alarm intrusion into the protected region according to the pre-alarm information of intrusion into the protected region.

[0038] Through the acquisition devices deployed in the carriages, key regions (such as the driver's cab and the mechanic's cabs) can be deployed for defense. Through the arrangement of a monitoring region, a monitoring area, pre-alarm time, and a pre-alarm output manner, safety prevention and protection for the key regions of the railway train can be realized.

[0039] A trajectory-dependent behaviour analysis technology is adopted for analyzing the pre-alarm of whether the protected region is intruded. A basic method involves acquiring a background image as a reference by using a sequence of continuously inputted images, comparing subsequent incoming images with the background image to acquire different pixels, marking connectivity of the pixels, marked regions being initial targets, then tracking the targets to form continuous tracking trajectories, and then analyzing the above foreground and tracking trajectories; and comparing preset rule information, and outputting the pre-alarm information.

[0040] The intrusion behaviour monitoring range may be set to any polygonal intrusion behaviour monitoring range.

(1) Multiple independent intrusion behaviour monitoring ranges may be set in a same scenario.

(2) For each intrusion behaviour monitoring range, one or two of "across a boundary of the intrusion behaviour monitoring range" and "within the intrusion behaviour monitoring range" may be set.

(3) For the monitoring in the intrusion behaviour monitoring range, the number of preset targets, the shortest alarm time, repeated alarm interval time, or the like, may be set.

(4) A direction of crossing may be in, out or both for the preset target across the boundary of the intrusion behaviour monitoring range. For the monitoring on whether the protected region is intruded, a minimum detection target size under CIF resolution is 10×10 pixels, a minimum response time is less than 1 second, and a monitoring success rate is higher than 90%.

[0041] How the monitoring system pre-alarms people crowding is described below.

[0042] FIG. 5 is a flowchart of analyzing, by the main computers for analysis of the monitoring system shown in FIG. 1, whether people are crowded. During implementation, the preset pre-alarm condition further includes reaching or exceeding a people number threshold.

[0043] As shown in FIG. 5, the main computers for analysis are specifically configured to analyze whether people are crowded, including step S500: analyzing whether a number of preset targets identified from a preset crowding monitoring range in a video of a specified region reaches or exceeds the people number threshold:

step S510: sending pre-alarm information of people crowding to the pre-alarm device when the people number threshold is reached or exceeded; and

step S520: not sending the pre-alarm information of people crowding when the people number threshold is not reached or exceeded.

[0044] The pre-alarm device is specifically configured to pre-alarm people crowding according to the pre-alarm information of people crowding.

[0045] The acquisition devices are provided at positions where the railway train is prone to crowding. That is, the position where the railway train is prone to crowding is a specified region, such as a passage between an entrance to the railway train and an entrance to the passenger compartment. A preset crowding monitoring range in a video of the specified region is a height range where a face is normally located, excluding a high position of the passage where the face cannot reach. When a number of preset targets identified from the preset crowding monitoring range in the video of the specified region reaches or exceeds a people number threshold, pre-alarm information of people crowding is sent to the pre-alarm device, so as to pre-alarm the crowding.

[0046] How the monitoring system pre-alarms abnormal sound is described below.

[0047] During implementation, the monitoring data further includes audios, and the preset pre-alarm condition further includes reaching or exceeding a sound pre-alarm threshold.

[0048] The main computers for analysis are further configured to analyze whether sound is abnormal, including analyzing whether volumes of sound in the audios reach or exceed the sound pre-alarm threshold;

sending pre-alarm information of abnormal sound to the pre-alarm device when the sound pre-alarm threshold is reached or exceeded; and

not sending the pre-alarm information of abnormal sound to the pre-alarm device when the sound pre-alarm threshold is not reached or exceeded.

[0049] The pre-alarm device is further configured to pre-alarm abnormal sound according to the pre-alarm information of abnormal sound.

[0050] The acquisition devices on two sides of the carriages of the railway train are cameras with pickups, which may collect audios in real time, and the main computers for analysis analyze and process the audios. If sound intensity exceeds the sound pre-alarm threshold, a pre-alarm of abnormal sound is generated. Sound intensity of the audios may be set. A minimum duration of a sound alarm may be set. A minimum response time for abnormal sound is 1 second, and a detection success rate is higher than 90%.

[0051] How the monitoring system pre-alarms a key person under surveillance is described below.

[0052] During implementation, the monitoring system further includes a face database.

[0053] The main computers for analysis are further configured to analyze whether a key person under surveillance is discovered, including: capturing a face image from the video, comparing the captured face image with faces in the face database for identification, and when the captured face image matches a face in the face database, sending pre-alarm information of discovery of the key person under surveillance to the pre-alarm device.

[0054] The pre-alarm device is further configured to pre-alarm discovery of the key person under surveillance according to the pre-alarm information of discovery of the key person under surveillance.

[0055] In this way, the key person under surveillance is pre-alarmed.

[0056] The pre-alarm of the key person under surveillance requires collection of information of passengers, and the main computers for analysis make comparison to realize retrieval and pre-alarming of the key person under surveillance. During specific implementation, the acquisition devices capture videos, and the main computers for analysis realize feature import and retrieval comparison query of the database.

