(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
7 March 2013 (07.03.2013)

WIPO | PCT

(10) International Publication Number
WO 2013/032371 A1

(51) International Patent Classification:
G08B 13/196 (2006.01) *B60R 25/10* (2013.01)

(21) International Application Number:
PCT/SE2011/000157

(22) International Filing Date:
30 August 2011 (30.08.2011)

(25) Filing Language: English

(26) Publication Language: English

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

WO 2013/032371 A1

(54) Title: VEHICLE SECURITY SYSTEM AND METHOD FOR USING THE SAME

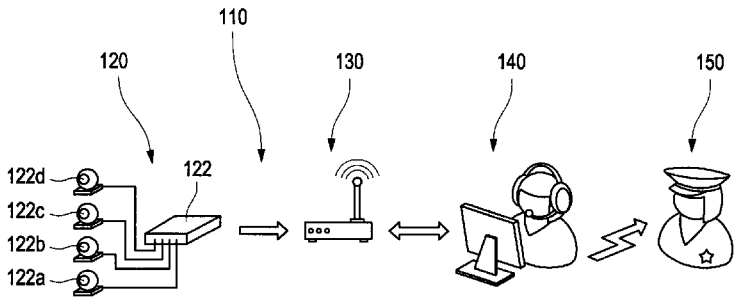

Fig. 2

(57) Abstract: The invention relates to a vehicle security system (110) and a method for operating the same, the system (110) comprising a camera system (120) attached to the vehicle (100) providing images (10a, 10b, 10c, 10d) of at least two different fields of view (v_a, v_b, v_c, v_d). A merging device (122, 124) is coupled to the camera system (120) for merging images (10a, 10b, 10c, 10d) captured by the camera system (120) into a single image (10); and a decision device (130) is coupled to the merging device (122, 124) for deciding if an alarm has to be triggered based on at least one alarm criterion.

DESCRIPTION

Vehicle Security System and Method for using the same

TECHNICAL FIELD

The invention relates to a vehicle security system, particularly for commercial vehicles, and a method for using the same.

BACKGROUND OF THE INVENTION

The value of goods being transported on road increases continuously. With over 1.7 billion tonnes per year, the "end products" category represents the main product group. It includes consumer goods like household appliances and electronics, as well as industrial end products. It is also the category with the highest value density, in average EUR 10 000 per ton, but for some products such as electronics this figure is many times greater. Furthermore, the forecasts indicate that this category will undergo the largest growth rate by 2016, meaning that the value of shipped goods will increase more than proportionally.

According to the Transported Asset Protection Association (TAPA), it is estimated that 8.2 billion Euros are lost every year across the whole Europe due to cargo theft. But if viewed in full economic loss terms, including cost of replacement goods, re-shipping, reputational damage and the resulting fear of violence, this is just a fraction of the actual damage.

US 5 027 104 A discloses a vehicle having a multitude of video cameras which are responsive to sensing persons approaching the vehicle. Video pictures captured by the cameras are transmitted to a remote location for analysis. A first remote receiver includes an alarm circuit activated by signals received from a first transmitter so as to notify the owner of the vehicle that an intrusion has been detected. A second transmitter is designed to transmit video signals to a second

remote receiver designed to receive these signals so that one may observe the intrusion from a remote location. The respective camera signals can be recorded.

SUMMARY OF THE INVENTION

It is an object of the invention to provide an improved vehicle security system which allows for a reliable confirmation of a threat for a vehicle, its driver or cargo.

Another object is to provide a method for operating a vehicle security system.

The objects are achieved by the features of the independent claims. The other claims, the drawing and the description disclose advantageous embodiments of the invention.

According to a first aspect of the invention, a vehicle security system is proposed, comprising a camera system attached to the vehicle providing images of at least two different fields of view. The system is characterized by a merging device coupled to the camera system for merging images captured by the camera system into a single image; a decision device coupled to the merging device for deciding if an alarm has to be triggered based on at least one alarm criterion.

Favourably, by combining the captured images of individual cameras of the camera system into a single video stream, the amount of data to be transferred can be minimized. Further, the merged image represents a quasi-natural representation of the surroundings of the vehicle also known as a birds eye view. The vehicle may be a land vehicle or a sea vehicle. For instance, the vehicle may be a ship or may be a commercial vehicle, e.g. a truck, which may include a trailer and/or a semitrailer. The merging device and the decision device may be the same unit.

Particularly, the camera system may include one or more video cameras, each providing a video stream to the merging device, which may be an electronic control unit. The individual video streams may be merged into a single video

stream in the merging device. The merging device may be arranged onboard the vehicle or at a remote location.

