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(54) Title: MIRROR ASSEMBLY FOR A VEHICLE HAVING A CAMERA SYSTEM

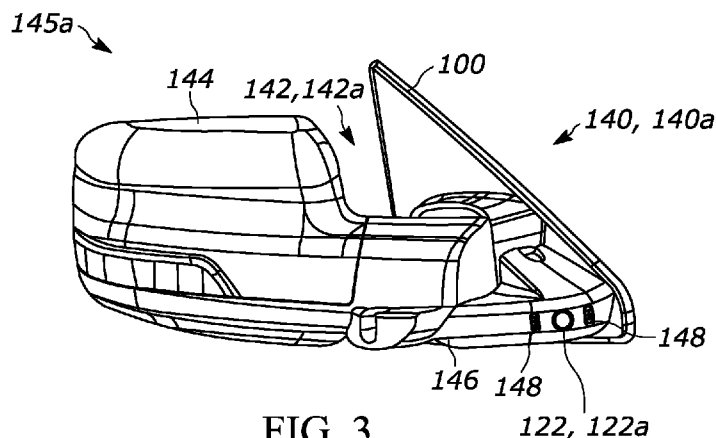


FIG. 3

(57) Abstract: A mirror assembly (140, 140a) for a vehicle having a camera system comprises a mirror housing (144), a mirror mounting mechanism (146) for securing the mirror housing (144) to the vehicle, wherein the mirror housing (144) is moveable between a first position (145a) and a second position (145b) relative to the mirror mounting mechanism (146), a camera (122, 122a) rotatably mounted to the mirror mounting mechanism (146), and at least one camera adjustment mechanism (148) to rotate the camera relative to the mirror mounting mechanism (146). A method of calibrating a camera field of view apart of a mirror assembly for a vehicle having a camera system is also disclosed.

Declarations under Rule 4.17:

- *as to the identity of the inventor (Rule 4.17(i))*
- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

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MIRROR ASSEMBLY FOR A VEHICLE HAVING A CAMERA SYSTEM

FIELD OF THE INVENTION

[0001] The invention relates generally to a mirror assembly for an automotive vehicle.

BACKGROUND OF THE INVENTION

[0002] Side-view mirrors, which grant a driver of a motor vehicle a view toward the exterior sides of the vehicle, are ubiquitous in motor vehicles. In the future, it is intended for the customary side-view mirrors to be substituted by or supplemented with camera monitor systems. In this way, a view toward the sides and vehicle surroundings is granted in that images recorded by cameras are displayed on monitors to a driver of a motor vehicle.

[0003] Side-view mirrors are arranged on a housing typically mounted to the vehicle at or near the A-pillars. The mirror housings are commonly moveable between extended and folded positions. The folded positions can be used to protect the mirrors in various situations, such as car washes. The folded positions can also be used to reduce the exterior width of the vehicle, e.g. for parking in tight spaces.

[0004] For an arrangement of cameras of camera-based mirror substitute/supplemental systems on vehicles, in particular as a substitute/supplement for exterior mirrors or side mirrors, cameras may be mounted to the side of the vehicle on the mirror housing itself. However, the field of view of the camera will change whenever the mirror housing is folded.

[0005] The background description provided herein is for the purpose of generally presenting the context of the disclosure. Work of the presently named inventors, to the extent it is described in this background section, as well as aspects of the description that may not otherwise qualify as prior art at the time of filing, are neither expressly nor impliedly admitted as prior art against the present disclosure.

SUMMARY OF THE INVENTION

[0006] According to one aspect of the invention, a mirror assembly for a vehicle having a camera system comprises a mirror housing, a mirror mounting mechanism for securing the mirror housing to the vehicle, wherein the mirror housing is moveable between a first position and a second position relative to the mirror mounting mechanism, a camera rotatably mounted to the mirror mounting mechanism, and at least one camera adjustment mechanism to rotate the camera relative to the mirror mounting mechanism.

[0007] According to one aspect of the invention, a method of calibrating a camera field of view apart of a mirror assembly for a vehicle having a camera system comprises showing an image of a field of view of a camera on a display, rotating the camera field of view with at least one camera adjustment mechanism to rotate an orientation of the field of view, and adjusting an orientation of the image on the display with a camera calibration system.

