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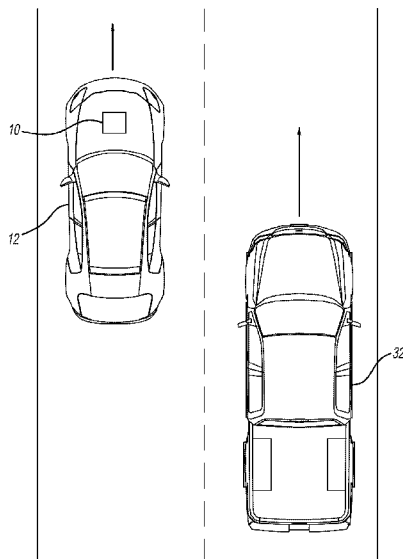


FIG. 1

(57) **Abstract:** A method and apparatus for assisting a driver of a first vehicle determines whether the first vehicle is traveling in a first lane of a multi-lane highway. The method further determines that another vehicle is approaching the first vehicle from behind in a second lane of the multi-lane highway. The method determines that the first vehicle is being passed by the second vehicle, and outputs a warning to the driver, instructing the driver to merge into the second lane where the second vehicle had been traveling.

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AUTOMOTIVE LANE DISCIPLINE SYSTEM, METHOD, AND APPARATUS

BACKGROUND

[0001] 1. Field of the invention

[0002] The present invention relates generally to automotive lane monitoring systems and, more particularly, to a lane discipline system.

[0003] 2. Description of Related Art

[0004] Various driver assistance systems are now available including automotive lane monitoring systems that can provide assistance to a driver of an automotive vehicle.

[0005] One type of driver assistance system is a lane departure warning ("LDW") system. A LDW system is able to detect whether a vehicle is departing or about to depart from the lane in which it is currently driving. Various technologies including visual and infrared cameras with associated image processing are used in a system to warn the driver. Systems of this type operate to warn a driver of the potential lane departure such that the driver can correct the lane departure, if desired, and return to the current lane in which the vehicle is operating.

[0006] Another type of driver assistance system is a Blind Spot Detection ("BSD") system. The BSD system is able to detect whether another vehicle is present in the blind spot of the driver's vehicle on the left and/or right side of the vehicle. BSD systems typically include radar-based detection and associated processing to warn the driver. Systems of these types can warn the driver of the presence of another vehicle in the blind spot, such that the driver can remain in the current lane.

[0007] These systems operate to warn the vehicle driver to remain in a traffic lane. The warnings can take a variety of forms, such as audible warnings (beeping), visual warnings (flashing lights), haptic warnings (vibration), or the like.

[0008] On multi-lane roads, meaning roads that have more than one lane assigned to the same direction of vehicle travel such as divided highways, efficient traffic flow is aided by proper use of the lanes. It is a generally accepted practice in the United States, and in some states and countries it is the law, that slower traffic use the right-most lane, with faster traffic using one of the left-most lanes to pass the slower moving traffic.

[0009] However, in many cases, drivers fail to follow the above-described convention. This can be due to a variety of reasons. The driver may be unaware of the convention. The driver may not understand the benefits to traffic efficiency and view the practice as a suggestion. The driver may have initially used the left lane to pass but forgotten to return to the right lane after passing. The driver may have become distracted. Some drivers may view the

left hand lane as the “fast lane” and be drawn to traveling in that lane because they don’t think of themselves as a slow driver.

[0010] In any event, drivers who use the left lane for purposes other than passing slower vehicles will often need to be passed by faster moving vehicles. With the left lane occupied by a slower moving vehicle, the faster moving vehicle will need to pass using a lane on the right. Passing on the right goes against the typical passing convention described above, but is necessitated by the left lane being occupied by a slower driver. The existence of a slower vehicle in the left lane can cause frustration in other drivers and can lead to aggressive, frustrated, and/or angry driving when passing on the right.

SUMMARY

[0011] A method for assisting a driver of a motor vehicle is provided. The method includes the steps of detecting, using a controller installed within a passenger vehicle, that the passenger vehicle is traveling on a roadway having at least two lanes for travel in a first direction and detecting that the passenger vehicle is traveling in a first lane of the at least two lanes. The method further includes detecting that a second vehicle is traveling in a second lane of the at least two lanes, wherein the second lane is different than the first lane, detecting that the second vehicle is behind the passenger vehicle, and detecting that the second vehicle is traveling faster than the passenger vehicle. The method further includes outputting a warning from the controller to the driver, wherein the warning instructs the driver to depart from the first lane.

[0012] In another approach, a system for providing lane discipline assistance to a driver of a first vehicle is provided. The system includes a computer readable medium having instructions stored thereon that, when executing by a computing device, cause the computing device to perform steps including: detecting, via a lane detect function, that the first vehicle is traveling in a first lane of a multi-lane highway; detecting, via a vehicle detect function, that a second vehicle is traveling in a second lane of the multi-lane highway at a faster speed than the first vehicle; determining that the second vehicle has passed the first vehicle; and outputting a warning in response to determining that the second vehicle has passed the first vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The accompanying drawings incorporated in and forming a part of the specification illustrate several aspects of the present invention, and together with the description serve to explain the principles of the invention. In the drawings:

- [0014] Figure 1 is a top view of a first vehicle traveling in the left lane of a multi-lane highway, and a second vehicle traveling in the right lane;
- [0015] Figure 2 is a schematic view of a driver assist system having a controller, a warning indicator, and an external warning;
- [0016] Figure 3 is a schematic view of the controller having a lane discipline reminder function including a lane detection function, a vehicle detection function, and a database;
- [0017] Figure 4 is a schematic view of a lane departure warning system having the lane detection function including an environment sensor;
- [0018] Figure 5 is a schematic view of a blind spot detection system having the vehicle detection function including a vehicle sensor;
- [0019] Figure 6 is a schematic view of the environment sensor having a camera and a processor;
- [0020] Figure 7 is a schematic view of the vehicle detection sensor having a sensing device and processing device;
- [0021] Figure 8 is a schematic view of the warning indicator, having a lamp warning, a message warning, a haptic warning, and an audio warning;
- [0022] Figure 9 is a schematic view of the external warning having a hazard light;
- [0023] Figure 10 is an illustration of a method for assisting a vehicle driver; and
- [0024] Figures 11A and 11B are an illustration of another method for assisting a vehicle driver.

DETAILED DESCRIPTION

[0025] Turning now to Figures 1-11, one embodiment of a driver assist system 10 for use with a vehicle 12 includes a controller 14, as shown in Figure 2. The controller 14 is in the form including a computer readable medium, such as a hard drive, flash storage, or the like, that includes instructions stored thereon, as well as a processor that can execute the instructions. The controller 14 can therefore include various algorithms and processes that are carried out in response to inputs, such as vehicle status, vehicle environment, and outputs from other controllers or devices. As shown in Figure 2, the system 10 further includes a warning indicator 16 that is operatively coupled to the controller 14 that is activated in response to the controller 14 determining that a warning is to be activated.

[0026] As shown in Figure 3, the controller 14 of system 10 includes a lane detection function 20. The lane detection function 20 detects the environment of the vehicle 12 on the

roadway. More specifically, the lane detection function 20 detects the type of road that the vehicle 12 is driving on, as well as the particular lane of the road that the vehicle 12 is driving on. The lane detection function 20 determines whether the vehicle is driving on a multi-lane highway. The lane detection function 20 further determines whether the vehicle 12 is driving in the left lane of a multi-lane highway.