The expression "field of view" refers to areas in positive and negative x-direction (±x-direction) and positive and negative y-direction (±y-direction) with the vehicle in the centre of an x-y-plane. The fields of view may refer to the areas in front of the front of the vehicle, behind the back of the vehicles and beside the left and right sides of the vehicle, for instance, the x- and y-axes corresponding to the main longitudinal and traversal axes of the vehicle. However, the x- and y-axes can be chosen differently, e.g. in a diagonal direction with respect to the vehicle axes.

Particularly, the field of view may be understood as the visual area over which image information can be extracted by a camera at a glance without camera movements. Advantageously, one camera may be provided per field of view. However, it can be possible that one camera is switched between two or more defined positions each with a fixed field of view. Particularly, the cameras monitoring different fields of view may be mounted fixedly. It is also possible that individual cameras may be mounted tiltable so as to scan over a broader field of view when the camera is tilted.

Advantageously, one or more or all cameras of the camera system may comprise a wide angle lens, i.e. a "fisheye" lens, which takes in a broad, panoramic and hemispherical image of the respective field of view. Advantageously, the camera's field of view can be very broad.

Particularly, at least two, particularly four separate cameras can be used, one for forward field of view, one for rearward field of view, one for right-hand-side field of view and one for left-hand side field of view. By using four separate cameras, the merged image displays an image of the vehicle from a virtual angle from above the vehicle. This allows for visually confirming the vehicle's surrounding e.g. in a parking space. With this, an operator in a remote location and/or a driver can monitor the vehicle's surroundings for potentially critical situations such as an unauthorized person approaching the vehicle closer than desired.

There may be more fields of view in a vehicle. For instance in a long rigid truck, it can be useful to provide more than one camera at each side of the truck. The field of view can be broadened by using more than one camera.

According to a favourable embodiment, the decision device may include a telematics unit. The merged image or video stream can be analyzed and transmitted to a monitor. The decision unit can be arranged onboard the vehicle of at a remote location. The decision unit can decide whether or not the one or more of the images and/or the merged image show a critical situation. This can preferably be decided depending on preset criteria, for instance when an intruder is detected within a preset distance of the vehicle and/or a sensor indicates that there is a threat for the vehicle such as an unauthorized manipulation of vehicle doors or the like. If one or more preset criteria are met, the decision unit recognizes that there is most probably a threat to the vehicle and further decides that the merged image shall be transmitted to a remote location and/or to a monitor in the driver's cabin.

The camera system allows visualizing the scene around the vehicle remotely and a person can assess the situation and take the fight actions in a short time. A person analysing the merged image may request a transmission of images or video streams of individual cameras of the camera system to gather more information about the possible threat to the vehicle.

According to a favourable embodiment, the at least one alarm criterion may be monitored in the merged image and/or by one or more sensors coupled to the vehicle. Particularly, the merging device may include computing means such as a processor and a memory, particularly a read and write memory, containing the predefined alarm criteria. Expediently, the merging device may be configured to analyse the image content of the merged image or video stream and/or of the individual images and/or video streams

The at least one alarm criterion may be one or more of the following: a person approaching the vehicle and entering a critical range around the vehicle; a noise

detection; a sensor signal indicating that one or more doors or hoods of the vehicle are opened, and the like.

According to a favourable embodiment, the decision device may be arranged onboard the vehicle. This allows to transmit a merged image only when a possible critical situation is detected.

According to a favourable embodiment, the camera system may be configured to have two or more camera subsystems, e.g. a main camera system and at least one further camera subsystem. This allows to have a main camera system e.g. on a truck as a towing vehicle and at least a camera subsystem on a trailer as a towed vehicle. Particularly, the camera subsystem at the trailer may comprise at least two, particularly at least three, or more cameras. Advantageously, the truck can be equipped with a multitude of different trailers for cargo transport which may or may be not equipped with a camera subsystem. The camera subsystem can communicate with the main camera system arranged at the towing vehicle. For instance, the camera subsystem may include three cameras which may be coupled in the camera system. For instance, on a boat with a masthead-mounted camera system, two cameras may be expedient.

According to a favourable embodiment, one camera subsystem may be arranged on a towed vehicle and one camera system may be arranged on a towing vehicle.