[0057] The main computers for analysis are each mainly divided into an image capture module, an image comparison module, a face database management module, and a face feature retrieval module.

(1) The image capture module captures real-time images in carriages of a high-speed rail through the acquisition devices in the railway train, detects face images in the captured video images every several frames, and transmits the face images to the image comparison module for comparison.

(2) The image comparison module extracts face features in the image capture module.

(3) The face database management module manages feature data of faces recorded in the system.

(4) The face feature retrieval module retrieves whether the extracted face features exist in the face database and judges whether to be a face of the key person under surveillance.

[0058] The core of the pre-alarm of the key person under surveillance is face recognition. A face recognition algorithm includes three parts: face detection, face key point detection, and face recognition. Face detection is used to find all faces included in an image. Face key point detection is used to detect key point coordinates of a face on a detected face image, and then estimate a posture of the face. Face recognition is used to change faces into vectors with specific numbers of dimensions, and judge whether to be face images of a same person according to similarities between the vectors.

[0059] During implementation, the main computers for analysis perform at least one analysis on the monitoring data acquired by the acquisition devices according to arranged positions of the acquisition devices, including: analysis of whether a dangerous behaviour exists, analysis of whether a protected region is intruded, analysis of whether people are crowded, analysis of whether sound is abnormal, and analysis of whether a key person under surveillance is discovered.

[0060] In this way, according to the positions of the acquisition devices, the monitoring data acquired by the acquisition devices is analyzed respectively, and the monitoring data is fully utilized.

[0061] Specifically, the protected region includes a driver's cab and/or mechanic's cabs of the railway train.

[0062] Specifically, the acquisition devices include a panoramic camera and hemispherical cameras with sound pickup functions.

[0063] As shown in FIG. 2, the panoramic camera 120 is arranged at a passing platform of the railway train; and the railway train is provided with four hemispherical cameras 110.

[0064] During implementation, the monitoring system further includes monitoring screens. The monitoring screens are arranged in each of the mechanic's cabs.

[0065] The monitoring screens are configured to display real-time monitoring pictures and configured to display the pre-alarm information.

Second Embodiment

[0066] A monitoring method for a railway train according to the embodiment of the present application includes the following steps:

acquiring monitoring data in the railway train, the monitoring data including videos;
receiving and storing the monitoring data, and transmitting the monitoring data;
identifying a preset target from the monitoring data and analyzing same, and when a behaviour of the preset target satisfies a preset pre-alarm condition, sending pre-alarm information; and
receiving the pre-alarm information, and giving a pre-alarm.

[0067] During implementation, the step of identifying a preset target from the monitoring data and analyzing same, and when a behaviour of the preset target satisfies a preset pre-alarm condition, sending pre-alarm information specifically includes:

analyzing whether a dangerous behaviour exists, including identifying the preset target from a preset dangerous behaviour monitoring range in a video of a passenger compartment region of the railway train and analyzing whether a behaviour motion amplitude of the preset target in the dangerous behaviour monitoring range reaches or exceeds a motion amplitude threshold; and
sending pre-alarm information of the dangerous behaviour when the motion amplitude threshold is reached or exceeded; wherein the pre-alarm condition includes reaching or exceeding the motion amplitude threshold.

[0068] The step of receiving the pre-alarm information, and giving a pre-alarm specifically includes:
pre-alarming the dangerous behaviour according to the pre-alarm information of the dangerous behaviour.
[0069] During implementation, the step of identifying a preset target from the monitoring data and analyzing same, and when a behaviour of the preset target satisfies a preset pre-alarm condition, sending pre-alarm information specifically includes:
analyzing whether a protected region is intruded, including identifying, from a preset intrusion behaviour monitoring range in a video of the protected region, whether the preset target exists:
sending pre-alarm information of intrusion into the protected region when the preset target exists; wherein the pre-alarm condition further includes the preset target existing in the protected region.
[0070] The step of receiving the pre-alarm information, and giving a pre-alarm specifically includes:
pre-alarming intrusion into the protected region according to the pre-alarm information of intrusion into the protected region.
[0071] During implementation, the step of identifying a preset target from the monitoring data and analyzing same, and when a behaviour of the preset target satisfies a preset pre-alarm condition, sending pre-alarm information specifically includes:
analyzing whether people are crowded, including analyzing whether a number of preset targets identified from a preset crowding monitoring range in a video of a specified region reaches or exceeds a people number threshold:
sending pre-alarm information of people crowding when the people number threshold is reached or exceeded; wherein the preset pre-alarm condition further includes reaching or exceeding the people number threshold.
[0072] The step of receiving the pre-alarm information, and giving a pre-alarm specifically includes:
pre-alarming people crowding according to the pre-alarm information of people crowding.
[0073] During implementation, the monitoring method for a railway train further includes:
analyzing whether sound is abnormal, including analyzing whether volumes of sound in the audios reach or exceed a sound pre-alarm threshold:

sending pre-alarm information of abnormal sound when the sound pre-alarm threshold is reached or exceeded; wherein the monitoring data further includes audios, and the preset pre-alarm condition further includes reaching or exceeding the sound pre-alarm threshold; and
pre-alarming abnormal sound according to the pre-alarm information of abnormal sound.