[0027] The lane detection function 20, in one approach, is part of a lane departure warning system 25 as shown in Figure 4 that is part of the lane discipline reminder 60. The lane departure warning system 25, as part of its function to determine if a vehicle is departing its lane or about to depart its lane, detects the environment of the vehicle 12, such as the type of road being traveled. For example, the lane departure warning system 25 detects whether the vehicle 12 is on a single lane highway or a multi-lane highway. Accordingly, it can detect if the vehicle 12 is traveling in the left lane of a multi-lane highway, as described above. However, it will be appreciated that the lane detection function 20 can be independent of a lane departure warning system of the vehicle 12 and can operate in addition to the separate lane departure warning system. Similarly, the lane detection function 20 can operate as a single system in a vehicle 12 without a lane departure warning system 25.

[0028] References to the lane detection function 20 herein will be made without reference to the lane departure warning system 25, but it will be appreciated that such references can apply to a system where the lane detection function 20 is part of the lane departure warning system 25, separate but in use in addition to the lane departure warning system 25, or separate and in use without a lane departure warning system.

[0029] With reference again to Figure 3, the system 10 and controller 14 also includes a vehicle detection function 30. The vehicle detection function 30 can be in the form of a vehicle mounted radar or vision system capable of detecting the presence, location, and/or speed of other vehicles. In another form, the vehicle detection function 30 can be in the form of a receiver that receives a signal broadcast from other vehicles that indicates the presence, location, and/or speed of the other vehicles.

[0030] The vehicle detection function 30 detects other vehicles 32 that are driving on the same highway as the driver. More particularly, the vehicle detection function 30 determines whether the other vehicles 32 are approaching the vehicle 12 from behind. Further, the vehicle detection function 30 determines whether other vehicles 32 are approaching from behind and in a right hand lane. The vehicle detection function 30 also detects whether these approaching vehicles 32 are passing the vehicle 12 on the right.

[0031] The vehicle detection function 20, in one approach, is part of a blind spot detection system 35 as shown in Figure 5. The blind spot detection system 35 detects whether the other vehicles 32 are present in the blind spot on the left and/or right side of the vehicle 12. Accordingly, it can detect whether other vehicles 32 are passing the vehicle 12 on the right side. It will be appreciated that the vehicle detection function 20 could be independent of the blind spot detection system 35, operating in addition to the separate blind spot detection system 35. Similarly, the lane detection function 20 can operate without a blind spot detection system installed in the vehicle 12.

[0032] References to the vehicle detection function 20 herein will be made without reference to the blind spot detection system 35, but it will be appreciated that such references can apply to a system where the vehicle detection function 20 is part of the blind spot detection system 35, separate but in use in addition to the blind spot detection system 35, or separate and in use without a blind spot detection system.

[0033] With reference to Figures 4 and 6, the lane detection function 20, as described above, detects whether the vehicle 12 is driving in the left lane of a multi-lane highway based on various inputs obtained from the vehicle environment. More specifically, the lane detection function 20 receives outputs from one or more environment or lane detection sensors 40. The lane detection sensors 40 are preferably in the form of one or more cameras 42 that are operably coupled to an associated processing device 44 configured to interpret the images captured by the cameras 42. The processing device 44 can be a part of or in addition to the controller 14. The cameras 42 can be visual cameras or infrared cameras, or other cameras capable of capturing an image sufficient to determine the type of highway being traveled. The processing device 44 evaluates the captured images to determine the type of highway and the lane in which the vehicle 12 is traveling. The lane detection function 20 can operate using cameras or sensors that can detect roadway median lines and road edges, or GPS information can indicate that the current highway on which the vehicle is traveling has multiple lanes in each direction and the particular lane in which the vehicle is traveling. For example, if the cameras 42 capture an image with a solid line on the left side of the vehicle, a dashed line on the right side of the vehicle 12, and a solid line further to the right, the processing device 44 will determine that the vehicle is traveling in the left lane of a two lane multi-lane highway. If the cameras 42 capture a dashed line on the left side of the vehicle and solid line further to the left, with the same dashed line and solid line on the right, then the processing device 44 will determine that the vehicle is traveling in the middle lane of a three-lane multi-lane highway.

[0034] It will be appreciated that various other street line configurations can be detected to indicate the lane and type of road in which the vehicle 12 is traveling. The processing device 44 is configured to analyze the images based on predetermined street marking practices of the intended location where the vehicle 12 is likely to be driven, and also preferably includes other known lane marking practices for other areas. The above described manner of determining the type of road and present lane position of the vehicle 12 is merely exemplary, and it will be appreciated that other manners of detecting road type and lane location could also be used, either by using cameras or other location detection devices. For example, the system 10 could analyze the driving habits of the driver to determine if the driver is in the left lane, such as by evaluating previous lane changes. Further, the system 10 could use a GPS system, or other positioning system, to determine a location of the vehicle 12. The GPS or other positioning system can indicate the type of road, such as a single lane highway where passing on the right is typically not possible or permitted due to the lack of an authorized passing lane, or a multi-lane highway where passing on the right is possible due to the presence of the additional lane in which to pass.

[0035] With reference to Figure 5 and 7, the vehicle detection function 30, as described above, detects whether other vehicles 32 are passing the vehicle 12 on the right. The detection occurs based on information received from vehicle detection sensors 50 that include a sensing device 51 that is operatively coupled to a processing device 52. The processing device 52 evaluates the outputs from the sensing device 51 to determine whether a vehicle is passing on the right. In one approach, the sensing device 51 is radar-based, and the information received from the radar is evaluated to determine the movement of the other vehicles 32 relative to the vehicle 12, similar to a radar gun used by law enforcement. Similarly, other devices or sensors that can detect relative speed, movement, or position relative to the vehicle 12 could be used, such as a laser-based system.

[0036] For example, the sensing device 51 will output that the other vehicle 32 is present on the right side of the vehicle 12, similar to how a blind spot detection system determines that another vehicle is located in the right side blind spot. The sensing device 51 will also output the speed at which the other vehicle 32 is traveling relative to the vehicle 12. The processor 52 will evaluate these outputs, and determine whether the other vehicle 32 is passing the vehicle 12 on the right. For example, if the location of the other vehicle 32 is confirmed to be on the right side of the vehicle 12, and the other vehicle 32 is confirmed to be traveling faster than the vehicle 12, such as the distance between the vehicles at successive

points in time decreasing, the processor 52 will determine that the other vehicle 32 is passing on the right.

[0037] The processor 52, as well as the processor 44, can be separate processing devices or as part of the controller 14. For purposes of discussion, the processors 52 and 44 will be discussed individually, but it will be appreciated that the controller 14 could also performing these processing functions.

[0038] The processor 52 can make these evaluations regarding being passed on the right relative to a predetermined period of time, and can log instances of the vehicle 12 being passed in a database 54 (Figure 3) that is operatively coupled to the controller 14.

[0039] In one approach, upon detection of the other vehicle 32 on the right side of the vehicle 12, the processor 52 can determine for how long the other vehicle 32 remains in that area. If the other vehicle 32 remains in that area for an extended period of time, for example, two minutes, the processor 52 may determine that the vehicle 12 is not being passed, even if the other vehicle 32 is determined to be traveling slightly faster than the vehicle 12 during portions of that time period. Of course, this time period is merely exemplary, and can be set to other predetermined periods, as desired

[0040] In one approach, the processor 52 can determine the number of other vehicles 32 that have passed the vehicle 12 during a predetermined period of time. For example, the processor 52 can determine whether or not two or more other vehicles 32 have passed the vehicle 12 within a period of five minutes. This can be accomplished by logging instances in the database 54 and evaluating the number of instances within the predetermined time period. This particularly quantity of passing instances and period of time is exemplary. Other predetermined quantities and periods can also be used, as desired.