According to a favourable embodiment, one or marker may be provided for merging the images. The markers may be used for merging of, for instance, truck and trailer images. When there is no trailer attached to the towing vehicle, markers are not necessary. The cameras arranged at the truck are fixed so it is possible to have a fixed way of merging the images originating from the cameras, e.g. through fixed merging points. The cameras arranged at the trailer are also fixed, but the angle or orientation between the truck and trailer changes over time, which means that to merge the images from the trailer with the ones from the truck, it is necessary to dynamically identify merging points.

The one or more markers can be arranged at the vehicle or can be dynamically identified in the surrounding of the vehicle. In case of a truck with an articulated trailer, images (or video streams) from the truck and the trailer have to be combined dynamically to form one single video stream. The images from e.g. the truck and the trailer may or may not be combined. It is expedient to have the images combined because one single video stream can then be transmitted to the monitor at the remote location. The images may be combined dynamically because the truck and the trailer can have different angles with respect to each other. One possibility for dynamic merging is to use a camera at the rear of the truck and markings on the front of the trailer or vice versa. By measuring the markings dynamically it is possible to have the right parameters for merging the images from other fields of view, e.g. from side cameras. Another possibility is the use of "stitching" the images together in the same way as satellite photos are merged together, by using matching points from cameras of specific fields of view, e.g. from the side cameras,

According to a favourable embodiment, the camera system may comprise at least one infrared camera and/or at least one optical camera. This allows for an improved surveillance of the vehicle's ambience, e.g. when the vehicle is parked. This will often happen during night where the visual conditions are poor. Night vision cameras can be employed to improve the image quality. All cameras can be infrared or all cameras can be optical cameras, or a mixture of infrared and optical cameras can be provided. There are two options for night view: night vision cameras, which can be infrared cameras, or optical cameras with image improvement by software. Additionally or alternatively, image processing can be employed to enhance contrast and highlight details of the captured images.

According to another aspect of the invention, a method for operating a vehicle security system, comprising a camera system attached to the vehicle providing images of at least two different fields of view. The method is characterized by the steps or merging the images captured by the camera system into a single image; deciding if an alarm has to be triggered based on at least one alarm criterion; and deciding based at least on the merged image if a security risk is present or not.

According to a favourable embodiment, the images of at least two different cameras and/or camera subsystems, e.g. a main camera system and one or more further camera subsystems, and/or fields of view, may be merged dynamically. The dynamic merging can eliminate errors caused by varying orientations of the towed vehicle with respect to the towing vehicle.

According to a favourable embodiment, one or marker may be defined at the vehicle and/or in images of at least two cameras and/or camera subsystems and/or fields of view for merging the images. Favourably, merging of the images or video streams is facilitated.

Favourably, the merged image may be generated onboard the vehicle. The number of data to be transmitted from the vehicle to a remote location can be reduced.

According to a favourable embodiment, the merged image or video stream may be transmitted to a remote location. Advantageously, the merged image or video stream needs only be transmitted if a critical situation for the vehicle such as an unauthorized approach is detected. The surveillance of the vehicle can be performed without a driver present in the vehicle.

According to a favourable embodiment, a camera subsystem may be coupled to a camera main system of the camera system and the camera subsystem may generate a merged image which is transmitted to a decision device and transmitted to a remote location.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention together with the above-mentioned and other objects and advantages may best be understood from the following detailed description of the embodiment(s), but not restricted to the embodiments, wherein is shown schematically:

Fig. 1a, 1b an example embodiment of images captured by a camera system according to the invention (Fig. 1a), and a merged image generated from the images captured by the camera system (Fig. 1b);

Fig. 2 an example embodiment of a vehicle security system according to the invention;

Fig. 3 a truck comprising a camera system according to an embodiment of the invention; and

Fig. 4a, 4b an image of an ambient view from a vehicle including a camera system according to the invention (Fig. 4a) and an improved image.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

In the drawings, equal or similar elements are referred to by equal reference numerals. The drawings are merely schematic representations, not intended to portray specific parameters of the invention. Moreover, the drawings are intended to depict only typical embodiments of the invention and therefore should not be considered as limiting the scope of the invention.

Figures 1a and 1b depict an example embodiment of images 10a, 10b, 10c, 10d captured by a camera system 120 of a vehicle security system 110 of a vehicle 100, particularly a truck, according to the invention in Figure 1a, and a merged image 10 generated from the images captured by the camera system 120 in Figure 1b.

