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(54) Title: AUTOMATED VEHICLE OPERATION BASED ON GESTURE TO PEDESTRIAN

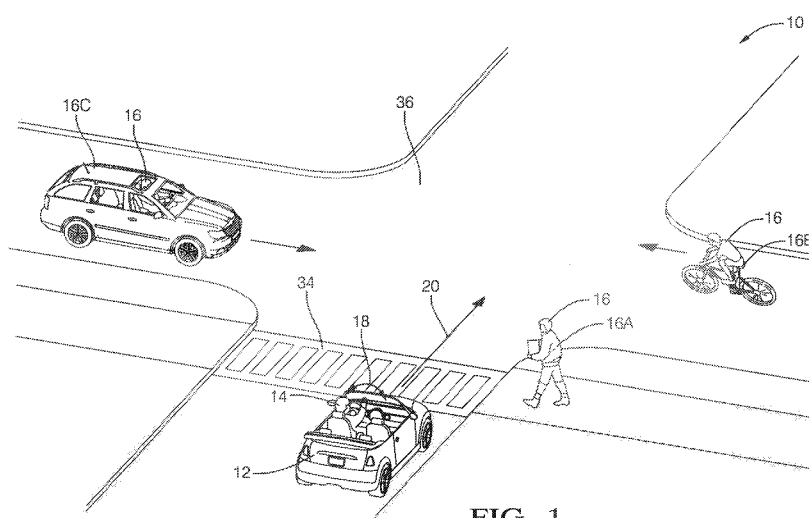


FIG. 1

(57) Abstract: A gesture detection system (10) suitable to operate an automated vehicle includes a gesture-detection-device (22), a pedestrian-detection-device (24), and a controller (26). The gesture-detection-device (22) is used to detect a gesture (18) made by an occupant (14) of a host-vehicle (12). The pedestrian-detection-device (24) is used to detect a pedestrian (16) proximate to the host-vehicle (12). The controller (26) is in communication with the gesture-detection-device (22) and the pedestrian-detection-device (24). The controller (26) is configured to control movement of the host-vehicle (12) along a travel-path (20) of the host-vehicle (12). The controller (26) waits to move the host-vehicle (12) until after the pedestrian (16) crosses the travel-path (20) when the occupant (14) gestures to the pedestrian (16) to proceed across the travel-path (20).

AUTOMATED VEHICLE OPERATION BASED ON GESTURE TO PEDESTRIAN

TECHNICAL FIELD OF INVENTION

[0001] This disclosure generally relates to a system for operating an automated vehicle, and more particularly relates to detecting a gesture made by an occupant of the vehicle to a pedestrian outside of the vehicle, and operating the vehicle in accordance with the gesture.

BACKGROUND OF INVENTION

[0002] The advent of automated vehicles makes it possible for an operator of an automated vehicle to, for example, read a news article on a tablet, or conduct business via a phone and/or computer while traveling in an automated vehicle. However, a pedestrian preparing to cross in front of an automated vehicle may hesitate if the operator or occupant of the vehicle appears to be unaware of the presence of the pedestrian, or is uncertain of how the automated vehicle will behave.

SUMMARY OF THE INVENTION

[0003] In accordance with one embodiment, a gesture detection system suitable to operate an automated vehicle is provided. The system includes a gesture-detection-device, a pedestrian-detection-device, and a controller. The gesture-detection-device is used to detect a gesture made by an occupant of a host-vehicle. The pedestrian-detection-device is used to detect a pedestrian proximate to the host-vehicle. The controller is in

communication with the gesture-detection-device and the pedestrian-detection-device.

The controller is configured to control movement of the host-vehicle along a travel-path of the host-vehicle. The controller waits to move the host-vehicle until after the pedestrian crosses the travel-path when the occupant gestures to the pedestrian to proceed across the travel-path.

[0004] Further features and advantages will appear more clearly on a reading of the following detailed description of the preferred embodiment, which is given by way of non-limiting example only and with reference to the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

[0005] The present invention will now be described, by way of example with reference to the accompanying drawings, in which:

[0006] Fig. 1 is an illustration of a traffic scenario encountered by a gesture detection system in accordance with one embodiment;

[0007] Fig. 2 is a diagram of the system of Fig. 1 in accordance with one embodiment; and

[0008] Fig. 3 is an illustration of another traffic scenario encountered by the system of Fig. 1 system in accordance with one embodiment.

DETAILED DESCRIPTION

[0009] Figs. 1 and 2 illustrate a non-limiting example of a gesture detection system 10, hereafter referred to as the system 10. The system 10 is generally suitable to operate an automated vehicle which in the description that follows is referred to as the host-vehicle

12. As will become apparent in the description that follows, the system 10 provides the means to detect when an occupant 14 of the host-vehicle 12 ‘communicates’ with a pedestrian 16 using a gesture 18 to indicate that the host-vehicle 12 will wait for the pedestrian 16 to proceed across a travel-path 20 of the host-vehicle 12.