[0074] During implementation, the monitoring method for a railway train further includes:

analyzing whether a key person under surveillance is discovered, including: capturing a face image from the video, comparing the captured face image with faces in a face database for identification, and when the captured face image matches a face in the face database, sending pre-alarm information of discovery of the key person under surveillance; and
pre-alarming discovery of the key person under surveillance according to the pre-alarm information of discovery of the key person under surveillance.

Third Embodiment

[0075] A monitoring device for a railway train according to the embodiment of the present application includes:

an acquisition module configured to acquire monitoring data in the railway train, the monitoring data including videos;
a receiving and storing module configured to receive and store the monitoring data, and transmit the monitoring data;
an analysis module configured to identify a preset target from the monitoring data and analyze same, and when a behaviour of the preset target satisfies a preset pre-alarm condition, send pre-alarm information; and

a pre-alarm module configured to receive the pre-alarm information, and give a pre-alarm.

[0076] During implementation, the analysis module includes:
a dangerous behaviour analysis submodule configured to analyze whether a dangerous behaviour exists, including identifying the preset target from a preset dangerous behaviour monitoring range in a video of a passenger compartment region of the railway train and analyzing whether a behaviour motion amplitude of the preset target in the dangerous behaviour monitoring range reaches or exceeds a motion amplitude threshold:
sending pre-alarm information of the dangerous behaviour when the motion amplitude threshold is reached or exceeded; wherein the pre-alarm condition includes reaching or exceeding the motion amplitude threshold.

[0077] The pre-alarm module includes:
a dangerous behaviour pre-alarm submodule configured to pre-alarm the dangerous behaviour according to the pre-alarm information of the dangerous behaviour.

[0078] During implementation, the analysis module further includes:
an intrusion analysis submodule configured to analyze whether a protected region is intruded, including identifying whether the preset target exists from a preset intrusion behaviour monitoring range in a video of the protected region:
sending pre-alarm information of intrusion into the protected region when the preset target exists; wherein the preset pre-alarm condition further includes the preset target existing in the protected region.

[0079] The pre-alarm module further includes:
an intrusion pre-alarm submodule configured to pre-alarm intrusion into the protected region according to the pre-alarm information of intrusion into the protected region.

[0080] During implementation, the analysis module further includes:
a crowding analysis submodule configured to analyze whether people are crowded, including analyzing whether a number of preset targets identified from a preset crowding monitoring range in a video of a specified region reaches or exceeds a people number threshold:
sending pre-alarm information of people crowding when the people number threshold is reached or exceeded; wherein the preset pre-alarm condition further includes reaching or exceeding the people number threshold.

[0081] The pre-alarm module further includes:
a crowding pre-alarm submodule configured to pre-alarm people crowding according to the pre-alarm information of people crowding.

[0082] During implementation, the analysis module further includes:
a sound analysis submodule configured to analyze whether sound is abnormal, including analyzing whether volumes of sound in the audios reach or exceed a sound pre-alarm threshold:
sending pre-alarm information of abnormal sound when the sound pre-alarm threshold is reached or exceeded; wherein the monitoring data further includes audios, and the preset pre-alarm condition further includes reaching or exceeding the sound pre-alarm threshold.

[0083] The pre-alarm module further includes:
a sound anomaly pre-alarm submodule configured to pre-alarm abnormal sound according to the pre-alarm information of abnormal sound.

[0084] During implementation, the analysis module further includes:

a key person under surveillance analysis submodule configured to analyze whether a key person under surveillance is discovered, including: capturing a face image from the video, comparing the captured face image with faces in a face database for identification, and when the captured face image matches a face in the face database, sending pre-alarm information of discovery of the key person under surveillance; and
the pre-alarm module further includes:
a key person under surveillance discovery pre-alarm submodule configured to pre-alarm discovery of the key person under surveillance according to the pre-alarm information of discovery of the key person under surveillance.

[0085] In the description of the present application and embodiments thereof, it is to be understood that terms such as "top", "bottom", and "height" should be construed to refer to the orientation as then described or as shown in the drawings under discussion. These relative terms are for convenience of description, do not require that the present application be constructed or operated in a particular orientation, and thus cannot be construed to limit the present application.

[0086] In the present application and embodiments thereof, unless specified or limited otherwise, the terms "arrange", "mount", "connect", and "couple", "fix" and the like are used broadly, and may be, for example, fixed connections, detachable connections, or integral connections; may also be mechanical or electrical connections, or communication; may also be direct connections or indirect connections via intervening structures; may also be inner communications of two elements or interaction between two elements. Specific meanings of the above terms in the present application can be understood by those of ordinary skill in the art according to specific situations.

[0087] In the present application and embodiments thereof, unless specified or limited otherwise, a structure in which a first feature is "on" or "below" a second feature may include an embodiment in which the first feature is in direct contact with the second feature, and may also include an embodiment in which the first feature and the second feature are not in direct contact but contacted via an additional feature therebetween. Furthermore, a first

feature "on," "above," or "on top of' a second feature may include an embodiment in which the first feature is right or obliquely "on," "above," or "on top of' the second feature, or just means that the first feature is at a height higher than that of the second feature. A first feature "below," "under," or "on bottom of' a second feature may include an embodiment in which the first feature is right or obliquely "below," "under," or "on bottom of' the second feature, or just means that the first feature is at a height lower than that of the second feature.