Each image 10a, 10b, 10c, 10d corresponds to a different field of view v_a, v_b, v_c, v_d, taken by a camera with a wide angle optics. Image 10a corresponds to a field of view v_a on the right side of the vehicle 100, image 10b corresponds to a field of view v_b on the left side of the vehicle 100, image 10c corresponds to a field of view v_c at the rear of the vehicle 100, and image 10d corresponds to a

field of view v_d at the front of the vehicle 100. The vehicle 100 can be considered to be in the centre of an x-y-plane with the x-axis corresponding to the longitudinal vehicle axis and the y-axis corresponding to the transverse vehicle axis perpendicular to the longitudinal vehicle axis.

The merged image 10 in Figure 1b represents a virtual view of the surroundings of the vehicle 100 from a virtual angle from above the vehicle 100.

Figure 2 shows an example embodiment of a vehicle security system 110 according to the invention. The security system 110 comprises a camera system 120 attached to the vehicle (100 in Figures 1a and 1b) comprising a multitude of cameras 122a, 122b, 122c, 122d, for instance four, each of which provides an image of a corresponding field of view. The cameras 122a, 122b, 122c, 122d are coupled to a merging device 122, e.g. an electronic control unit for merging captured by the camera system 120 into a single image (10 in Figure 1b). The cameras 122a, 122b, 122c, 122d are preferably video cameras, the individual video stream of which is merged by the merging unit 122 to a single video stream representing a single image or video. The merging unit 122 is coupled to a decision unit 130 which reads the merged video stream from the camera system 120 and may transmit it to a remote location 140 such as a back office system. The camera system 120 provides an around-view of the surrounding of the vehicle.

The decision unit 130 includes a telematics portion and is responsible for processing an alarm, either by detecting a critical situation from the video stream of the camera system 120 or from one or more additional sensors, such as presence sensors. An alarm may, by way of example, be detected by a motion detection provided by the camera system 120.

When an alarm is triggered, for instance when a motion is detected in the merged image generated from the individual images or video streams captured in the camera system 120, the telematics unit of the decision unit 130 sends the alarm to the remote location 140, where an operator can request a wireless video transmission of the merged around-view images. In case the operator identifies a

risk, a video transmission from individual cameras can also be requested. In case a thread is confirmed, the operator can take an action such as calling the police 150. In addition, the video can be recorded in the decision unit 130 or in the camera system 120, e.g. in the merging unit 122, or in the remote location 140, for post-analysis.

Additionally, the vehicle may be equipped with an alarm device such as a buzzer or sound alarm that warns an intruder that the intruder has been discovered. In this case, when the risk is confirmed, the operator may remotely activate a sound alarm or may display a pre-recorded voice that tells the persons near the vehicle to step away or that the police are on its way.

Figure 3 shows a truck (vehicle 100) comprising a camera system 120 according to an embodiment of the invention. The truck has a towing vehicle 102 and a trailer as towed vehicle 104. The camera system 120 is partitioned in camera subsystems 120a, 120b, e.g. a main camera system 120a arranged at the towing vehicle 102 and a further camera subsystem 120b arranged at the towed vehicle 104.

The main camera system 120a on the towing vehicle 102 comprises e.g. four cameras 122a, 122b, 122c, 122d coupled to a merging unit 122 and monitoring the sides and the rear and front of the vehicle 100. The merging unit 122 is coupled to a decision unit 130 including a telematics device. The camera subsystem 120b on the towed vehicle 104 comprises e.g. three cameras 124a, 124b and 124c, monitoring the sides and the rear of the towed vehicle 104. The connection between the main and subsystem 120a, 120b on the towing and towed vehicles 102, 104 may be a wireless link to easily connect different trailers to a truck. Expediently, the camera subsystem 120b may be connected to a merging unit 122 on the towed vehicle 104 for pre-processing the images or video streams so as to transmit only the merged video streams or images to the merging unit 122 of the towing vehicle 102.

The image merging and alignment of the cameras 122a, 122b, 122c, 122d and 124a, 124b, 124c in one embodiment is dynamic, i.e. because the towing vehicle

102 (truck) and the towed vehicle (trailer) will have different angles, because they move with respect to each other as when cornering, for instance, the images have to be merged dynamically and cannot have a fixed way of merging. Even if the system 120 is supposed to be used primarily when the vehicle 100 is parked, it could be that the truck (towing vehicle 102) and trailer (towed vehicle 104) are not completely aligned when in a tight parking place

The images or video streams from an articulated trailer 104 together with the ones from the towing vehicle 102 are expediently combined dynamically to form one single video stream which can be transmitted to the remote location 140 (Figure 2). One possibility for the dynamic merging is to use the camera 122b in the rear of the towing vehicle 102 and markings in the towed vehicle. By measuring the markings dynamically it is possible to have the right parameters to merge the individual images or video streams from the side cameras 122a, 124a and 122b, 124b.