[0008] Other aspects and advantages will become apparent upon consideration of the following detailed description and the attached drawings wherein like numerals designate like structures throughout the specification.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

[0010] Figure 1 is a schematic view of an exemplary embodiment of a mirror assembly for a vehicle having a camera system;

[0011] Figure 2 is a schematic view of an exemplary system architecture of a mirror assembly for vehicle having a camera system of the present invention;

[0012] Figure 3 is a schematic of a mirror assembly for a vehicle having a camera system with an exterior camera and a mirror in a first position for the camera system;

[0013] Figure 4 is a schematic of a mirror assembly for a vehicle having a camera system with an exterior camera and a mirror in a second position for the camera system;

[0014] Figure 5 is a schematic of a mirror assembly for a vehicle having a camera system with the exterior camera and a mirror in the second position illustrating adjustment of the camera; and

[0015] Figure 6 is a first embodiment of a method for calibrating the camera of the camera system.

[0016] Like reference symbols in the various drawings indicate like elements.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] The following description of the preferred embodiment(s) is merely exemplary in nature and is in no way intended to limit the invention, its application, or uses.

[0018] Referring to FIGS. 1-2, a vehicle 100 has camera system 110. The camera system 110 is configured with a sensor system 120, which includes camera(s) 122, 122a-122d and a radar/lidar system 124. In particular, at least side facing cameras 122a, 122b are able to view the environment proximate to the vehicle 100.

[0019] The camera(s) 122, 122a-122d may be single lens, dual lens, fish eye, etc. Further, images from multiple cameras 122a-122d may be stitched together and analyzed to detect objects and the environment that are in view of multiple cameras at once or are moving from view of one camera to another.

[0020] In one embodiment, the camera system 110 is also configured with a body control system 130. The body control system 130 includes at least one electro-mechanical actuator, such as mirror actuator(s) 142, 142a-142b associated with the side mirror assemblies 140, 140a-140b of the vehicle 100. The camera system 110 also includes a controller 150 configured with both the sensor system 120 and the body control system 130. In one alternate embodiment the controller 150 may be a body control module 132 that is part of the body control system 130. In another alternate embodiment the camera calibration system 200 may be part of the body control system 130 and the corresponding body control

module 132. Further, in another embodiment the mirror actuator(s) 142, 142a-142b may be mechanical device(s) that are actuated by a human.

[0021] The sensor system 120, in particular the camera(s) 122, 122a-122d sense the environment around the vehicle 100. An image analysis system 300 includes an image orientation detection algorithm 310 which performs image analysis of the images recorded by the camera(s) 122, 122a-122d to detect if the image recorded by the camera is at a correct vertical orientation relative to the ground. In one embodiment, the image orientation detection algorithm 310 may also detect if the correct horizontal orientation relative to the vehicle body is present. The image orientation detection algorithm 310 may further provide an image adjustment recommendation 210 to the camera calibration system 200.

[0022] However, the image adjustment is limited in how much compensation of the image orientation may be provided digitally. In some instances the image adjustment recommendation 210 may also be manually compensated as explained with reference to FIGS. 3-5.

[0023] The image analysis system 300 may also include an image object analysis algorithm 320 for detecting objects in the image, for example. An image stitching algorithm 330 may also be included in the image analysis system 300 to stitch images from multiple cameras 122, 122a-d together for viewing on the display 136 by a vehicle operator. The display 136 may be a component of a user human machine interface 131.

[0024] FIGS. 3-5 illustrate a mirror assembly 140, 140a. Mirror assembly 140b operates in the same manner as shown and described here but is

mounted to a different location on the vehicle 100. The mirror assembly 140, 140a has a mirror actuator 142a which can actuate a mirror housing 144 between a first position 145a and second position 145b. The mirror housing 144 is rotatably mounted to the vehicle with a mirror mounting element 146. The camera 122, 122a is mounted to the mirror mounting element 146 such that it does not rotate when the mirror housing 144 is rotated. FIG. 3 illustrates the mirror housing 144 in the first, folded, position 145a. FIG. 4 illustrates the mirror housing 144 in the second, extended, position 145b. Camera adjustment mechanisms 148 allow adjustment of the camera orientation to ensure proper vertical and horizontal orientation of the camera.

[0025] The camera 122, 122a is secured to the mirror mounting element 146 such that the camera field of view does not rotate/move whether the mirror housing 144 is in the first position 145a or the second position 145b.