[0088] Various implementations and examples are provided above to implement different structures of the present application. In order to simplify the present application, components and settings in specific examples are described above. However, these components and settings are only by way of example and are not intended to limit the present application. In addition, reference numerals and/or reference letters may be repeated in different examples in the present application. This repeating is for the purpose of simplification and clarity and does not refer to relations between different implementations and/or settings. Furthermore, examples of different processes and materials are provided in the present application. However, it would be appreciated by those of ordinary skill in the art that other processes and/or materials may be also applied.

[0089] Although some alternative embodiments of the present application have been described, additional variations and modifications to these embodiments may occur to those skilled in the art once they learn of the basic inventive concepts. It is therefore intended that the following appended claims are interpreted as including some alternative embodiments and all alterations and modifications falling within the scope of the present application.

[0090] It will be apparent to those skilled in the art that various changes and variations may be made to the present application without departing from the spirit and scope of the present application. Thus, if such modifications and variations to the present application fall within the scope of the claims of the present application and their equivalents, the present application is also intended to include such modifications and variations.

Claims

1. A monitoring system for a railway train, comprising:

acquisition devices configured to acquire monitoring data in the railway train, the monitoring data comprising videos;
a monitoring server, connected to the acquisition devices to receive and store the monitoring data, and transmitting the monitoring data to main computers for analysis;
a plurality of main computers for analysis, respectively provided in carriages of the railway train, and configured to identify a preset target from the monitoring data and analyze same, and when a behaviour of the preset target satisfies a preset pre-alarm condition, send pre-alarm information to a pre-alarm device; and
a pre-alarm device, connected to the monitoring server, and configured to give a pre-alarm upon receipt of the pre-alarm information forwarded by the monitoring server.

2. The monitoring system for a railway train according to claim 1, wherein the pre-alarm condition comprises reaching or exceeding a motion amplitude threshold;
the main computers for analysis are specifically configured to analyze whether a dangerous behaviour exists, comprising identifying the preset target from a preset dangerous behaviour monitoring range in a video of a passenger compartment region of the railway train and analyzing whether a behaviour motion amplitude of the preset target in the dangerous behaviour monitoring range reaches or exceeds the motion amplitude threshold:

sending pre-alarm information of the dangerous behaviour to the pre-alarm device when the motion amplitude threshold is reached or exceeded; and
the pre-alarm device is specifically configured to pre-alarm the dangerous behaviour according to the pre-alarm information of the dangerous behaviour.

3. The monitoring system for a railway train according to claim 2, wherein the pre-alarm condition further comprises the preset target existing in a preset intrusion behaviour monitoring range in a protected region;
the main computers for analysis are specifically configured to analyze whether the protected region is intruded, comprising identifying, from the preset intrusion behaviour monitoring range in a video of the protected region, whether the preset target exists:

sending pre-alarm information of intrusion into the protected region to the pre-alarm device when the preset target exists; and
the pre-alarm device is specifically configured to pre-alarm intrusion into the protected region according to the pre-alarm information of intrusion into the protected region.

4. The monitoring system for a railway train according to claim 3, wherein the pre-alarm condition further comprises reaching or exceeding a people number threshold;
the main computers for analysis are specifically configured to analyze whether people are crowded,

comprising analyzing whether a number of preset targets identified from a preset crowding monitoring range in a video of a specified region reaches or exceeds the people number threshold:

sending pre-alarm information of people crowding to the pre-alarm device when the people number threshold is reached or exceeded; and the pre-alarm device is specifically configured to pre-alarm people crowding according to the pre-alarm information of people crowding.

5. The monitoring system for a railway train according to claim 4, wherein the monitoring data further comprises audios; and the pre-alarm condition further comprises reaching or exceeding a sound pre-alarm threshold;
the main computers for analysis are further configured to analyze whether sound is abnormal, comprising analyzing whether volumes of sound in the audios reach or exceed the sound pre-alarm threshold:

sending pre-alarm information of abnormal sound to the pre-alarm device when the sound pre-alarm threshold is reached or exceeded; and
the pre-alarm device is further configured to pre-alarm abnormal sound according to the pre-alarm information of abnormal sound.

6. The monitoring system for a railway train according to claim 5, further comprising a face database;

the main computers for analysis are further configured to analyze whether a key person under surveillance is discovered, comprising: capturing a face image from the video, comparing the captured face image with faces in the face database for identification, and when the captured face image matches a face in the face database, sending pre-alarm information of discovery of the key person under surveillance to the pre-alarm device; and
the pre-alarm device is further configured to pre-alarm discovery of the key person under surveillance according to the pre-alarm information of discovery of the key person under surveillance.

7. The monitoring system for a railway train according to claim 6, wherein the main computers for analysis perform at least one analysis on the monitoring data acquired by the acquisition devices according to arranged positions of the acquisition devices, comprising: analysis of whether a dangerous behaviour exists, analysis of whether a protected region is intruded, analysis of whether people are crowded, analysis of whether sound is abnormal, and analysis of whether a key person under surveillance is discovered.