The transmission of the merged video stream (or merged images) starts when an unauthorized person is approaching the vehicle 100. For detecting an approaching person or object, motion detection can be used wherein the video output from the camera system 120 can be used and processed to detect objects that are moving. Alternatively or additionally, one or more sensors (not shown) can be used to detect a person around the vehicle 100, e.g. a radar sensor or the like. Expediently, such one or more sensors are integrated into the security system 110 in order to trigger an alarm indicating a potential critical situation.

The invention can improve surveillance when the vehicle 100 is parked which often happens during the night. Figure 4 illustrates images 20a, 20b of an ambient view from a vehicle 100 including a camera system 120 according to the invention. The picture 20a on the left side shows a view with low or no light in the darkness of a parking spot. The right picture 20b shows the image of 20a with enhanced contrast which is the result of image processing. Additionally or alternatively, the vehicle security system 110 can include one or more night vision cameras.

To summarize, the invention allows for a reliable assessment of the situation around the vehicle remotely and to take the right action in a short time. It is possible to have an overview of the complete surroundings of the vehicle in one single video stream or image as well as to provide detailed views from individual cameras. It may be possible to identify the intruders by using the images captured by the camera system. The final, merged image may cover a few metres, e.g. 2-5 metres, preferably about 3 metres around the vehicle, but individual cameras of the camera system may cover more than the merged image, for instance more than 5 metres.

CLAIMS

1. A vehicle security system (110), comprising a camera system (120) attached to the vehicle (100) providing images (10a, 10b, 10c, 10d) of at least two different fields of view (v_a, v_b, v_c, v_d),
characterized by
- a merging device (122, 124) coupled to the camera system (120) for merging images (10a, 10b, 10c, 10d) captured by the camera system (120) into a single image (10);
- a decision device (130) coupled to the merging device (122, 124) for deciding if an alarm has to be triggered based on at least one alarm criterion.

2. The system according to claim 1, characterized in that the camera system (120) includes at least one fish-eye lens.

3. The system according to claim 1 or 2, characterized in that the decision device (130) includes a telematics unit.

4. The system according to anyone of the preceding claims, characterized in that the at least one alarm criterion is monitored in the merged image and/or by one or more sensors coupled to the vehicle (100).

5. The system according to anyone of the preceding claims, characterized in that the decision device (130) is arranged onboard the vehicle (100).

6. The system according to anyone of the preceding claims, characterized in that the camera system (120) is configured to have two or more camera subsystems (120a, 120b).

7. The system according to claim 6, characterized in that one camera subsystem (120b) is arranged on a towed vehicle (104) and one camera system (120a) is arranged on a towing vehicle (102).

8. The system according to anyone of the preceding claims, characterized in that one or more markers are provided for merging the images (10a, 10b, 10c, 10d).

9. The system according to anyone of the preceding claims, characterized in that the camera system (120) comprises at least one infrared camera and/or at least one optical camera.

10. A method for operating a vehicle security system (110), comprising a camera system (120) attached to the vehicle (100) providing images (10a, 10b, 10c, 10d) of at least two different fields of view (v_a, v_b, v_c, v_d), characterized by

- merging the images (10a, 10b, 10c, 10d) captured by the camera system (120) into a single image (10);
- deciding if an alarm has to be triggered based on at least one alarm criterion; and
- deciding based at least on the merged image (10) if a security risk is present or not.

11. The method according to claim 10, characterized in that the images (10a, 10b, 10c, 10d) of at least two different cameras and/or camera subsystems (120a, 102b) and/or fields of view (v_a, v_b, v_c, v_d) are merged dynamically.

12. The method according to claim 10 or 11, characterized in that one or marker are defined at the vehicle (100) and/or in images (10a, 10b, 10c, 10d) of at least two least two different cameras and/or camera subsystems (120a, 102b) and/or fields of view (v_a, v_b, v_c, v_d) for merging the images (10a, 10b, 10c, 10d).

13. The method according to anyone of the claims 10 to 12, characterized in that that the merged image (10) is generated onboard the vehicle (100).

14. The method according to anyone of the claims 10 to 13, characterized in that the merged image (10) is transmitted to a remote location (140).

15. The method according to anyone of the claims 10 to 14, characterized in that a camera subsystem (120a) is coupled to a camera main system (120a) of the camera system (120) and that the camera subsystem (120b) generates a merged image which is transmitted to a decision device (130) and transmitted to a remote location (140).