[0010] The system 10 includes a gesture-detection-device 22 used to detect a gesture 18 made by an occupant 14 of a host-vehicle, for example an operator or passenger of the host-vehicle 12. It is contemplated that the gesture-detection-device may detect a gesture made by a passenger seated at a location in the host-vehicle 12 other than where an operator or driver of a vehicle traditionally sits. If the host-vehicle 12 is a fully autonomous type of vehicle that does not provide for any means for an occupant of the host-vehicle to control steering or braking of the vehicle, then a person traveling in the host-vehicle may be more properly referred to as a passenger or occupant rather than an operator. The gesture-detection-device 22 may include, but is not limited to, a camera such as a video camera, a radar-unit, a lidar-unit, an ultrasonic-transducer, or any combination thereof as will be recognized by those in the art.

[0011] While Fig. 2 suggests that the gesture 18 is a sideways waving gesture made by the occupant 14 moving his/her arm in an appropriate manner, it is contemplated that a suitable gesture may be a hand-signal such as pointing of the finger of the occupant 14, or a head-signal such as tipping, nodding, and/or side-to-side movement of the head of the occupant 14. In one instance the gesture 18 may indicate to the pedestrian 16 that the host-vehicle 12 will wait for the pedestrian to cross the travel-path. In another instance, the gesture 18 may be an open-palm intended to advise the pedestrian to hold his/her

current position because, for example, there is some perceived or unrecognized danger to the pedestrian from an approaching-vehicle 60 (Fig. 3).

[0012] The system 10 also includes a pedestrian-detection-device 24 used to detect an instance of the pedestrian 16 that is proximate to the host-vehicle 12. By way of example and not limitation, the pedestrian 16 may be a person characterized as traveling on-foot 16A, a person on a bicycle 16B, a person in an other-vehicle 16C, or any combination thereof. The pedestrian-detection-device 24 may include, but is not limited to, a camera such as a video camera, a radar-unit, a lidar-unit, an ultrasonic-transducer, or any combination thereof as will be recognized by those in the art. It is contemplated that multiple instances of the pedestrian-detection-device 24 may be preferable to enable detection of the pedestrian 16 over a wide variety of locations relative to the host-vehicle 12.

[0013] The system 10 also includes a controller 26 in communication with the gesture-detection-device 22 and the pedestrian-detection-device 24. The controller 26 may include a processor (not specifically shown) such as a microprocessor or other control circuitry such as analog and/or digital control circuitry including an application specific integrated circuit (ASIC) for processing data as should be evident to those in the art. The controller 26 may include memory (not specifically shown), including non-volatile memory, such as electrically erasable programmable read-only memory (EEPROM) for storing one or more routines, thresholds, and captured data. The one or more routines may be executed by the processor to perform steps for determining if signals 28, 30 received by the controller 26 indicate the nearby presence of the pedestrian 16 and/or the expression of the gesture 18 by the occupant 14 as described herein.

[0014] The controller 26 is generally configured or programmed to control movement of the host-vehicle 12 along the travel-path of the host-vehicle 12 by way of communication with the vehicle-controls 32 of the host-vehicle. The vehicle-controls 32 may include, but are not limited to, the means to control the steering, accelerator, and brakes of the host-vehicle 12. In one example instance, the controller 26 waits to move the host-vehicle 12 (e.g. applies the brakes) until after the pedestrian 16 crosses the travel-path 20 when the occupant 14 gestures to the pedestrian 16 to proceed across the travel-path 20. By way of further example, the host-vehicle 12 may wait for the person characterized as traveling on-foot 16A to proceed across a crosswalk 34 that passes in front of the host-vehicle 12, or wait for the person on a bicycle 16B and/or the person in the other-vehicle 16C to proceed through an intersection 36 that the travel-path 20 traverses.

[0015] To this end, the controller 26 may include a traffic-analysis-function 58 that considers data relevant to the locations of any pedestrians, other-vehicle, roadway markings, traffic signals, and the like to provide a path-planning-function 38 with options regarding the operation of the host-vehicle 12. The path-planning-function 38 may be configured to generally determine, among other things, the travel-path 20 for the host-vehicle, and instructs a vehicle-operation-function 40 to either wait, i.e. keep the host-vehicle 12 at the present position, or to proceed along the travel-path 20.