[0026] In the embodiment shown the camera adjustment mechanisms 148 comprise arched slots 147a, 147b defined by the mirror mounting element 146 and fasteners 149a, 149b which extend through the slot and are secured to a camera mounting element 126 mainly located within the mirror mounting element 146. The camera 122, 122a is fixably secured to the camera mounting element 126. However, the camera mounting element 126 is rotatable relative to the mirror mounting element 146 allowing adjustment as illustrate by the arrows shown in FIG. 5.

[0027] Alternatively, the camera mounting element 126 may be fixably secured to the mirror mounting element 146 and the camera 122, 122a may

be rotated within the camera mounting element 126 via adjustment mechanisms 148.

[0028] In a further embodiment, an image recorded by the camera(s) 122, 122a-122b may be shown on a display 136 to facilitate adjustment of the camera field of view. The display 136 may also be part of an external device configured with the camera(s) 122, 122a-122b such that the image can be seen by a person external to the vehicle 100. Therefore, the camera field of view can be seen as the adjustment mechanism is rotating the camera(s) 122, 122a-122b. If required, further image adjustment may be carried out by the camera calibration system 200 via the image adjustment algorithm 210 during vehicle operation.

[0029] A further embodiment of a mirror assembly 140 proposed here comprises more than one camera or device secured to each mirror assembly 140, 140a-140b. Firstly, this results in for each single field of view, additional information, for example depth information, about the image content may be obtained. Secondly, it is possible in this case to combine cameras with different image-capturing properties; for example a camera with telephoto properties and a camera with wide-angle properties.

[0030] In a further embodiment of the mirror assembly 140 proposed here, the at least two cameras cover at least two different fields of view. Firstly, this has the result that different viewing angles can be covered with cameras from a single mirror assembly 140. Secondly, it is possible in this case to combine cameras with different image-capturing properties; for example a camera with telephoto properties for a narrow image area, which reaches into the distance,

possibly to the horizon, and a camera with wide-angle properties for a wide image area.

[0031] A further embodiment of mirror assembly 140 proposed here additionally comprises at least one sensor. The at least one sensor used can for example to make additional functionality of the mirror assembly 140 possible, for example by virtue of a distance sensor. For example, at least one ultrasonic sensor may be arranged in the mirror assembly 140, 140a and the mirror housing 144 may be moved to the first position 145a by the control unit 132 if an obstacle which may collide with the mirror housing 144 is detected.

[0032] In a further embodiment, the second camera/device comprises the additional devices, such as radio antenna, position light, heating elements, etc.

[0033] Referring to FIG. 6, a field of view of a camera of a mirror assembly for a vehicle may be calibrated using an image from the camera. Flow chart 600 displays the steps undertaken by the calibration process. At step 610, an image of a field of view of a camera is shown on a display. Next at step 620, the camera field of view is rotated with at least one camera adjustment mechanism to rotate an orientation of the field of view. At step 630, an orientation of the image on the display is adjusted with a camera calibration system.

[0034] While this specification contains many specifics, these should not be construed as limitations on the scope of the disclosure or of what may be claimed, but rather as descriptions of features specific to particular implementations of the disclosure. Certain features that are described in this

specification in the context of separate implementations can also be implemented in combination in a single implementation. Conversely, various features that are described in the context of a single implementation can also be implemented in multiple implementations separately or in any suitable sub-combination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claimed combination may be directed to a sub-combination or variation of a sub-combination.

[0035] Similarly, while operations are depicted in the drawings in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. In certain circumstances, multi-tasking and parallel processing may be advantageous. Moreover, the separation of various system components in the embodiments described above should not be understood as requiring such separation in all embodiments, and it should be understood that the described program components and systems can generally be integrated together in a single software product or packaged into multiple software products.

[0036] A number of implementations have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the disclosure. Accordingly, other implementations are within the scope of the following claims. For example, the

actions recited in the claims can be performed in a different order and still achieve desirable results.

CLAIMS

What is claimed is:

1. A mirror assembly for a vehicle having a camera system, comprising:
a mirror housing;
a mirror mounting mechanism for securing the mirror housing to the vehicle,
wherein the mirror housing is movable between a first position and a second position relative to the mirror mounting mechanism;
a camera rotatably mounted to the mirror mounting mechanism; and
at least one camera adjustment mechanism to rotate the camera relative to the mirror mounting mechanism.
2. The mirror assembly of claim 1, wherein an orientation of a field of view of the camera is rotated when the camera is rotated.
3. The mirror assembly of claim 1, wherein the vertical orientation of the field of view is rotated.
4. The mirror assembly of claim 1, wherein the camera is rotated via the at least one camera adjustment mechanism after the mirror mounting mechanism is secure to the vehicle.