8. The monitoring system for a railway train according to claim 7, wherein the protected region comprises a driver's cab and/or mechanic's cabs of the railway train.

9. The monitoring system for a railway train according to claim 8, wherein the acquisition devices comprise a panoramic camera and hemispherical cameras with sound pickup functions;

the panoramic camera is arranged at a passing platform of the railway train; and
the railway train is provided with four hemispherical cameras.

10. The monitoring system for a railway train according to claim 9, wherein the pre-alarm device comprises monitoring screens, the monitoring screens being arranged in each of the mechanic's cabs; and
the monitoring screens being configured to display real-time monitoring pictures and configured to display the pre-alarm information.

11. A monitoring method for a railway train, comprising the following steps:

acquiring monitoring data in the railway train, the monitoring data comprising videos;
receiving and storing the monitoring data, and transmitting the monitoring data;
identifying a preset target from the monitoring data and analyzing same, and when a behaviour of the preset target satisfies a preset pre-alarm condition, sending pre-alarm information; and
receiving the pre-alarm information, and giving a pre-alarm.

12. The monitoring method for a railway train according to claim 11, wherein the step of identifying a preset target from the monitoring data and analyzing same, and when a behaviour of the preset target satisfies a preset pre-alarm condition, sending pre-alarm information specifically comprises:

analyzing whether a dangerous behaviour exists, comprising identifying the preset target from a preset dangerous behaviour monitoring range in a video of a passenger compartment region of the railway train and analyzing whether a behaviour motion amplitude of the preset target in the dangerous behaviour monitoring range reaches or exceeds a motion amplitude threshold:
sending pre-alarm information of the dangerous behaviour when the motion amplitude threshold is reached or exceeded; wherein the pre-alarm

condition comprises reaching or exceeding the motion amplitude threshold; and
the step of receiving the pre-alarm information, and giving a pre-alarm specifically comprises:
pre-alarming the dangerous behaviour according to the pre-alarm information of the dangerous behaviour.

13. The monitoring method for a railway train according to claim 12, wherein the step of identifying a preset target from the monitoring data and analyzing same, and when a behaviour of the preset target satisfies a preset pre-alarm condition, sending pre-alarm information specifically comprises:

analyzing whether a protected region is intruded, comprising identifying, from a preset intrusion behaviour monitoring range in a video of the protected region, whether the preset target exists:
sending pre-alarm information of intrusion into the protected region when the preset target exists; wherein the pre-alarm condition further comprises the preset target existing in the protected region; and
the step of receiving the pre-alarm information, and giving a pre-alarm specifically comprises:
pre-alarming intrusion into the protected region according to the pre-alarm information of intrusion into the protected region.

14. The monitoring method for a railway train according to claim 13, wherein the step of identifying a preset target from the monitoring data and analyzing same, and when a behaviour of the preset target satisfies a preset pre-alarm condition, sending pre-alarm information specifically comprises:

analyzing whether people are crowded, comprising analyzing whether a number of preset targets identified from a preset crowding monitoring range in a video of a specified region reaches or exceeds a people number threshold:
sending pre-alarm information of people crowding when the people number threshold is reached or exceeded; wherein the preset pre-alarm condition further comprises reaching or exceeding the people number threshold; and
the step of receiving the pre-alarm information, and giving a pre-alarm specifically comprises:
pre-alarming people crowding according to the pre-alarm information of people crowding.

15. The monitoring method for a railway train according to claim 14, further comprising:
analyzing whether sound is abnormal, comprising analyzing whether volumes of sound in the audios reach or exceed a sound pre-alarm threshold:
sending pre-alarm information of abnormal sound when the sound pre-alarm threshold is reached or exceeded; wherein the monitoring data further comprises audios, and the preset pre-alarm condition further comprises reaching or exceeding the sound pre-alarm threshold; and
pre-alarming abnormal sound according to the pre-alarm information of abnormal sound.

16. The monitoring method for a railway train according to claim 15, further comprising:

analyzing whether a key person under surveillance is discovered, comprising: capturing a face image from the video, comparing the captured face image with faces in a face database for identification, and when the captured face image matches a face in the face database, sending pre-alarm information of discovery of the key person under surveillance; and
pre-alarming discovery of the key person under surveillance according to the pre-alarm information of discovery of the key person under surveillance.

17. A monitoring device for a railway train, comprising:

an acquisition module configured to acquire monitoring data in the railway train, the monitoring data comprising videos;
a receiving and storing module configured to receive and store the monitoring data, and transmit the monitoring data;
an analysis module configured to identify a preset target from the monitoring data and analyze same, and when a behaviour of the preset target satisfies a preset pre-alarm condition, send pre-alarm information; and
a pre-alarm module configured to receive the pre-alarm information, and give a pre-alarm.