[0041] In addition to determining whether the vehicle 12 is being passed by other vehicles 32 on the right, the system can also use the vehicle detection function 30 to determine whether the vehicle 12 is being approached from behind but in the same lane. The sensors 52 will determine whether the other vehicle 32 is present in the same lane as the vehicle 12 and whether the other vehicle 32 is traveling at a faster speed than the vehicle 12. The processor 52 will evaluate the location and speed of the other vehicle 32 and output that the other vehicle 32 is fast approaching the vehicle 12. These instances of same lane vehicle approaches can also be logged in the database 54, similar to the instances of right side passes.

[0042] It will be appreciated that the vehicle detection function 20 can be used to detect the location and relative speeds of other vehicles at a variety of locations, including the lane or lanes to the left of the vehicle. The vehicle detection function can also detect the presence of

other vehicles, as well as their speeds, in lanes that are not adjacent the lane in which the vehicle is driving, such that the other vehicles 32 would be detected two lanes over, three lanes over, etc.

[0043] The lane detection function 20 and the vehicle detection function 30 are used together as inputs to a lane discipline reminder function 60, as shown in Figure 3. The above described detections performed by the sensors and associated processors of the lane detection function 20 and the vehicle detection function 30 are evaluated by the vehicle detection function 60 in order to warn the driver of other vehicles 32 passing on the right, or likely to pass on the right.

[0044] If the lane discipline reminder function 60 and the controller 14 determine that the warning indicator 16 should be activated, the controller 14 will cause the warning indicator 16 to be activated.

[0045] The warning indicator 16 can have a variety of forms. In one approach, the warning indicator is in the form of a warning lamp 64. In another approach, the warning indicator 16 is in the form of a textual message 66. In another aspect, the warning indicator 16 is in the form of a haptic signal 68, such as a vibration in the steering wheel or seat. Each of these warning indicators 16 are capable of being activated alone, or in a variety of combinations with each other. For example, in one approach, the warning indicator 16 includes each of the warning lamp 64, the textual message 66, and the haptic signal 68. Additionally, or alternatively, the warning indicator 16 can be in the form of an audio warning 69, such as beeping or a spoken phrase. Of course, it will be appreciated that other warning indicators could also be used to alert the driver.

[0046] Additionally, or alternatively, to warning the driver, if the lane discipline reminder function 60 determines that the vehicle 12 is being passed on the right by other vehicles 32 sufficiently to prompt a warning, the controller 14 will cause an external driver warning 70 (Figure 2) to be activated.

[0047] The external driver warning 70 is intended to warn other drivers that the vehicle 12 is travelling slower than the other vehicles 32 and is being passed on the right. In this aspect, as shown in Figure 9, the external driver warning 70 is in the form of a hazard light 72, such as flashing turn signals on both sides of the vehicle 12 or other external warning indicators.

[0048] The lane discipline reminder function 60 is configured to activate one or both of the above warnings 16, 70 in response to certain conditions occurring. As described above, the warnings 16, 70 are preferably activated in response to detecting that the other vehicles 32 are passing the vehicle 12 on the right. However, it can be appreciated that it may not be desirable,

in certain situations, to activate the warnings 16, 70 in response to a singular incidence of being passed on the right. Accordingly, the lane discipline reminder function 60 will preferably activate one of the warnings 16, 70 in response to the number of passing vehicles reaching a threshold level.

[0049] The threshold level is preferably predetermined as a function of a number of other vehicles 32 passing the vehicle 12 as well as a predetermined time period. For example, in one approach, the threshold level is two other vehicles 32 passing the vehicle 12 on the right within a span of two minutes. This threshold level is merely exemplary, and other quantities of passing vehicles within other time periods could also be used as the threshold level.

[0050] It will also be appreciated that in certain driving environments or times of day that it is desirable for the lane discipline reminder function 60 to refrain from activating either of the warnings 62, 70. For example, during rush hour the stop and go nature of traffic in all lanes can result in the vehicle 12 being passed by other vehicles 32 multiple times, but the traffic congestion inherent in such situations would make warnings to the driver of vehicle 12 unnecessary or undesirable.

[0051] Determining that the vehicle 12 is currently engaged in rush hour or stop-and-go type traffic environments can be performed using various known vehicle and traffic sensors, or by monitoring the speed and speed changes of the vehicle 12, or other known methods via the controller 14 or associated control devices.

[0052] Similarly, if the vehicle 12 is present in a city environment rather than a highway environment, it may be desirable to refrain from warning the driver. For example, if the vehicle 12 is traveling between a series of stoplights or stop signs where frequent speed changes commonly occur, the rate at which the vehicle 12 accelerates and decelerates between such traffic control points can result in other vehicles 32 passing the vehicle 12. In such a situation, the vehicle 12 is not hindering traffic flow or the ability of the other vehicles to pass on the left.

[0053] Detecting the city environment can be performed by monitoring for speed and speed changes, vehicles and their proximity, camera or GPS recognition, or other known environmental detection methods via the controller 14 or other associated control devices.

[0054] Furthermore, it may be desirable to refrain from warning the driver or using the lane discipline reminder function 60 in instances where the vehicle 12 is present in a directional lane. A directional lane is one in which the driver is directed to be present, or one out of which the driver is directed to travel. For example, if the vehicle 12 is in a left-turn lane, the vehicle 12 may be passed by many vehicles, but is not hindering traffic flow, and it would be inappropriate to warn or instruct the driver to merge out of the left-turn lane. In another example, the vehicle

12 could be present in a lane that is about to merge with another highway, and it would be undesirable to warn or instruct the driver to depart from the lane.

[0055] Having described the abilities of a preferred embodiment of the system, as well as other aspects of other additional or alternative embodiments, a method 100 for executing the lane discipline reminder function 60 is illustrated with reference to Figure 10.

[0056] As shown in Figure 10, the method 100 for executing the lane discipline reminder is illustrated as a closed loop algorithm. At step 140, the controller 14 will determine, via the lane detect function 20, whether the vehicle 12 is traveling in the left lane of a multi-lane highway. If yes, the method 100 will proceed to the next step. If not, the method 100 will return to the start to continue monitoring for when the vehicle 12 is present in the left lane.

[0057] If the controller 14 determines that the vehicle 12 is in the left lane, at step 180 the controller 14 will determine, via the vehicle detection function 30, whether another vehicle is in the right lane traveling faster than the vehicle 12. If yes, the method 100 will proceed to the next step. If not, the method 100 will return to the start to continue monitoring for when the vehicle 12 is present in the left lane.

[0058] If the controller 14 determines that another vehicle is in the right lane traveling faster, then the method will proceed to step 199, where the controller 14 will activate the warning indicator 16.

[0059] After activating the warning indicator 16, the method 100 will return to the start.

[0060] Of course it will be appreciated that modifications to the method 100 are possible according to the above described functionality and capabilities of the system 10. For instance, the method could be modified that in the event that no vehicle was detected in the right lane traveling faster, the method 100 could continue to perform step 180 and monitor for vehicles in the right lane traveling faster without returning to the start of the method 100 to determine whether the vehicle was in the left lane. Similarly, after activating the warning indicator 16, the method 100 could return to step 180 to monitor for passing vehicles rather than determining whether the vehicle is in the left lane.

[0061] Another embodiment of the use of the system 10 is illustrated as a method 200 is illustrated in Figure 11.

[0062] With reference to Figure 11, the method 200 begins at step 210 by determining whether the vehicle 12 is traveling in a city or highway environment. This determination can be made by the controller 14 and, in one approach, by the lane detection function 20 and associated components. Of course, other known detection systems for determining a city or highway environment could also be used. If the controller 14 determines that the vehicle 12 is

traveling in a city environment, the method 200 will not perform any further steps and will return to the beginning. If the controller 14 determines that the vehicle 12 is traveling in a highway environment, then it will proceed to the next step.