[0016] In some circumstances it may be difficult for the pedestrian 16 to see that the occupant 14 has made a particular gesture. For example, bright sun-light may cause glare on the windshield of the host-vehicle, or it may be night-time so the ambient light is inadequate, so the pedestrian 16 is unable to see the gesture 18. In one embodiment the

system 10, or more specifically the controller 26, is configured to operate a horn 42 of the host-vehicle 12, and activate the horn 42 when the occupant 14 gestures to the pedestrian 16 to proceed across the travel-path 20. In another embodiment the controller 26 may be configured to operate the headlights 44 of the host-vehicle, and flash the headlights 44 when the occupant 14 gestures to the pedestrian 16 to proceed across the travel-path 20. Alternatively, the controller may be configured to both activate the horn 42 and flash the headlights 44 when the occupant gestures to the pedestrian to proceed across the travel-path.

[0017] The decision to activate the horn 42 and/or flash the headlights 44 may be based on information from the pedestrian-detection-device 24 that indicates, for example, that the pedestrian 16 is looking away from the host-vehicle 12 so likely did not see the occupant 14 perform the gesture 18. The decision to activate the horn 42 and/or flash the headlights 44 may also be based on the relative-location of the pedestrian 16 relative to the host-vehicle. For example, the activation of the horn 42 may be especially useful to attract the attention of the person characterized as traveling on-foot 16A located as shown in Fig. 1. In contrast, the flashing of the headlights 44 may be especially useful to attract the attention of the person on a bicycle 16B and/or the person in the other-vehicle 16C located as shown in Fig. 1.

[0018] The decision for the host-vehicle 12 to either wait or proceed may also be based on further analysis of information from the pedestrian-detection-device 24 such as an other-vehicle intent 46, a pedestrian-gesture 48, or a pedestrian-intent 50. For example, if the person on a bicycle 16B appears to be resting and does not exhibit any intent to proceed soon, the host-vehicle 12 may proceed through the intersection 36 before the

person on a bicycle 16B proceeds across the travel-path 20. As another example, the pedestrian-detection-device 24 may indicate that the person in the other-vehicle 16C expressed the pedestrian-gesture 48 to the occupant 14 to proceed, so the controller 26 operate the host-vehicle through the intersection 36 without waiting. Similarly, the pedestrian-intent 50 of the person characterized as traveling on-foot 16A may indicate that the person characterized as traveling on-foot 16A is talking to another person.

[0019] The controller 26 may also be configured to move the host-vehicle 12 along the travel-path 20 when the pedestrian 16 does not begin to proceed across the travel-path 20 during a wait-interval 52, e.g. three seconds (3s). That is, even if no particular type of the other-vehicle intent 46, the pedestrian-gesture 48, and/or the pedestrian-intent 50 is detected, the controller 26 may be configured to proceed if the pedestrian 16 makes no attempt to proceed for longer than the wait-interval 52.

[0020] Various schemes for vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), and vehicle-to-pedestrian (V2P) communications have been contemplated. To make use of any of these schemes, the system 10 may include a transceiver 54 usable for wireless communication with the pedestrian 16, for example to communicate with a smart-phone 56 carried/operated by the pedestrian 16. It follows that the controller 26 may be further configured to operate the transceiver 54 to communicate an intention of the host-vehicle 12 to either proceed or to wait for the pedestrian 16 to proceed across the travel-path 20.

[0021] Fig. 3 illustrates another non-limiting example of a traffic scenario that the system 10 may encounter when the pedestrian 16 is proceeding or is about to proceed across the travel-path 20, and an approaching-vehicle 60 is unable to see the pedestrian 20 because the line-of-sight from the approaching-vehicle 60 to the pedestrian 20 is

occluded by the host-vehicle 12. The controller 26 may be configured to operate the transceiver 54 to communicate to the approaching-vehicle 60 that the pedestrian 16 is proceeding or is about to proceed across the travel-path 20 because the pedestrian 16 is responding to a gesture from the occupant 14, or the pedestrian 16 decided to proceed without receiving a gesture.

[0022] Alternatively, the host-vehicle 12 may transmit a signal to the approaching-vehicle 60 that the pedestrian 16 is likely to traverse the travel-path of the approaching vehicle independent of any gesture being expressed to the pedestrian 16. It is also contemplated that the pedestrian-detection-device 24, the transceiver 54, and the controller 26 could be part of infrastructure as part of a vehicle-to-infrastructure (V2I) system and not necessarily installed in the host-vehicle 12.

[0023] Accordingly, a gesture detection system (the system 10), a controller 26 for the system 10 and a method of operating the controller 26 and the system 10 are provided. The system 10 is equipped to detect a gesture 18 performed or expressed by the occupant 14 of the host-vehicle 12 to a pedestrian 16 nearby, and operate the host-vehicle 12 in accordance with the gesture 18. This provides for a more human-like and cooperative operational characteristic of the host-vehicle 12.

[0024] While this invention has been described in terms of the preferred embodiments thereof, it is not intended to be so limited, but rather only to the extent set forth in the claims that follow.