18. The monitoring device for a railway train according to claim 17, wherein the analysis module comprises:

a dangerous behaviour analysis submodule configured to analyze whether a dangerous behaviour exists, comprising identifying the preset target from a preset dangerous behaviour monitoring range in a video of a passenger compartment region of the railway train and analyzing whether a behaviour motion amplitude of the preset target in the dangerous behaviour monitoring range reaches or exceeds a motion amplitude threshold:

sending pre-alarm information of the dangerous behaviour when the motion ampli-

tude threshold is reached or exceeded; wherein the pre-alarm condition comprises reaching or exceeding the motion amplitude threshold; and
the pre-alarm module comprises:

a dangerous behaviour pre-alarm submodule configured to pre-alarm the dangerous behaviour according to the pre-alarm information of the dangerous behaviour.

19. The monitoring device for a railway train according to claim 18, wherein the analysis module further comprises:

an intrusion analysis submodule configured to analyze whether a protected region is intruded, comprising identifying whether the preset target exists from a preset intrusion behaviour monitoring range in a video of the protected region:

sending pre-alarm information of intrusion into the protected region when the preset target exists; wherein the preset pre-alarm condition further comprises the preset target existing in the protected region; and
the pre-alarm module further comprises:

an intrusion pre-alarm submodule configured to pre-alarm intrusion into the protected region according to the pre-alarm information of intrusion into the protected region.

20. The monitoring device for a railway train according to claim 19, wherein the analysis module further comprises:

a crowding analysis submodule configured to analyze whether people are crowded, comprising analyzing whether a number of preset targets identified from a preset crowding monitoring range in a video of a specified region reaches or exceeds a people number threshold:

sending pre-alarm information of people crowding when the people number threshold is reached or exceeded; wherein the preset pre-alarm condition further comprises reaching or exceeding the people number threshold; and
the pre-alarm module further comprises:

a crowding pre-alarm submodule configured to pre-alarm people crowding according to the pre-alarm information of people crowding.

21. The monitoring device for a railway train according to claim 20, wherein the analysis module further comprises:

a sound analysis submodule configured to analyze whether sound is abnormal, comprising analyzing whether volumes of sound in the audios reach or exceed a sound pre-alarm threshold:

sending pre-alarm information of abnormal sound when the sound pre-alarm threshold is reached or exceeded; wherein the monitoring data further comprises audios, and the preset pre-alarm condition further comprises reaching or exceeding the sound pre-alarm threshold; and
the pre-alarm module further comprises:

a sound anomaly pre-alarm submodule configured to pre-alarm abnormal sound according to the pre-alarm information of abnormal sound.

22. The monitoring device for a railway train according to claim 21, wherein the analysis module further comprises:

a key person under surveillance analysis submodule configured to analyze whether a key person under surveillance is discovered, comprising: capturing a face image from the video, comparing the captured face image with faces in a face database for identification, and when the captured face image matches a face in the face database, sending pre-alarm information of discovery of the key person under surveillance; and
the pre-alarm module further comprises:
a key person under surveillance discovery pre-alarm submodule configured to pre-alarm discovery of the key person under surveillance according to the pre-alarm information of discovery of the key person under surveillance.

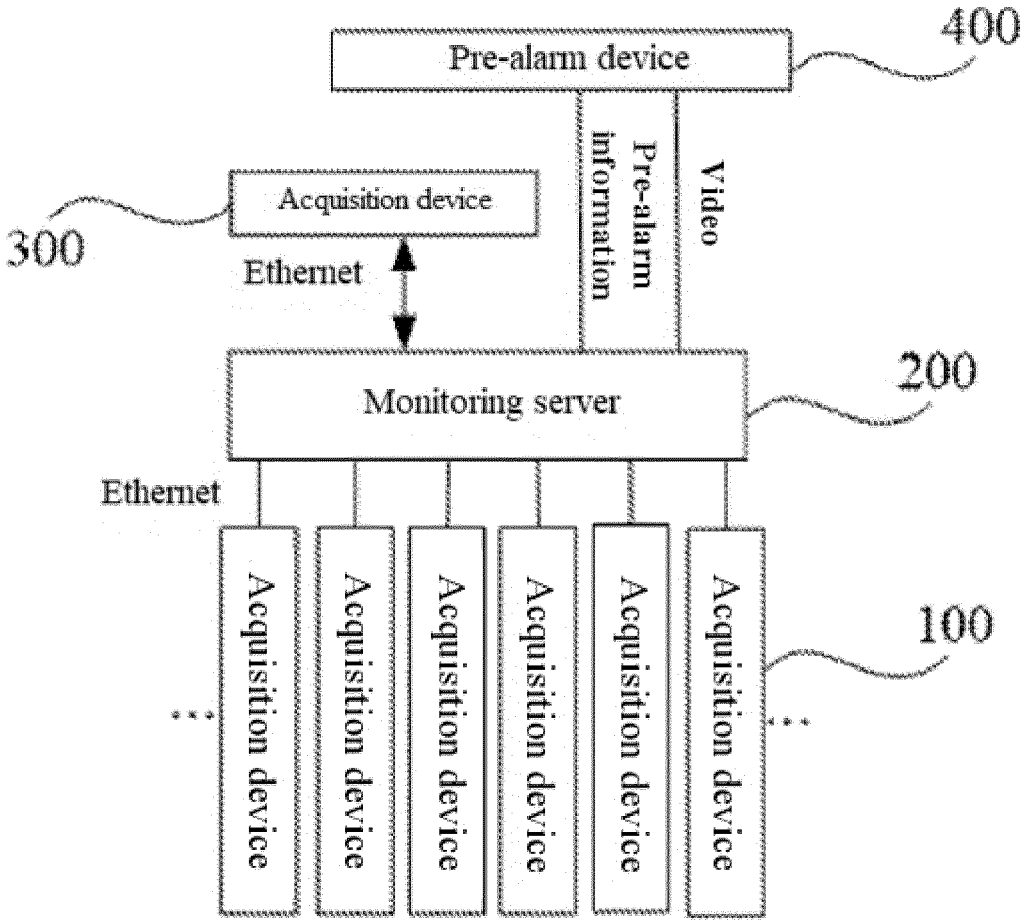
400
Pre-alarm device
Video
Pre-alarm information
Acquisition device
300
Ethernet
200
Monitoring server
Ethernet
Acquisition device
Acquisition device
Acquisition device
Acquisition device
Acquisition device
Acquisition device
100