[0063] In step 220, the controller 14 will determine whether the vehicle 12 is traveling in a stop and go traffic. This can be determined using known methods for monitoring vehicle speed and changes to vehicle speed. If the controller 14 determines that the vehicle 12 is in stop-and-go traffic, then the method 200 will return to the beginning or will continue monitoring the stop-and-go status of the vehicle 12. If the controller 14 determines that the vehicle 12 is not in stop-and-go traffic, the method 200 proceeds to the next step.

[0064] In step 240, the controller 14 determines whether the vehicle 12 is traveling in the left lane of a multi-lane highway as described above with reference to the lane detection function 20. If not, the method 200 will return to the beginning or will continue monitoring to determine whether the vehicle 12 is in the left lane. If the vehicle 12 is determined to be in the left lane, the method 200 will proceed to the next step.

[0065] In step 260, the controller 14 will determine if another vehicle is approaching from behind as described above with reference to the vehicle detection function 30. If not, the method 200 will return to the beginning or to continue monitoring to determine if another vehicle is approaching from behind. If another vehicle is determined to be approaching, the method 200 will proceed to the next step.

[0066] In step 270, the controller 14 will determine if the additional vehicle is in the right lane. If not, the method will return to the beginning or will continue to monitor to determine if another vehicle is present in the right lane. If the other vehicle is in the right lane, then the method 200 will proceed to the next step.

[0067] In step 280, the controller 14 will determine if the other vehicle, approaching from behind and in the right lane, is traveling faster than the vehicle 12. If not, the method 200 will return to the beginning or will continue to monitor to determine when the other vehicle is traveling faster.

[0068] If it is determined that the other vehicle is traveling faster at step 280, the method 200 will proceed to step 285, where the controller 14 will log in the database 54 that the vehicle 12 has been passed.

[0069] After logging an instance of the vehicle being passed at step 285, the controller 14 will monitor a period of time from the first logged instance. If the elapsed time exceeds a predetermined period of time T, then the method 200 will clear the log 54 at step 287.

[0070] If the elapsed time has not exceeded time T, then the controller 14 will determine whether the number of logged instances exceed a predetermined quantity L. If the number of logged instances exceeds the quantity L, then the method 200 will output a warning at step 299. The warning can be in the form of any of the warning indicators 16 described above. After outputting the warning, the method 200 will return to the beginning to continue monitoring.

[0071] If the number of logged instances is less than quantity L, then the method 200 will return to step 240, where it will monitor to determine if the vehicle 12 is in the left lane. The method 200 will continue to repeat steps 240, 260, 270, and 280, and will continue to log instances of the vehicle 12 being passed, until such point as the number of passing instances exceeds the predetermined quantity L within the predetermined time period T.

[0072] The above described method 200 is one example, and it will be appreciated that various steps could be modified to suit the needs of the user. For example, in the case where a determination is made such that the method 200 will go back to the beginning, the method 200 can be altered to go back to a particular step instead of the beginning, if desired. It may be desirable to return to an intermediate step without conducting preceding steps if the preceding steps are unlikely to result in a different condition. These determinations can be based on elapsed times or other events that would trigger whether an earlier step should be repeated. For example, if a relatively short period of time has elapsed, it is more likely that the vehicle 12 is still in the left lane, and repeating the step to determine whether the vehicle 12 is in the left lane may not be necessary.

[0073] The above description has related to driving conventions in the United States, where vehicles typically travel on the right side of the road. It will be appreciated that the system could also be used where it is typical for vehicles to travel on the left side of the road, such as in England or other foreign countries with similar driving conventions. In such an instance, references to the left and right lanes, and left and right positions relative to the vehicle 12 would be reversed.

[0074] The features of the subject matter of this case as set forth in the herein above description, the patent claims, the summary, and the drawings, can be important individually or in desired combinations with one another in order to realize the invention in its various forms.

[0075] The present invention is, of course, in no way restricted to the specific disclosure of the specification and drawings, but also encompasses any modifications within the scope of the appended claims. The foregoing description of various embodiments of the invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise embodiments disclosed. Numerous modifications or

variations are possible in light of the above teachings. The embodiments discussed were chosen and described to provide the best illustration of the principles of the invention and its practical application to thereby enable one of ordinary skill in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. All such modifications and variations are within the scope of the invention as determined by the appended claims when interpreted in accordance with the breadth to which they are fairly, legally, and equitably entitled.

What is claimed is:

1. A method for assisting a driver of a passenger vehicle, the method comprising:
detecting, at a controller installed within the passenger vehicle, that the passenger vehicle is traveling on a roadway having at least two lanes for travel in a first direction;
detecting that the passenger vehicle is traveling in a left lane of the at least two lanes;
detecting that a second vehicle is traveling in a right lane of the at least two lanes, wherein the right lane is different than the left lane;
detecting that the second vehicle is behind the passenger vehicle;
detecting that the second vehicle is traveling faster than the passenger vehicle;
detecting that the second vehicle has passed and is ahead of the passenger vehicle
outputting a warning from the controller to the driver, wherein the warning instructs the driver to depart from the left lane after detecting that the second vehicle is ahead of the passenger vehicle.
2. The method of claim 1, wherein the warning instructs the driver to merge into the right lane.
3. The method of claim 1 or 2, wherein the detecting that the passenger vehicle is traveling in the left lane is performed by receiving an output from a camera.
4. The method of one of claims 1-3, wherein the detecting that the second vehicle is traveling faster than the passenger vehicle is performed by receiving an output from a radar device.
5. The method of one of claims 1-4 further comprising logging an instance in a database that the second vehicle has passed the passenger vehicle.
6. The method of claim 5 further comprising detecting that at least one additional vehicle in addition to the second vehicle has passed the passenger vehicle and logging the at least one additional vehicle to define a number of passing vehicles.
7. The method of claim 6, wherein the outputting the warning is performed in response to the number of passing vehicles exceeding a predetermined threshold level.

8. The method of one of claims 1-7 further comprising detecting whether the passenger vehicle is engaged in stop-and-go traffic, and performing the method only in response to determining that the passenger vehicle is not engaged in stop-and-go traffic.
9. The method one of claims 1-8, further comprising detecting whether the vehicle is traveling in a city environment or a highway environment, and performing the method only in response to determining that the passenger vehicle is traveling in a highway environment.
10. The method of one of claims 5-9 further comprising measuring an elapsed time from a time corresponding to the logging in the database.
11. The method of claim 10 further comprising clearing the log in response to the elapsed time exceeding a predetermined level.
12. The method of claim 11, wherein the log is cleared in response to the detecting no further vehicles in addition to the second vehicle.
13. The method of one of claims 1-12, wherein the warning is at least one of an audible warning, a text-based warning, and a haptic warning.
14. The method of one of claims 1-13, further comprising detecting whether the passenger vehicle is present in a directional lane, and performing the method only in response to determining that the passenger vehicle is not present in a directional lane.
15. The method of one of claims 1-14, further comprising outputting an external warning to alert drivers of other vehicles that the vehicle is being passed by other vehicles.
16. An apparatus for providing lane discipline assistance to a driver of a first vehicle, the apparatus comprising a computer readable medium having instructions stored thereon that, when executing by a computing device, cause the computing device to perform steps comprising:
 - detecting, via a lane detect function, that the first vehicle is traveling in a first lane of a multi-lane highway;

detecting, via a vehicle detect function, that a second vehicle is traveling in a second lane of the multi-lane highway at a faster speed than the first vehicle;
determining that the second vehicle has passed the first vehicle; and
outputting a warning in response to determining that the second vehicle has passed the first vehicle.