WE CLAIM:

1. A gesture detection system (10) suitable to operate an automated vehicle, said system (10) comprising:
a gesture-detection-device (22) used to detect a gesture (18) made by an occupant (14) of a host-vehicle (12);
a pedestrian-detection-device (24) used to detect a pedestrian (16) proximate to the host-vehicle (12); and
a controller (26) in communication with the gesture-detection-device (22) and the pedestrian-detection-device (24), said controller (26) configured to control movement of the host-vehicle (12) along a travel-path (20) of the host-vehicle (12), wherein the controller (26) waits to move the host-vehicle (12) until after the pedestrian (16) crosses the travel-path (20) when the occupant (14) gestures to the pedestrian (16) to proceed across the travel-path (20).
2. The system (10) in accordance with claim 1, wherein the pedestrian (16) is one of a person characterized as traveling on-foot (16A), a person on a bicycle (16B), a person in an other-vehicle (16C).
3. The system (10) in accordance with claim 1, wherein the controller (26) is further configured to operate a horn (42) of the host-vehicle (12), and activate the horn (42) when the occupant (14) gestures to the pedestrian (16) to proceed across the travel-path (20).

4. The system (10) in accordance with claim 1, wherein the controller (26) is further configured to operate headlights (44) of the host-vehicle (12), and flash the headlights (44) when the occupant (14) gestures to the pedestrian (16) to proceed across the travel-path (20).
5. The system (10) in accordance with claim 1, wherein the controller (26) is further configured to operate a horn (42) and the headlights (44) of the host-vehicle (12), and activate the horn (42) and flashes the headlights (44) when the occupant (14) gestures to the pedestrian (16) to proceed across the travel-path (20).
6. The system (10) in accordance with claim 1, wherein the controller (26) is further configured to move the host-vehicle (12) along the travel-path (20) when the pedestrian (16) does not begin to proceed across the travel-path (20) during a wait-interval (52).
7. The system (10) in accordance with claim 1, wherein the system (10) includes a transceiver (54) for wireless communication with the pedestrian (16), and the controller (26) is further configured to operate the transceiver (54) to communicate an intention to wait for the pedestrian (16) to proceed across the travel-path (20).

8. The system (10) in accordance with claim 1, wherein the system (10) includes a transceiver (54) for wireless communication with an approaching-vehicle (60), and the controller (26) is further configured to operate the transceiver (54) to communicate to the approaching-vehicle (60) that the pedestrian (16) is proceeding across the travel-path (20).
9. A pedestrian (16) protection system (10) suitable to operate an automated vehicle, said system (10) comprising:
 - a pedestrian-detection-device (24) used to detect a pedestrian (16) proximate to a travel-path (20) of an approaching-vehicle (60);
 - a transceiver (54) for wireless communication with the approaching-vehicle (60); and
 - a controller (26) in communication with the transceiver (54) and the pedestrian-detection-device (24), said controller (26) configured to operate the transceiver (54) to communicate to the approaching-vehicle (60) that the pedestrian (16) is likely to cross the travel-path (20).
10. The system (10) in accordance with claim 9, wherein the pedestrian (16) is one of a person characterized as traveling on-foot (16A), a person on a bicycle (16B), a person in an other-vehicle (16C).
11. The system (10) in accordance with claim 9, wherein the pedestrian-detection-device (24), the transceiver (54), and the controller (26) are installed in a host-vehicle (12).

12. The system (10) in accordance with claim 11, wherein the controller (26) is further configured to operate a horn (42) of the host-vehicle (12), and activate the horn (42) to warn the pedestrian (16) of the approaching-vehicle (60).
13. The system (10) in accordance with claim 11, wherein the controller (26) is further configured to operate headlights (44) of the host-vehicle (12), and flash the headlights (44) to warn the pedestrian (16) of the approaching-vehicle (60).
14. The system (10) in accordance with claim 11, wherein the controller (26) is further configured to operate a horn (42) and the headlights (44) of the host-vehicle (12), and activate the horn (42) and flashes the headlights (44) to warn the pedestrian (16) of the approaching-vehicle (60).