5. The mirror assembly of claim 1, wherein the camera is a single lens camera.
6. The mirror assembly of claim 1, wherein the camera is a dual lens camera.
7. The mirror assembly of claim 1, wherein the camera is a fish eye camera.
8. The mirror assembly of claim 1, wherein the assembly further comprises a second camera.
9. The mirror assembly of claim 8, wherein images from the cameras are stitched together and analyzed to detect objects and an environment.
10. The mirror assembly of claim 1, wherein the mirror assembly further comprises a body control system.
11. The mirror assembly of claim 10, wherein the body control system further comprises at least one electro-mechanical actuator.
12. The mirror assembly of claim 1, wherein the camera adjustment mechanism further comprises arched slots.

13. The mirror assembly of claim 1, wherein the mirror assembly further comprises a display.

14. The mirror assembly of claim 1, wherein the mirror assembly further comprises at least one sensor.

15. A method of calibrating a camera field of view apart of a mirror assembly for a vehicle having a camera system, comprising:

showing an image of a field of view of a camera on a display;

rotating the camera field of view with at least one camera adjustment mechanism to rotate an orientation of the field of view; and

adjusting an orientation of the image on the display with a camera calibration system.

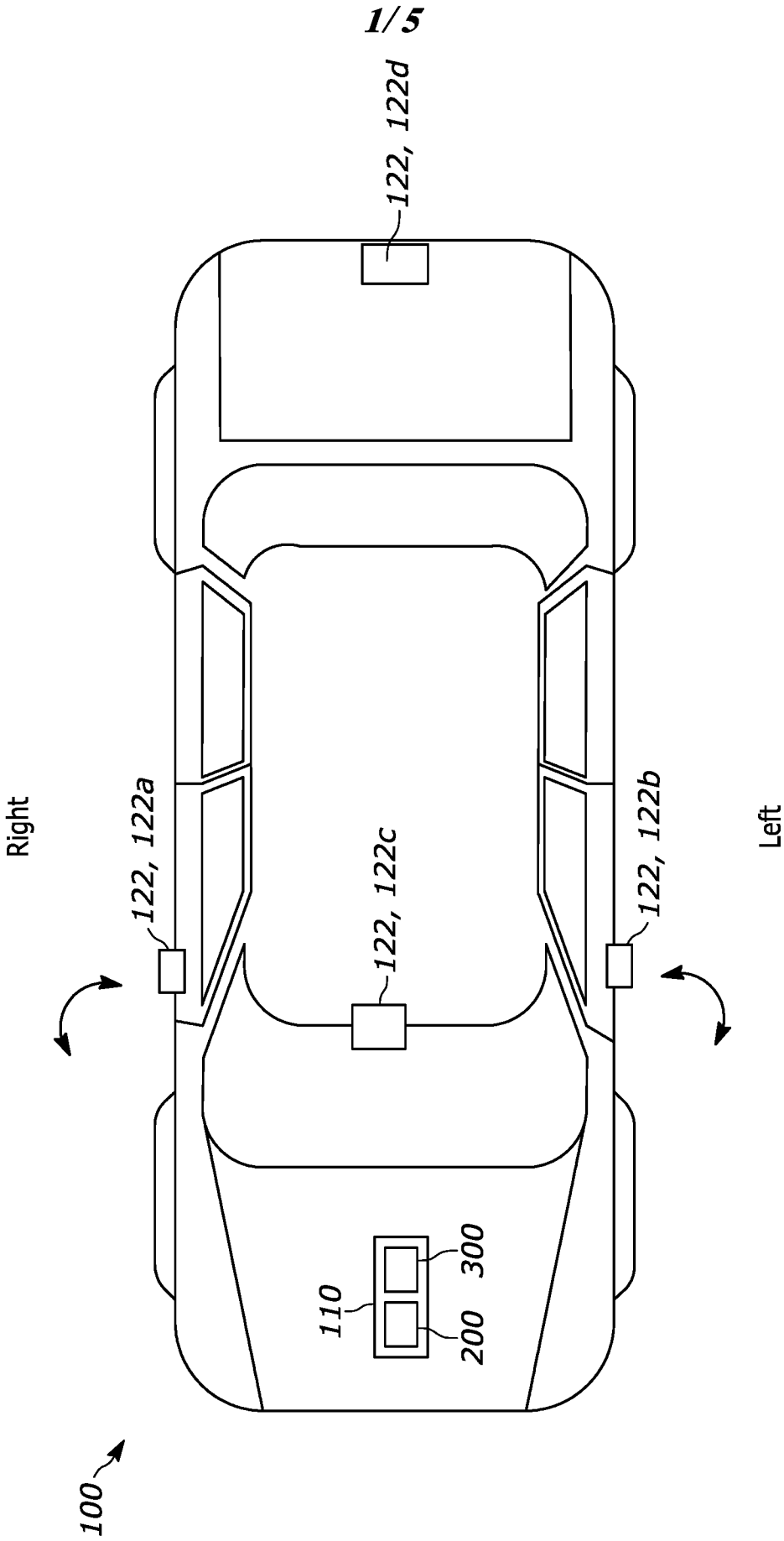


FIG. 1

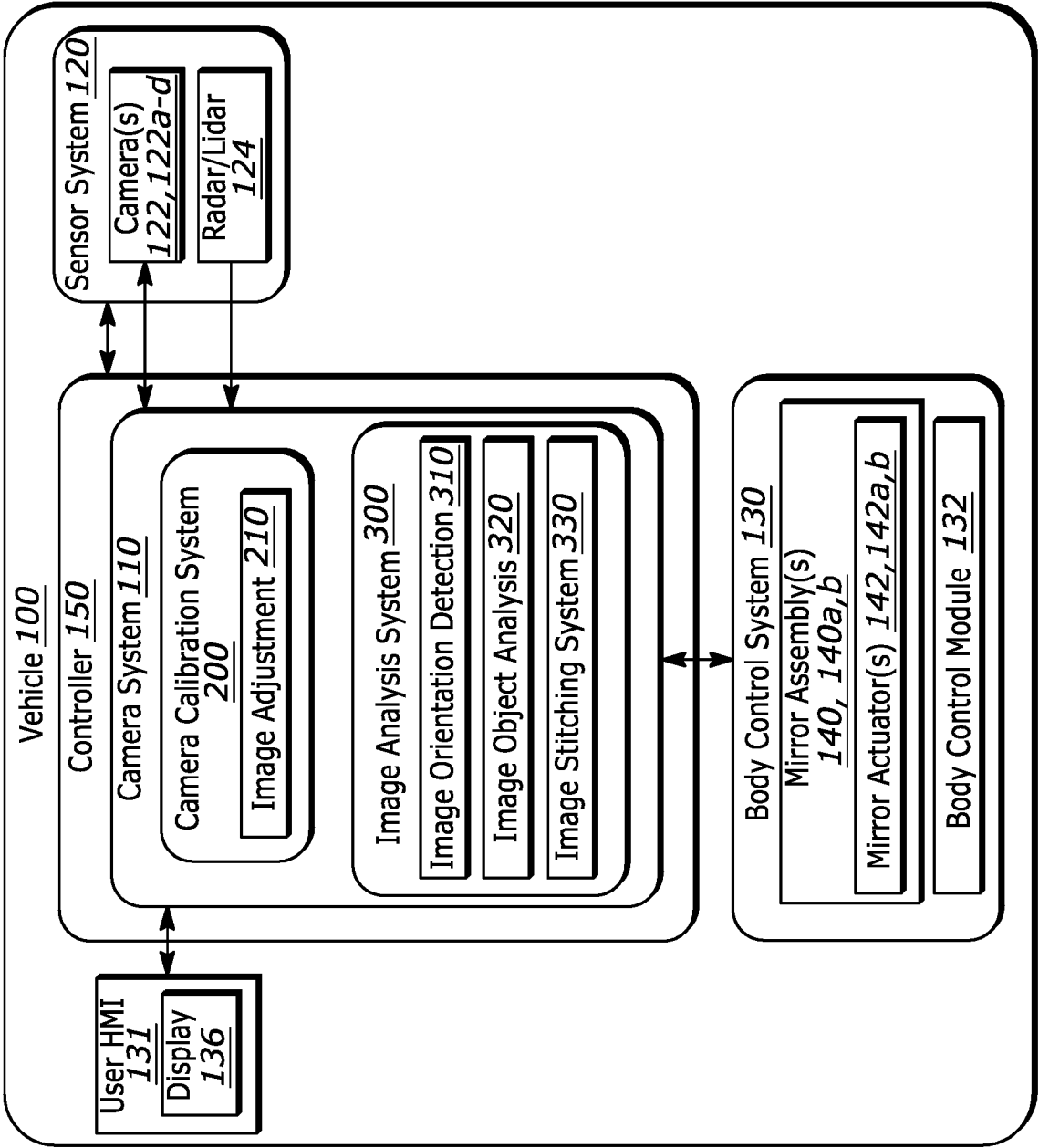
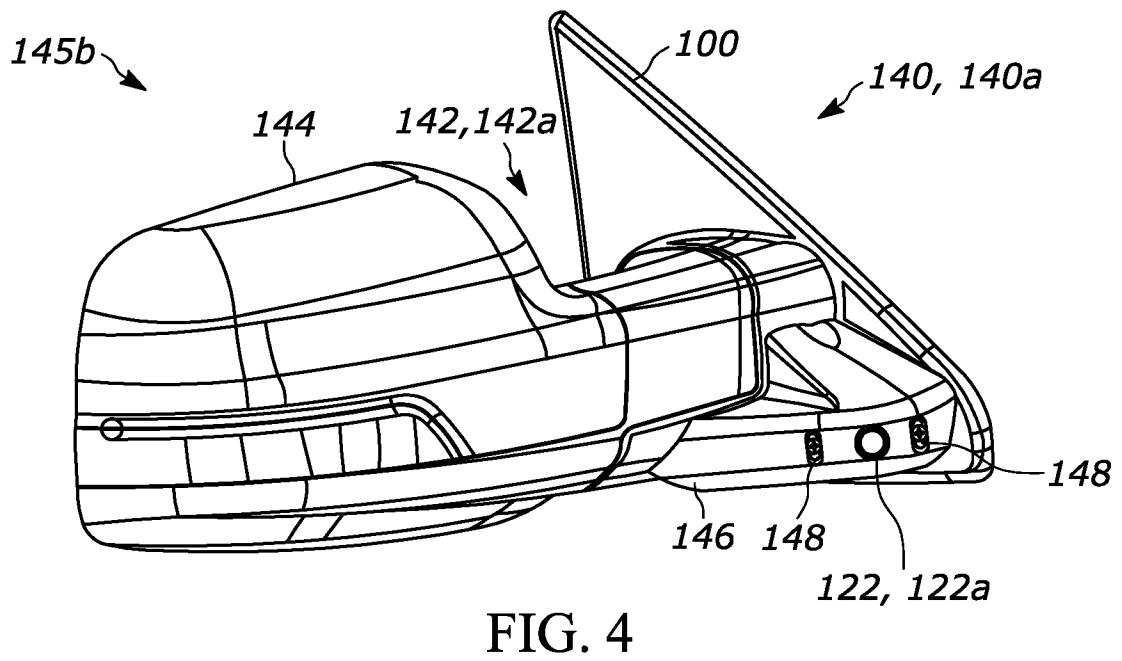
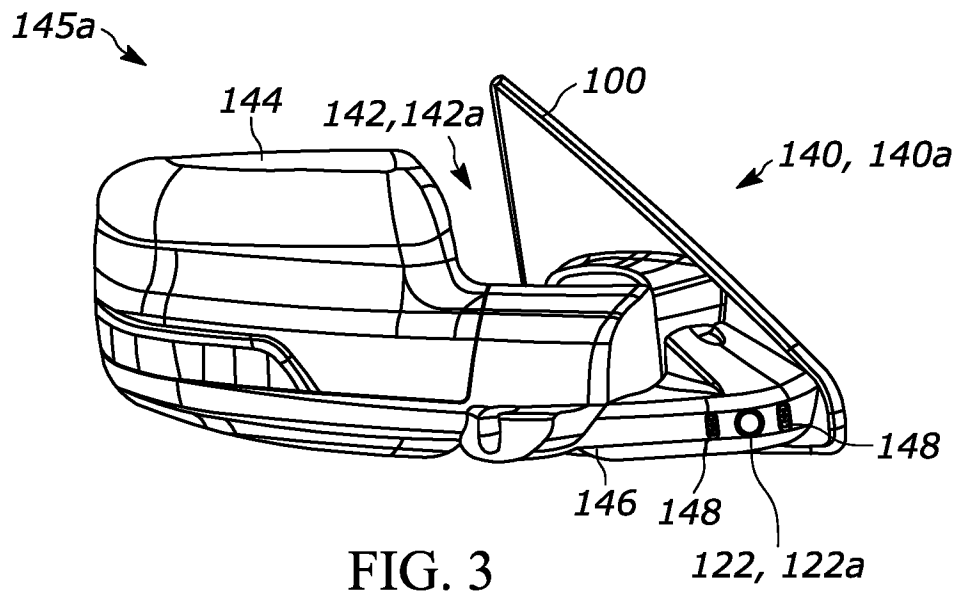