17. The apparatus of claim 16, wherein the vehicle detect function includes a radar device to determine whether the second vehicle is traveling faster than the first vehicle.

18. The apparatus of claim 16 or 17, wherein the lane detect function includes cameras and an associated image processor to detect that the first vehicle is traveling in a multi-lane highway.

19. The apparatus of one of claims 16-18, wherein the warning instructs the driver to merge into the second lane where the second vehicle had been detected.

20. The apparatus of one of claims 16-19, wherein the first lane is a left lane and the second lane is a right lane.

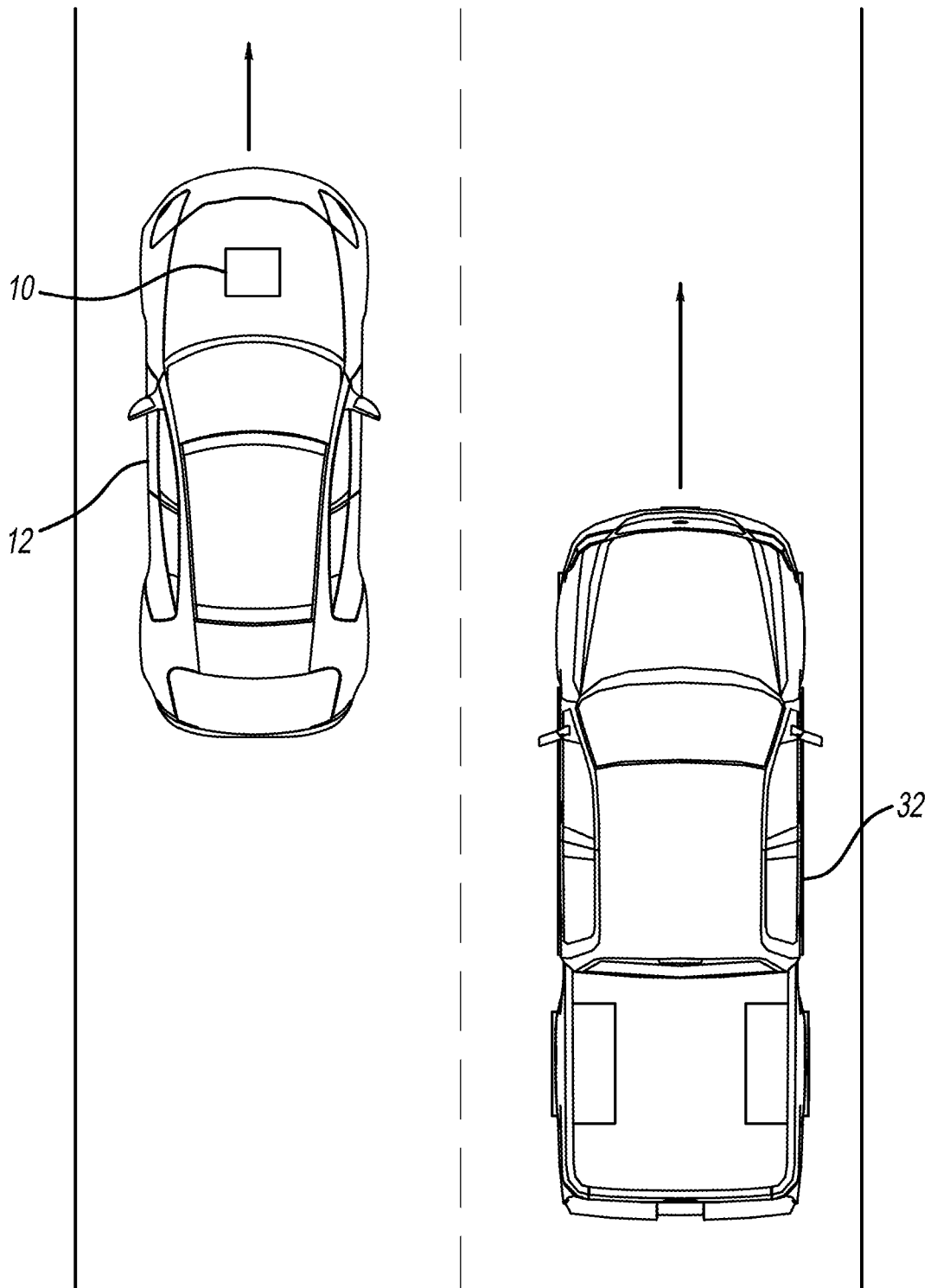
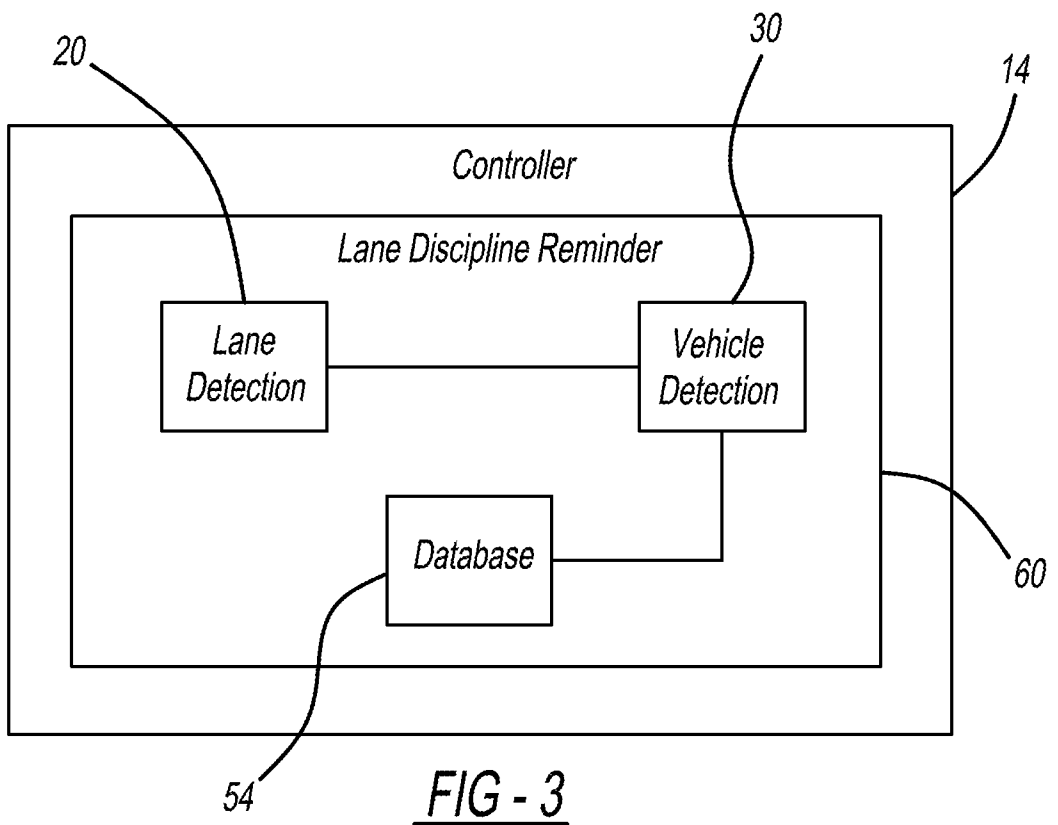
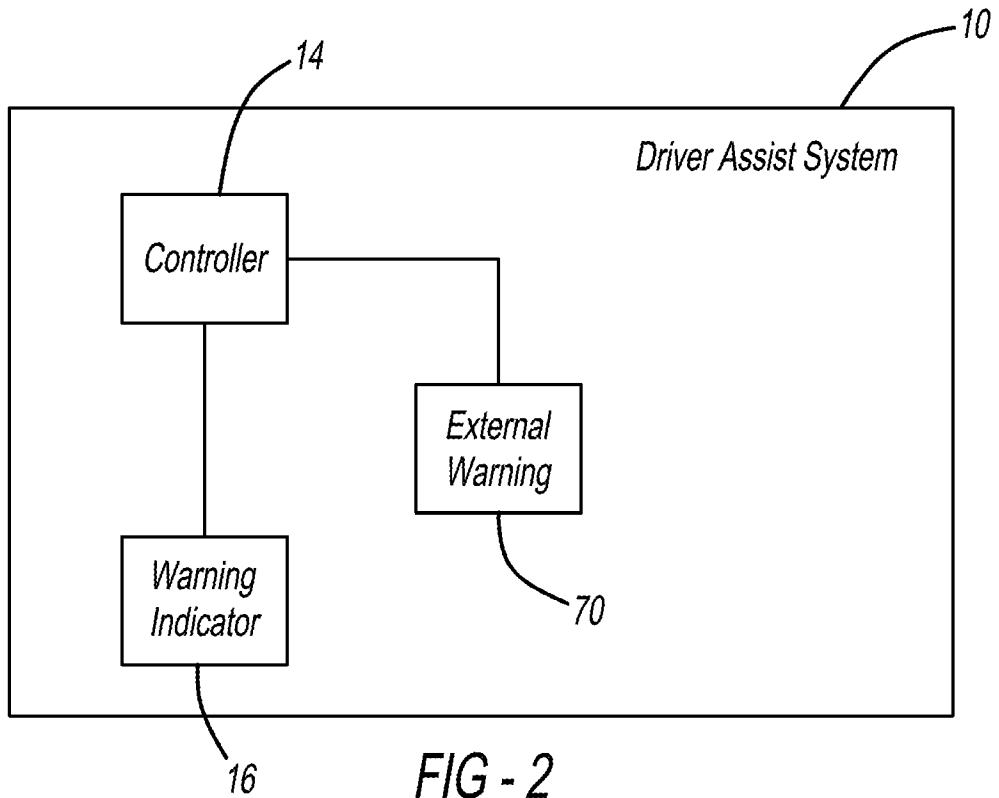
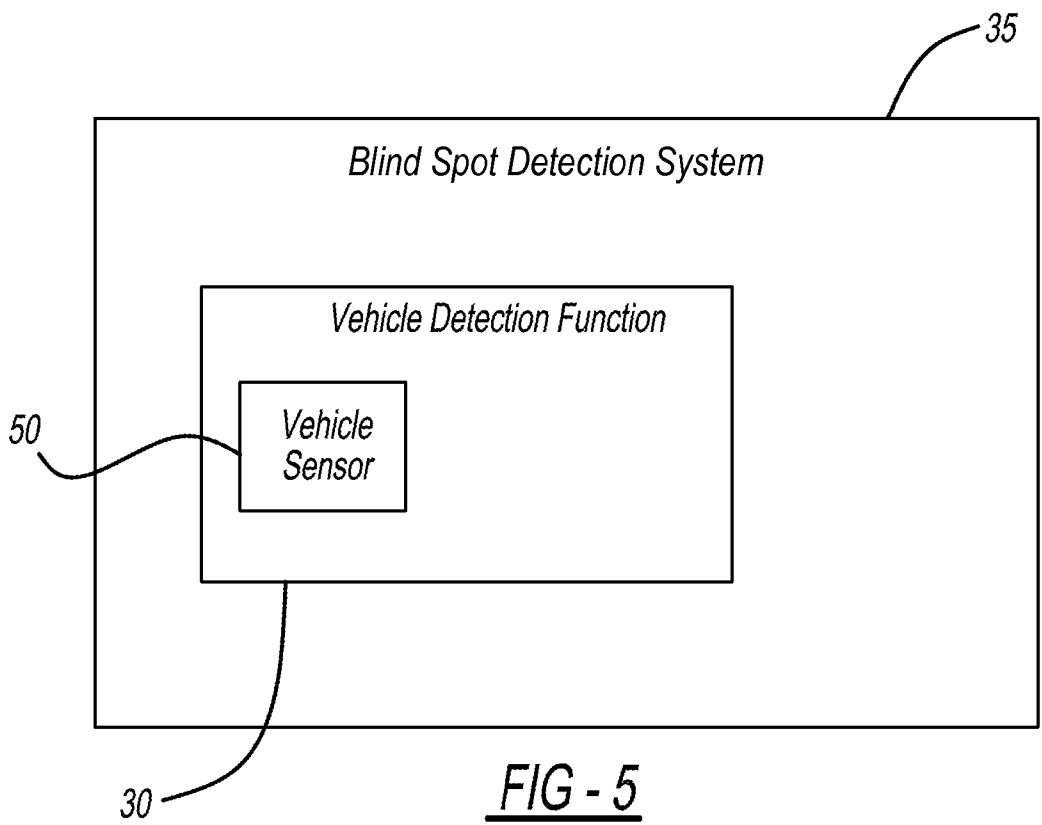
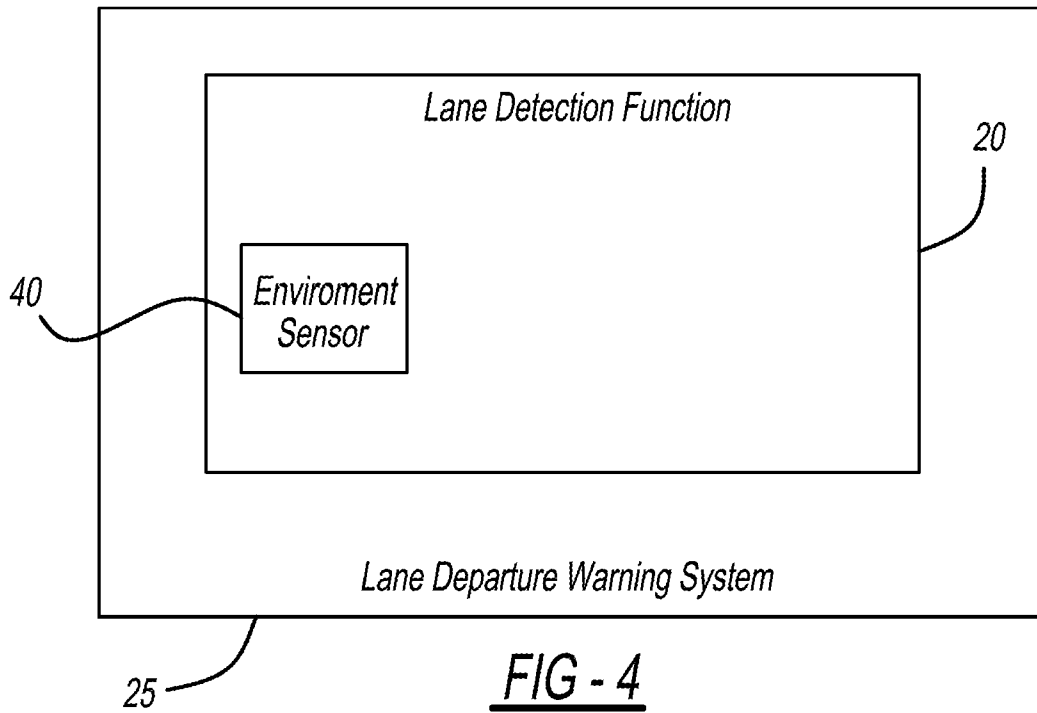