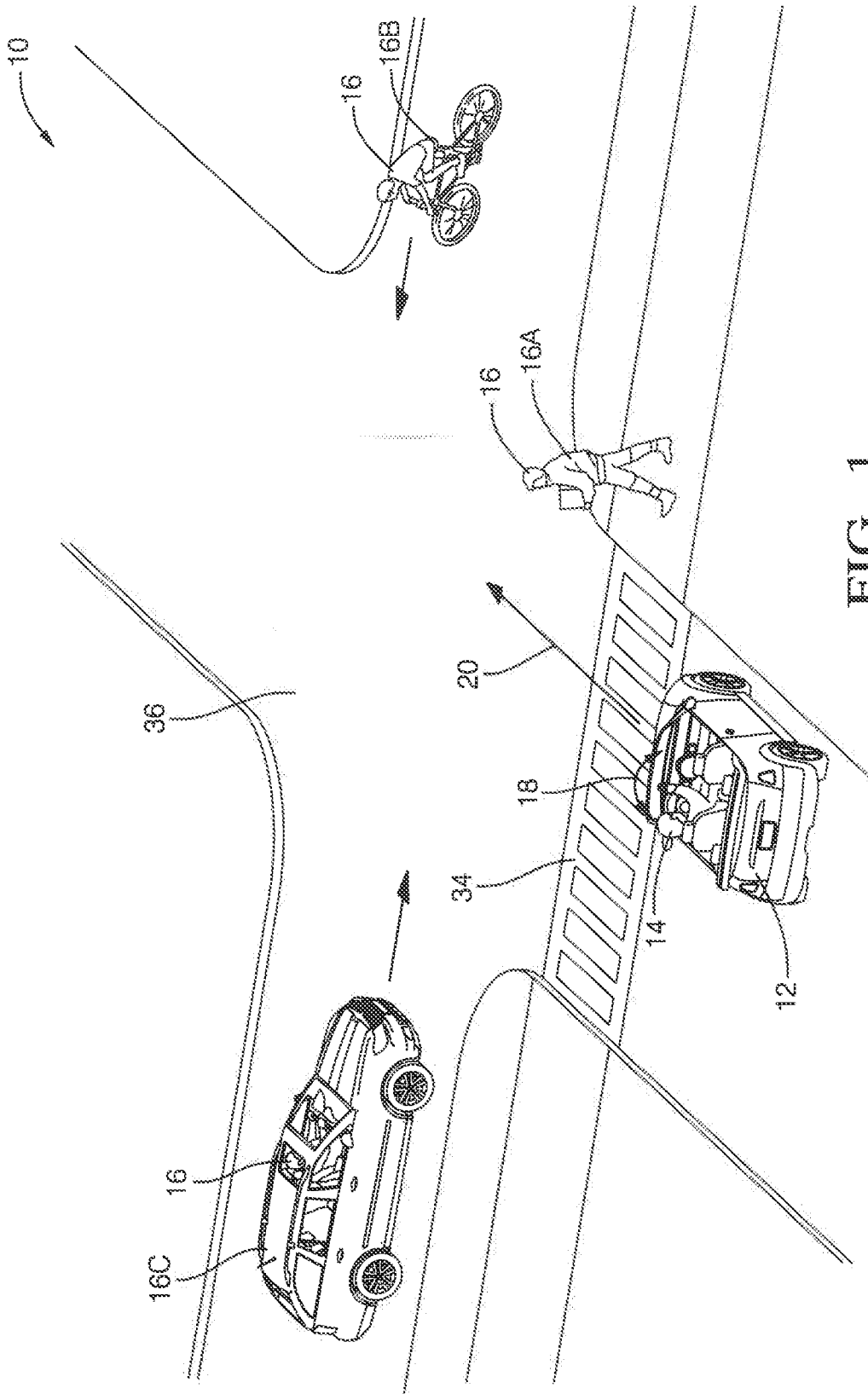


FIG. 1