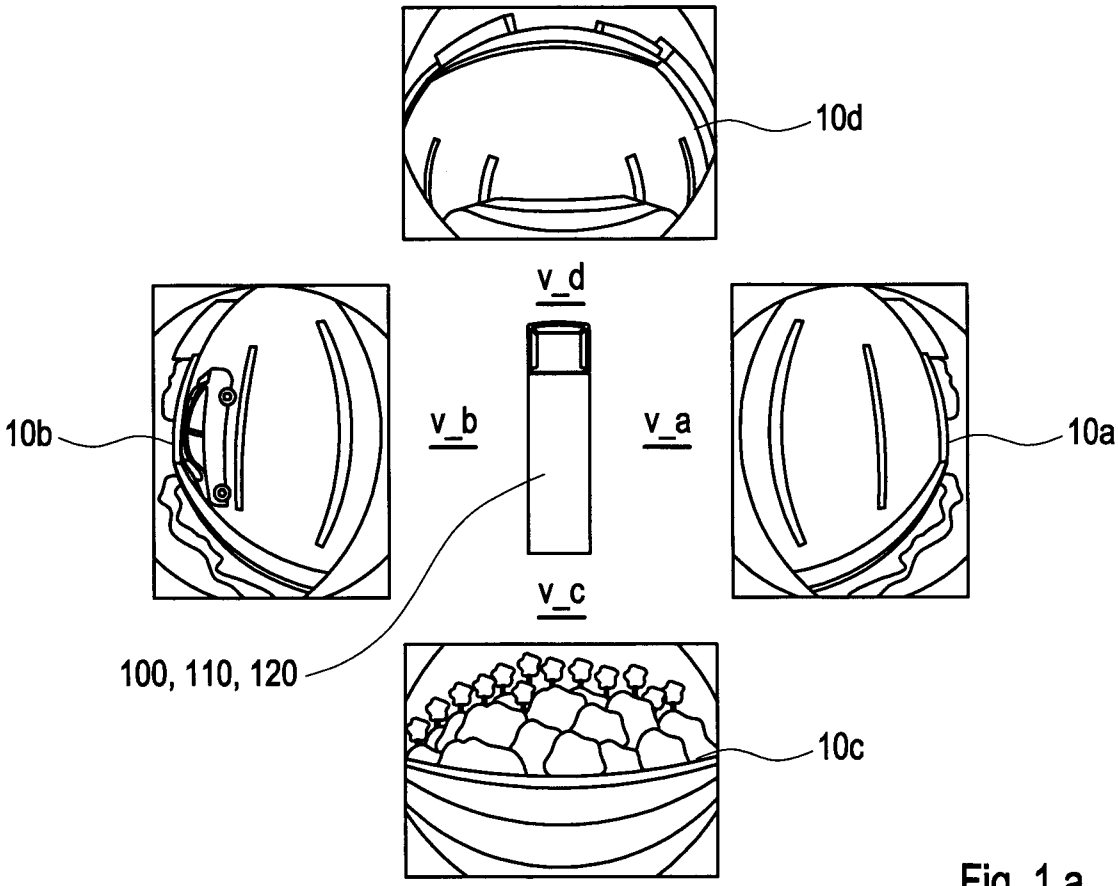

Fig. 1 a

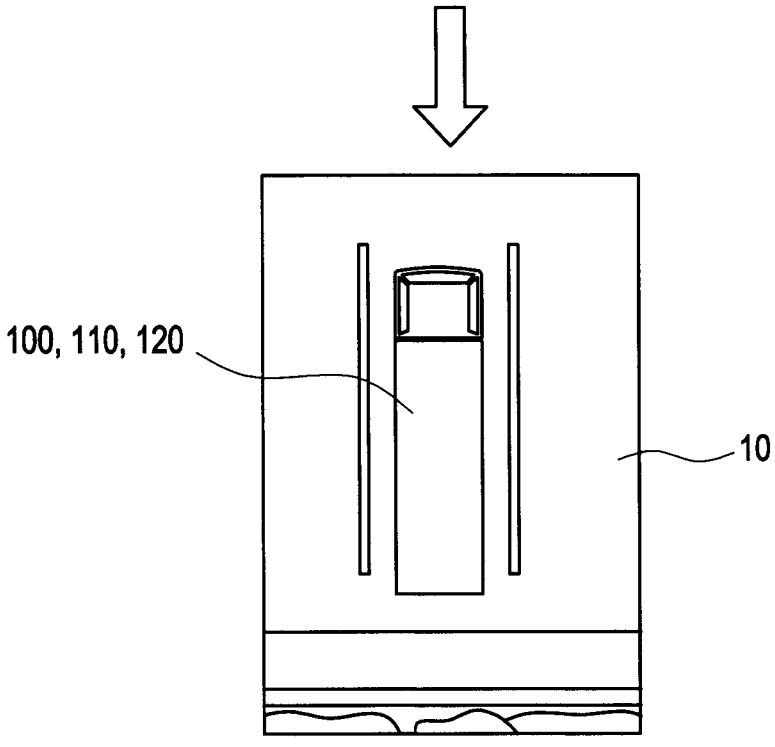

Fig. 1 b

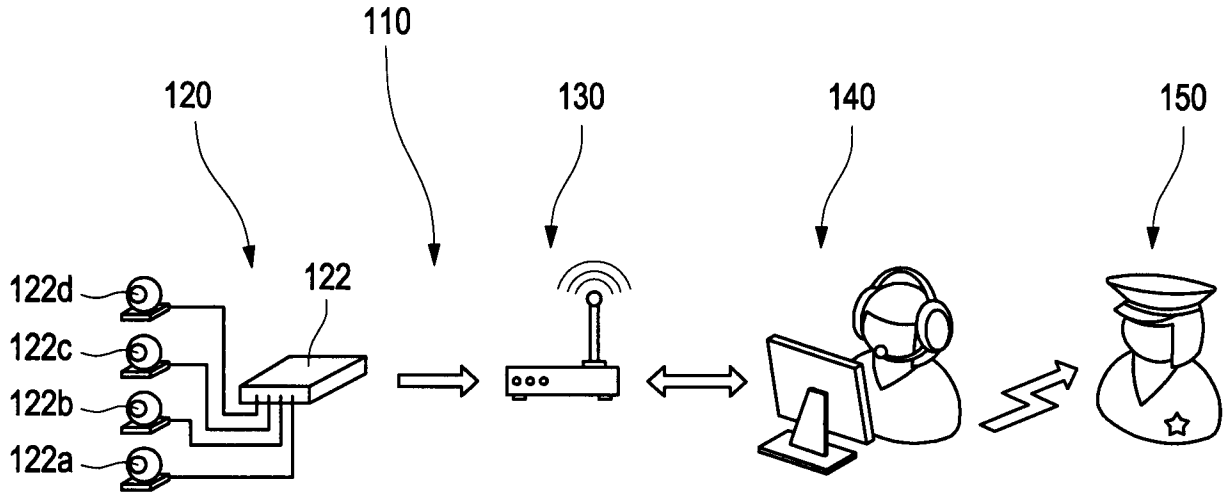
110
120
130
140