FIG. 2

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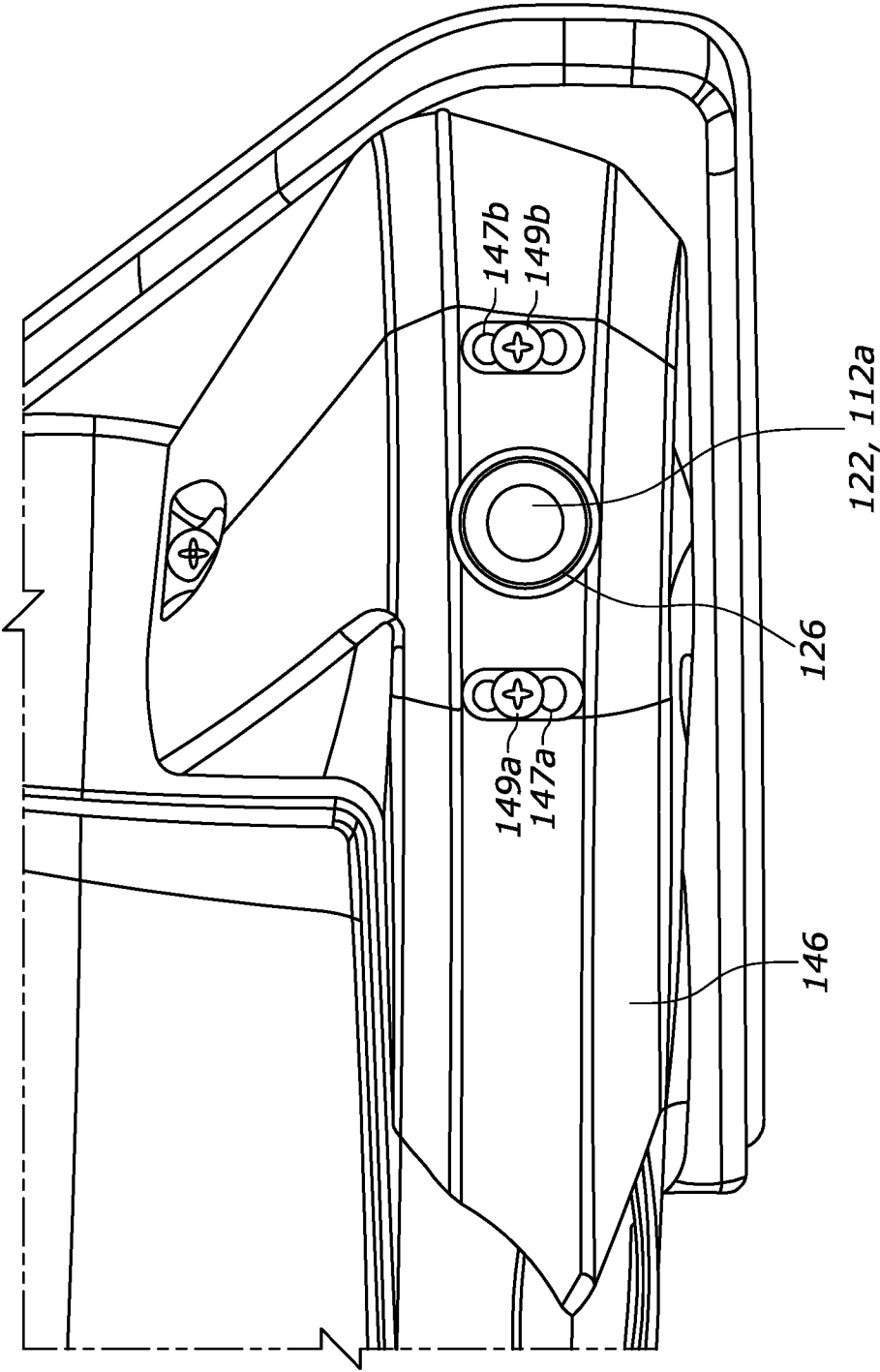