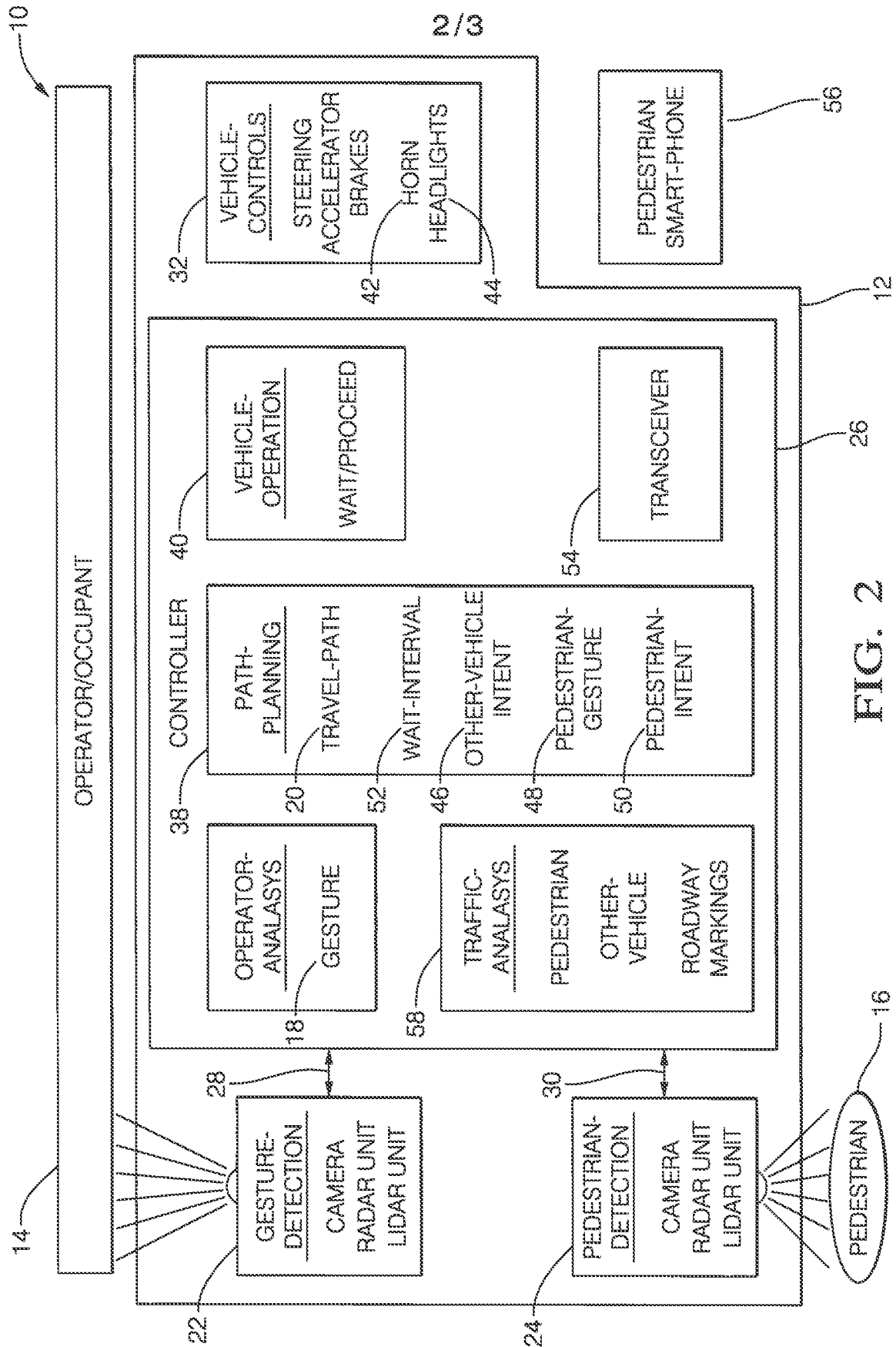
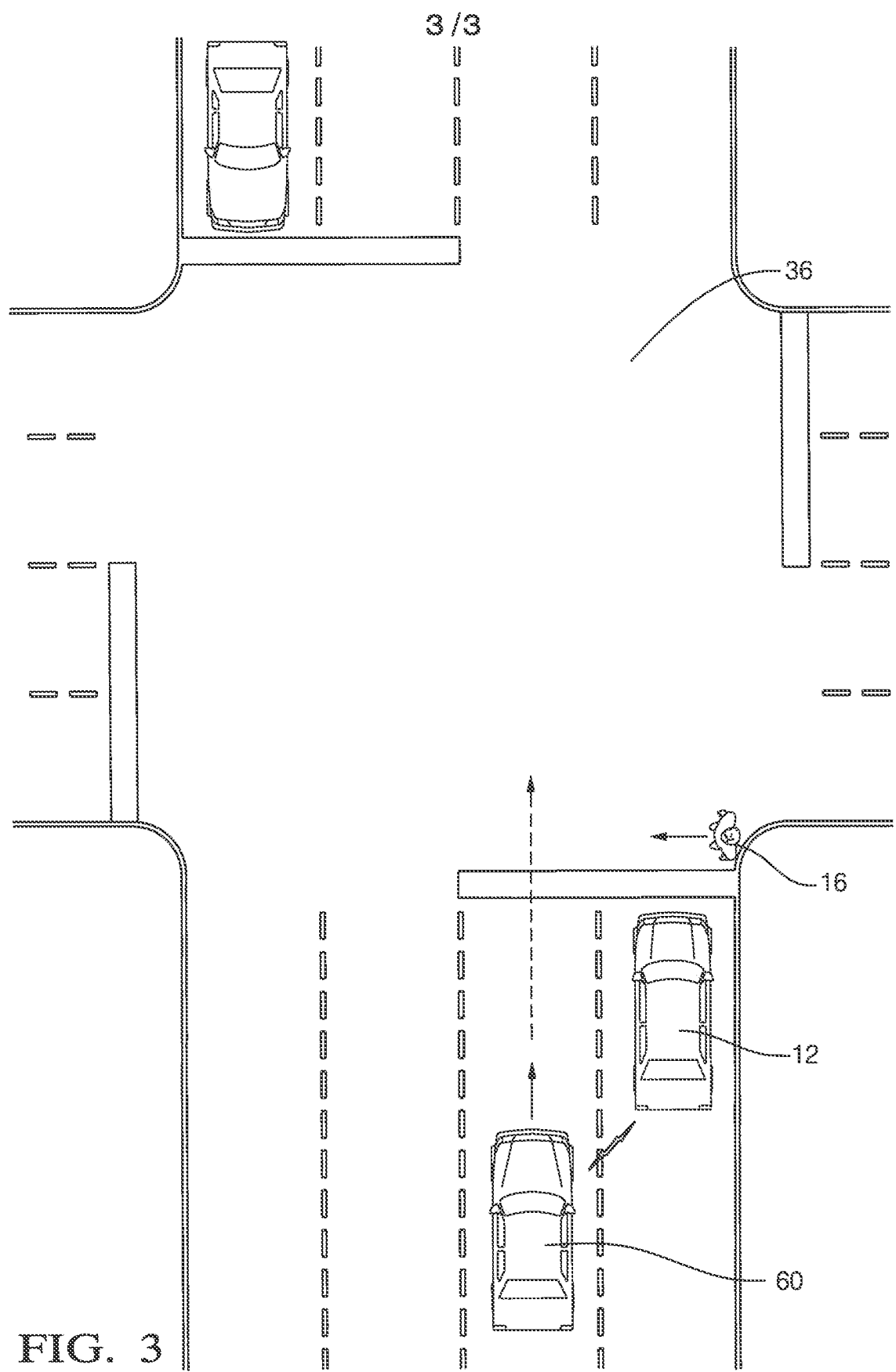