150
122d
122c
122b
122a
122

Fig. 2

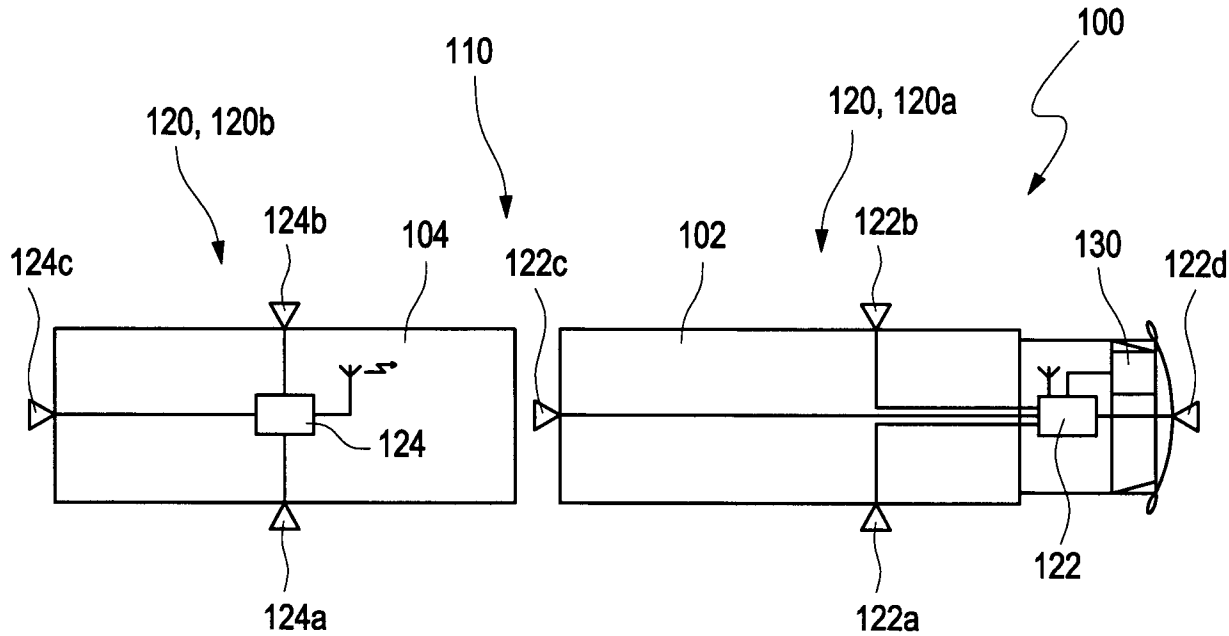
100
110
120, 120b
120, 120a
124b
104
102
122b
130
122d
124c
122c
124
122
124a
122a