FIG. 1

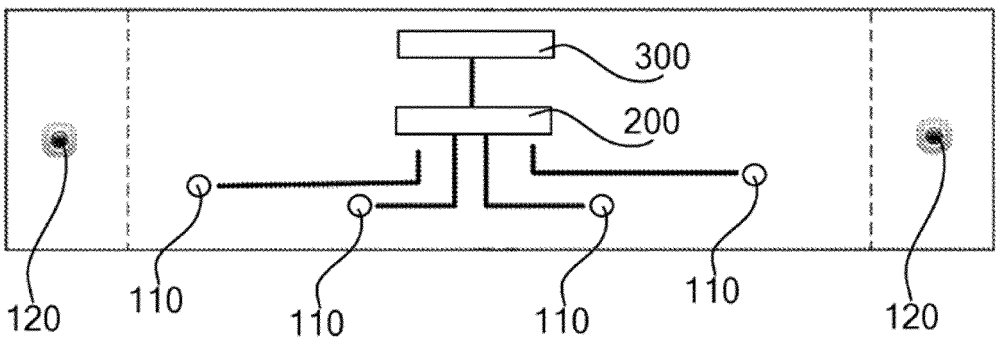
300
200
120
110
110
110
110
120

FIG. 2

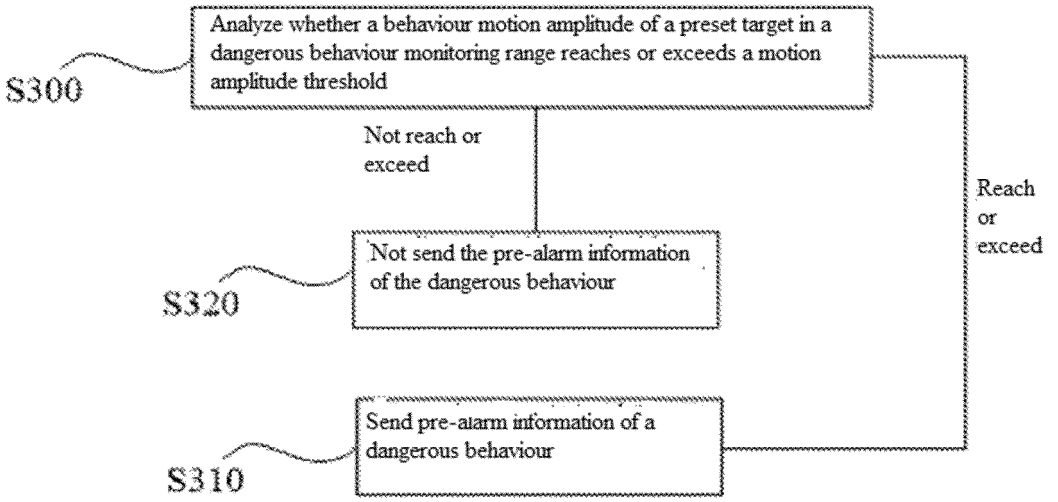
S300
Analyze whether a behaviour motion amplitude of a preset target in a dangerous behaviour monitoring range reaches or exceeds a motion amplitude threshold
Not reach or exceed
Reach or exceed
S320
Not send the pre-alarm information of the dangerous behaviour
S310
Send pre-alarm information of a dangerous behaviour