FIG. 2



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/063853**A. CLASSIFICATION OF SUBJECT MATTER****B60W 50/08(2006.01)i, B60W 30/08(2006.01)i, G06F 3/01(2006.01)i, B60Q 1/08(2006.01)i, B60Q 5/00(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)

B60W 50/08; G08G 1/16; H04N 5/225; B60R 25/104; B60R 25/01; G05D 1/02; B60W 40/02; G01C 3/08; B60W 30/08; G06F 3/01; B60Q 1/08; B60Q 5/00

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: gesture, detect, automated vehicle, pedestrian, wait

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2015-0232065 A1 (FLEXTRONICS AP, LLC) 20 August 2015 See paragraphs [0335]-[0338], [0422]-[0423], [0481]-[0498]; and figures 2, 6A-8C.	1-14
Y	US 2010-0191418 A1 (MIMEAULT et al.) 29 July 2010 See paragraph [0089]; and figures 1-2C.	1-14
A	US 9014905 B1 (GOOGLE INC.) 21 April 2015 See column 10, line 48 - column 19, line 49; and figures 3-4D.	1-14
A	WO 2011-106578 A2 (GENTEX CORPORATION et al.) 01 September 2011 See paragraphs [0171]-[0202]; and figures 16-30.	1-14
A	US 2015-0077235 A1 (TOYOTA MOTOR ENGINEERING & MANUFACTURING NORTH AMERICA, INC. et al.) 19 March 2015 See paragraphs [0080]-[0089]; and figures 19-23.	1-14



Further documents are listed in the continuation of Box C.



See patent family annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2015-0232065 A1	20/08/2015	US 2014-0306814 A1	16/10/2014
		US 2014-0306817 A1	16/10/2014
		US 2014-0306826 A1	16/10/2014
		US 2014-0306835 A1	16/10/2014
		US 2014-0307655 A1	16/10/2014
		US 2014-0307724 A1	16/10/2014
		US 2014-0308902 A1	16/10/2014
		US 2014-0309790 A1	16/10/2014
		US 2014-0309804 A1	16/10/2014
		US 2014-0309805 A1	16/10/2014
		US 2014-0309815 A1	16/10/2014
		US 2014-0309838 A1	16/10/2014
		US 2014-0309839 A1	16/10/2014
		US 2014-0309847 A1	16/10/2014
		US 2014-0309852 A1	16/10/2014
		US 2014-0309853 A1	16/10/2014
		US 2014-0309864 A1	16/10/2014
		US 2014-0309865 A1	16/10/2014
		US 2014-0309867 A1	16/10/2014
		US 2014-0309869 A1	16/10/2014
		US 2014-0309870 A1	16/10/2014
		US 2014-0309872 A1	16/10/2014
		US 2014-0309873 A1	16/10/2014
		US 2014-0309875 A1	16/10/2014
		US 2014-0309876 A1	16/10/2014
		US 2014-0309877 A1	16/10/2014
		US 2014-0309878 A1	16/10/2014
		US 2014-0309879 A1	16/10/2014
		US 2014-0309880 A1	16/10/2014
		US 2014-0309885 A1	16/10/2014
		US 2014-0309886 A1	16/10/2014
		US 2014-0309891 A1	16/10/2014
		US 2014-0309892 A1	16/10/2014
		US 2014-0309893 A1	16/10/2014
		US 2014-0309913 A1	16/10/2014
		US 2014-0309919 A1	16/10/2014
		US 2014-0309920 A1	16/10/2014
		US 2014-0309921 A1	16/10/2014
		US 2014-0309922 A1	16/10/2014
		US 2014-0309923 A1	16/10/2014
		US 2014-0309929 A1	16/10/2014
		US 2014-0309930 A1	16/10/2014
		US 2014-0309934 A1	16/10/2014
		US 2014-0309935 A1	16/10/2014
		US 2014-0309982 A1	16/10/2014
		US 2014-0310075 A1	16/10/2014
		US 2014-0310186 A1	16/10/2014
		US 2014-0310277 A1	16/10/2014
		US 2014-0310379 A1	16/10/2014