FIG. 5

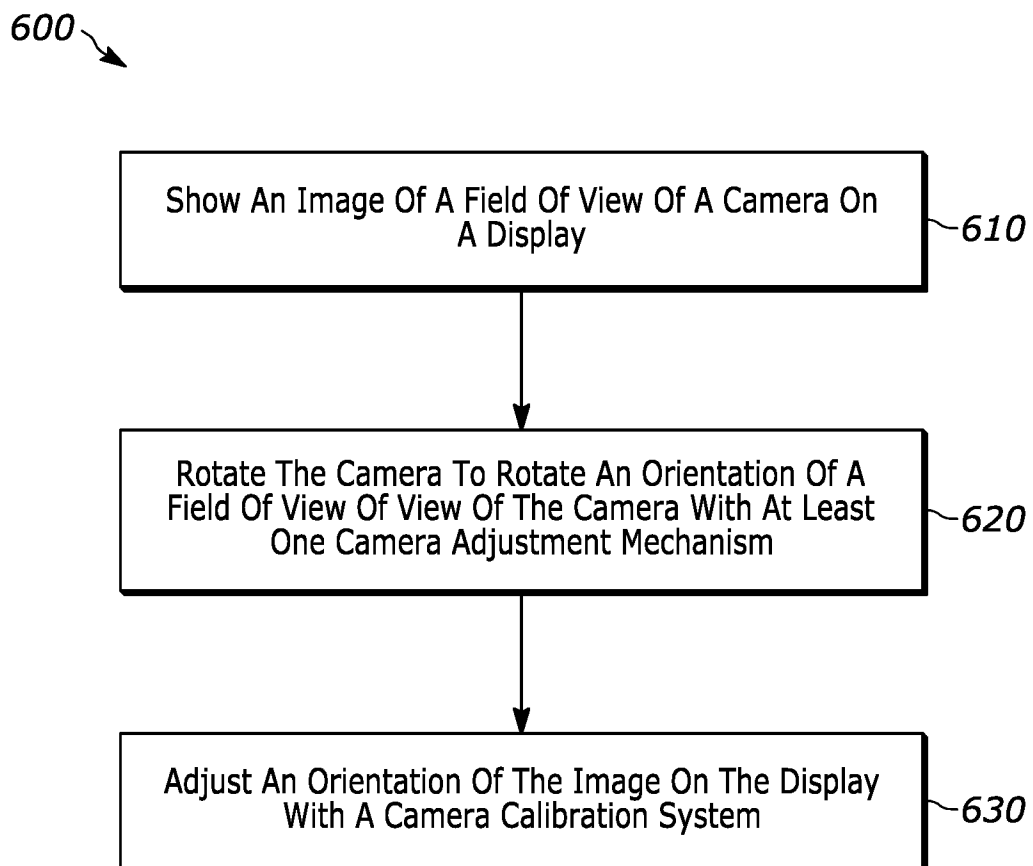
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FIG. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2022/036304

A. CLASSIFICATION OF SUBJECT MATTER INV. B60R1/06 B60R1/12 B60R11/04 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) B60R		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 437 261 A2 (MURAKAMI CORP [JP]) 14 July 2004 (2004-07-14) paragraphs [0105] - [0114]; figures 12-16 -----	1-15
X	KR 100 774 647 B1 (HYUNDAI MOTOR CO LTD [KR]) 8 November 2007 (2007-11-08) figure 1 -----	1, 4, 5, 10, 11, 13
X	US 2019/126829 A1 (LAI I-JEN [TW] ET AL) 2 May 2019 (2019-05-02) claim 1; figures 1-8 -----	1-15
☐ 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 "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) "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
21 October 2022		02/11/2022
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Matos Gonçalves, M

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2022/036304

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