FIG. 3

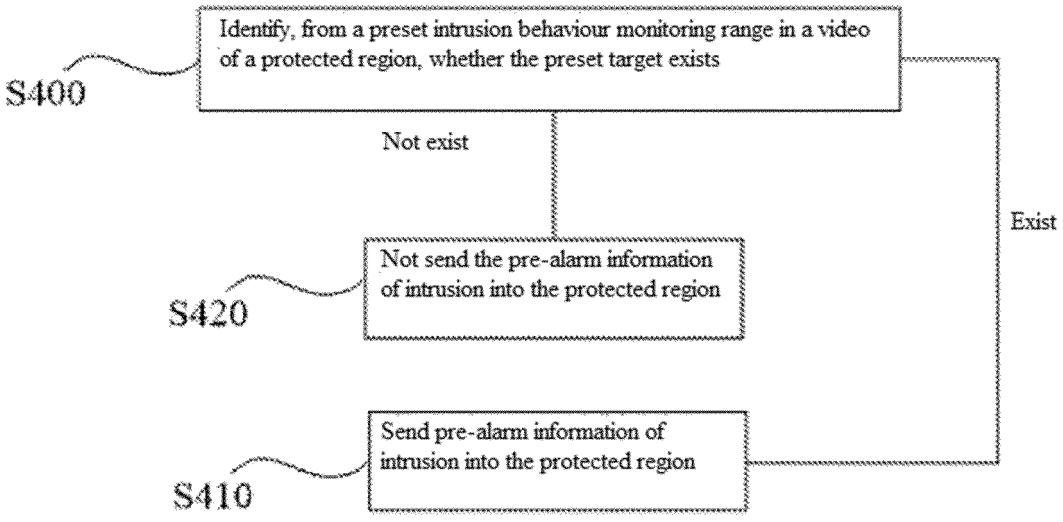
S400
Identify, from a preset intrusion behaviour monitoring range in a video of a protected region, whether the preset target exists
Not exist
Exist
S420
Not send the pre-alarm information of intrusion into the protected region
S410
Send pre-alarm information of intrusion into the protected region

FIG. 4

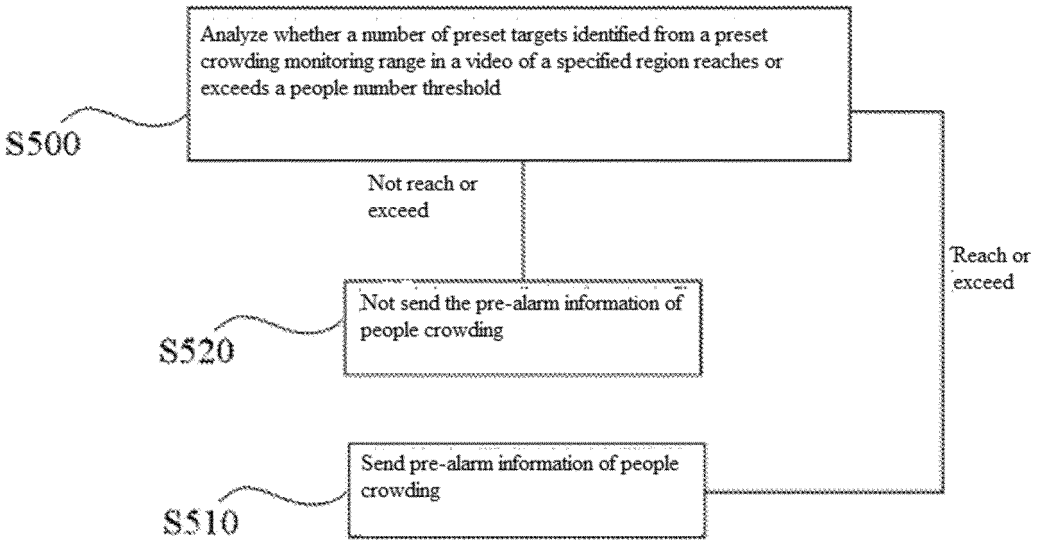
Analyze whether a number of preset targets identified from a preset crowding monitoring range in a video of a specified region reaches or exceeds a people number threshold
S500
Not reach or exceed
Reach or exceed
Not send the pre-alarm information of people crowding
S520
Send pre-alarm information of people crowding
S510

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2020/085920

A. CLASSIFICATION OF SUBJECT MATTER

B61L 23/00(2006.01)i

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)

B61L,B61K,G06K,H02N

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)

CNKI, VEN, CNABS; 列车, 监控, 预警, 报警, 视频; vehicle, monitor+, video+, alarm+;

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 1710875 A (ZETONG DIGITAL CODE CO., LTD., SHENYANG) 21 December 2005 (2005-12-21) description, pages 1-6, figures 1-3	1-22
Y	CN 109543538 A (SHENZHEN ONECONNECT TECHNOLOGY CO., LTD.) 29 March 2019 (2019-03-29) description, pages 5-14, and figures 1-10	1-22
A	EP 2945370 A1 (MITSUBISHI ELECTRIC CORP.) 18 November 2015 (2015-11-18) entire document	1-22
A	CN 110588729 A (SOUTHWEST JIAOTONG UNIVERSITY) 20 December 2019 (2019-12-20) entire document	1-22
A	CN 102385791 A (TIANJIN YINJIAN TECHNOLOGY CO., LTD.) 21 March 2012 (2012-03-21) entire document	1-22
A	CN 205847433 U (BEIJING THNET TECHNOLOGY CO., LTD.) 28 December 2016 (2016-12-28) entire document	1-22

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 July 2020	**12 November 2020**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration (ISA/CN)** **No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088** **China** Facsimile No. **(86-10)62019451**	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2020/085920

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A	CN 108900814 A (ANHUI ANWEI TECHNOLOGY CO., LTD.) 27 November 2018 (2018-11-27) entire document	1-22

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Information on patent family members

International application No.
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		JP WO2014109039 A1	19 January 2017
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CN 108900814 A	27 November 2018	None	

Form PCT/ISA/210 (patent family annex) (January 2015)