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/063853

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		US 2014-0310594 A1	16/10/2014
		US 2014-0310610 A1	16/10/2014
		US 2014-0310702 A1	16/10/2014
		US 2014-0310739 A1	16/10/2014
		US 2016-0039426 A1	11/02/2016
		US 2016-0039430 A1	11/02/2016
		US 2016-0040998 A1	11/02/2016
		US 2016-0041820 A1	11/02/2016
		US 2016-0047662 A1	18/02/2016
		US 2016-0082839 A1	24/03/2016
		US 2016-0155326 A1	02/06/2016
		US 2016-0163133 A1	09/06/2016
		US 2016-0205419 A1	14/07/2016
		US 2016-0223347 A1	04/08/2016
		US 2016-0244011 A1	25/08/2016
		US 2016-0246526 A1	25/08/2016
		US 2016-0249853 A1	01/09/2016
		US 2016-0250985 A1	01/09/2016
		US 2016-0313730 A1	27/10/2016
		US 2016-0318467 A1	03/11/2016
		US 2016-0318468 A1	03/11/2016
		US 2016-0318524 A1	03/11/2016
		US 2016-0321848 A1	03/11/2016
		US 2016-0325755 A1	10/11/2016
		US 9020697 B2	28/04/2015
		US 9058703 B2	16/06/2015
		US 9117318 B2	25/08/2015
		US 9123186 B2	01/09/2015
		US 9135764 B2	15/09/2015
		US 9142071 B2	22/09/2015
		US 9142072 B2	22/09/2015
		US 9147296 B2	29/09/2015
		US 9147297 B2	29/09/2015
		US 9153084 B2	06/10/2015
		US 9183685 B2	10/11/2015
		US 9218698 B2	22/12/2015
		US 9230379 B2	05/01/2016
		US 9235941 B2	12/01/2016
		US 9290153 B2	22/03/2016
		US 9305411 B2	05/04/2016
		US 9317983 B2	19/04/2016
		US 9349234 B2	24/05/2016
		US 9378602 B2	28/06/2016
		US 9466161 B2	11/10/2016
US 2010-0191418 A1	29/07/2010	CA 2633377 A1	28/06/2007
		CA 2633377 C	10/05/2016
		CA 2691138 A1	24/12/2008
		CA 2691141 A1	24/12/2008
		CA 2691141 C	26/11/2013

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/063853

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		CN 101356450 A	28/01/2009
		CN 101356450 B	05/08/2015
		EP 2158579 A1	03/03/2010
		EP 2158579 B1	15/10/2014
		EP 2160629 A1	10/03/2010
		EP 2160629 A4	06/03/2013
		JP 2009-520194 A	21/05/2009
		JP 2010-529932 A	02/09/2010
		JP 2013-257888 A	26/12/2013
		JP 2014-170001 A	18/09/2014
		JP 2015-187891 A	29/10/2015
		US 2007-0228262 A1	04/10/2007
		US 2010-0194595 A1	05/08/2010
		US 2011-0205521 A1	25/08/2011
		US 7855376 B2	21/12/2010
		US 8242476 B2	14/08/2012
		US 8436748 B2	07/05/2013
		US 8600656 B2	03/12/2013
		WO 2007-071032 A1	28/06/2007
		WO 2008-154736 A1	24/12/2008
		WO 2008-154737 A1	24/12/2008
US 9014905 B1	21/04/2015	None	
WO 2011-106578 A2	01/09/2011	CN 102834309 A	19/12/2012
		EP 2539197 A2	02/01/2013
		EP 2539197 A4	25/09/2013
		US 2012-0050074 A1	01/03/2012
		US 2013-0250113 A1	26/09/2013
		US 8456327 B2	04/06/2013
		US 9230183 B2	05/01/2016
		WO 2011-106578 A3	15/12/2011
US 2015-0077235 A1	19/03/2015	US 9387824 B2	12/07/2016