Fig. 3

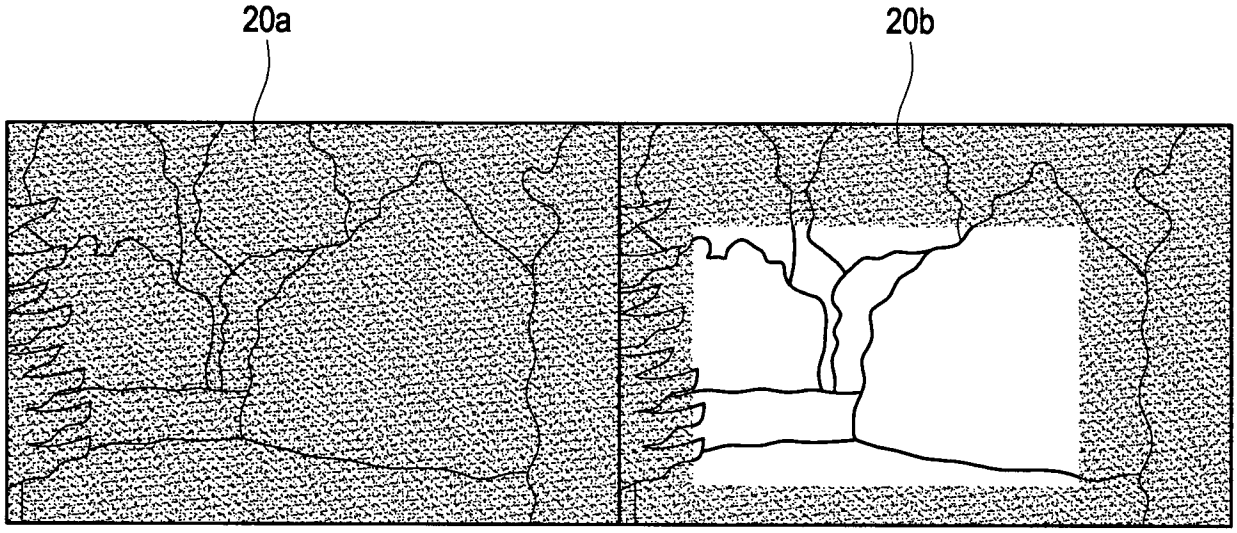

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2011/000157

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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)

IPC: B60R, G08B

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

SE, DK, FI, NO classes as above

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

EPO-Internal, PAJ, WPI data, COMPENDEX, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2007042798 A2 (AUTOCOMPAC LTD ET AL), 19 April 2007 (2007-04-19); abstract; paragraphs [0010], [0016], [0022], [0044]; figure 3 --	1-15
Y	US 5027104 A1 (REID DONALD J), 25 June 1991 (1991-06-25); abstract; column 1, line 34 - line 39; column 2, line 56 - line 61; column 2, line 17 - line 20 --	1-15
Y	US 20090097708 A1 (MIZUTA MASAKI), 16 April 2009 (2009-04-16); abstract; paragraphs [0003], [0007], [0018], [0037]; figure 5 --	1-15

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

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

"E" earlier application or patent but published on or after the international filing date

"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)

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Date of the actual completion of the international search	Date of mailing of the international search report
07-05-2012	08-05-2012

Name and mailing address of the ISA/SE	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No.
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Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2011155651 A (TOSHIBA CORP), 11 August 2011 (2011-08-11); abstract; paragraphs [0001], [0007], [0016]; figure 12; See translation of the document.	1-15
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International Patent Classification (IPC)

G08B 13/196 (2006.01)
B60R 25/10 (2006.01)

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