FIG - 1





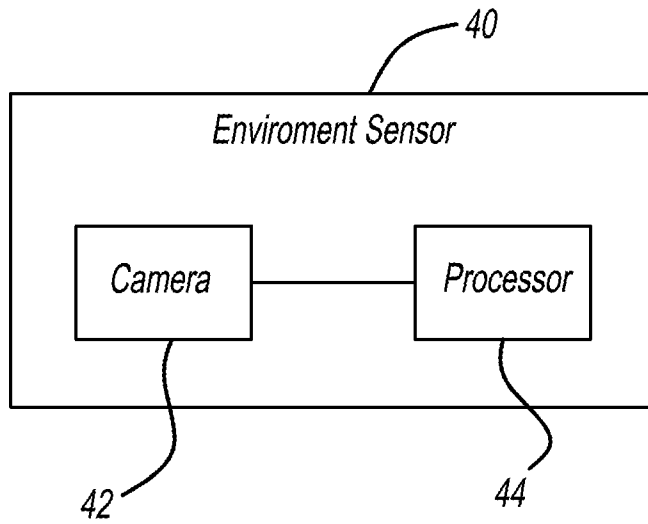


FIG - 6

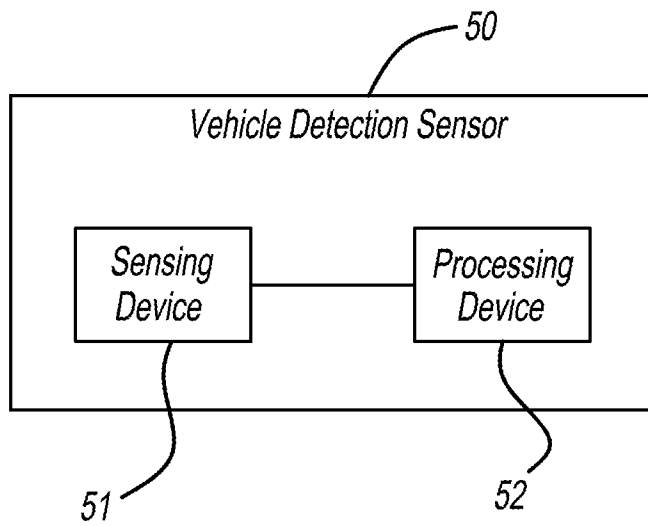


FIG - 7

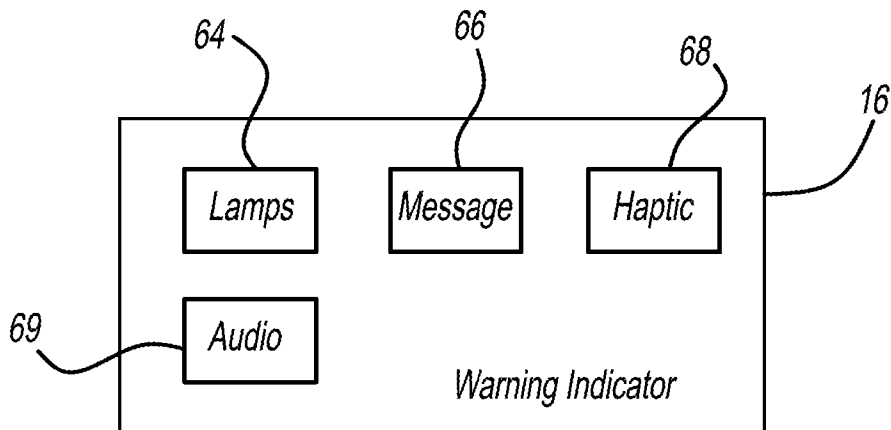


FIG - 8

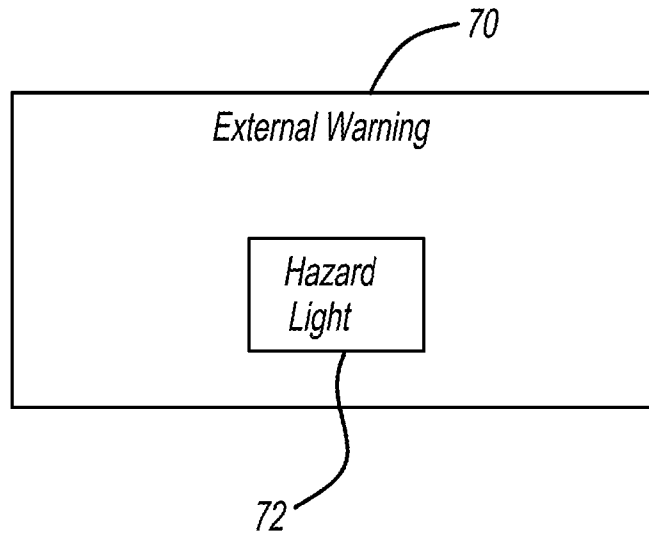


FIG - 9

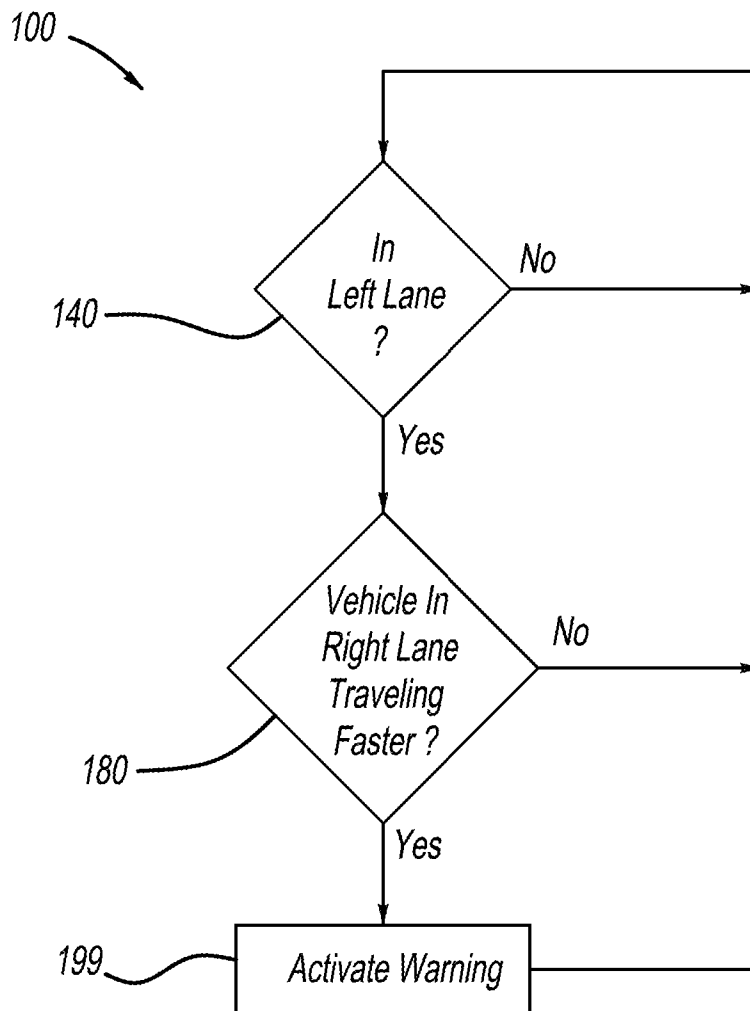
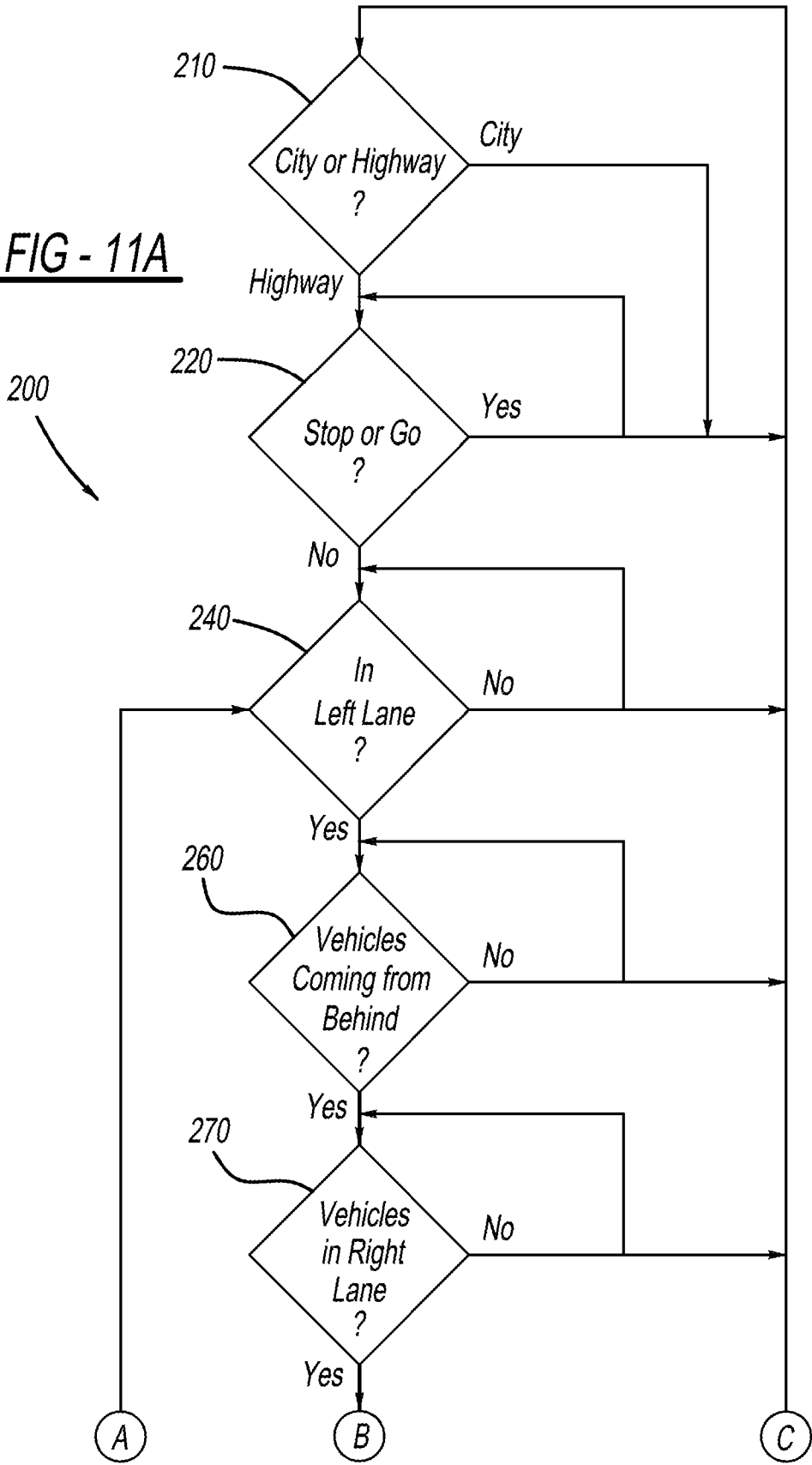


FIG - 10

FIG - 11A



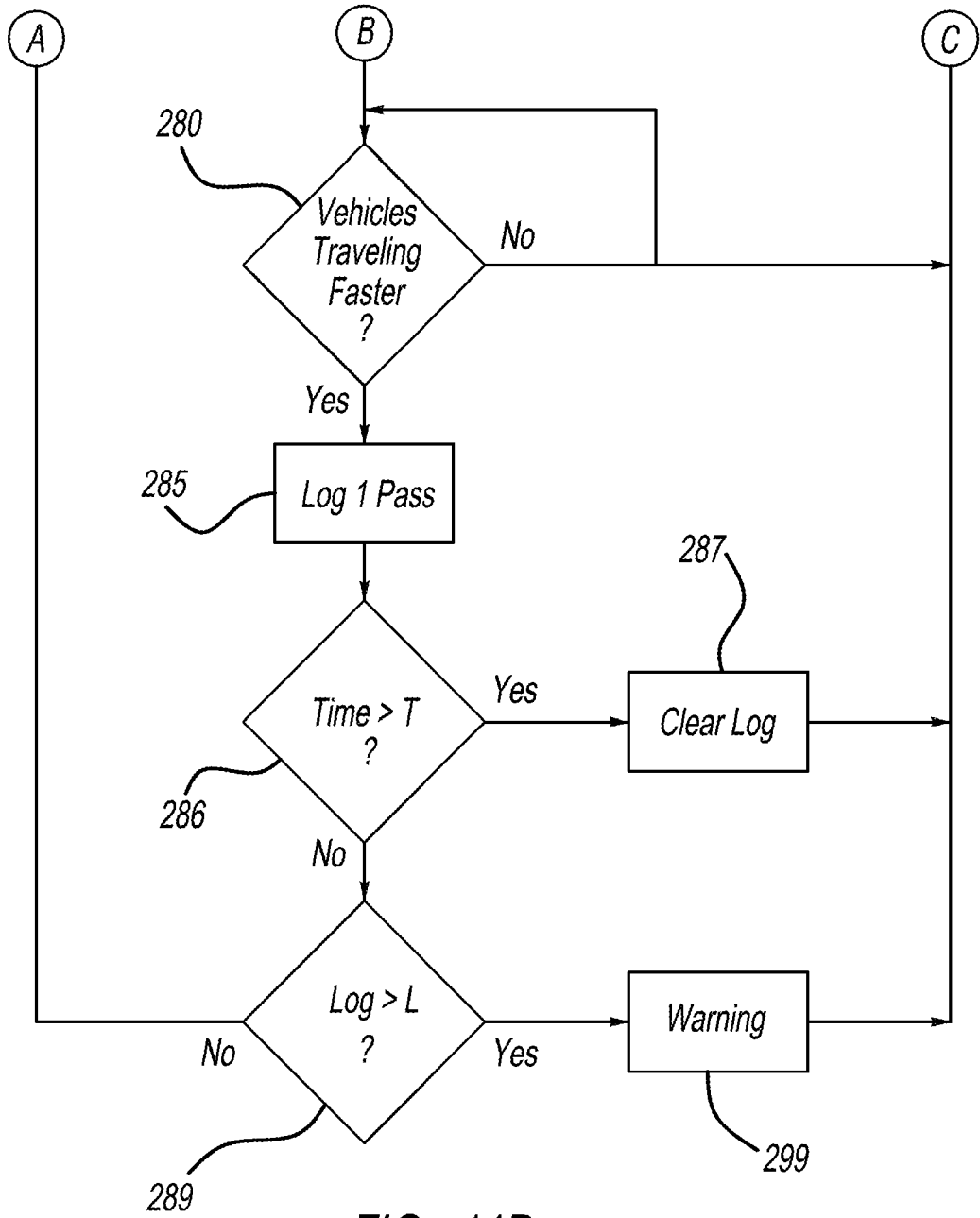


FIG - 11B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 15/33687

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - G06F 17/00 (2015.01), G06G 7/78 (2015.01)
CPC - G01C 21/20, G01C 21/26, G09B 29/2016
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(8)-G06F 17/00 (2015.01), G06G 7/78 (2015.01)
CPC-G01C 21/20, G01C 21/26, G09B 29/2016

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC-701/301, 701/1, 701/9, 701/10, 701/300, 700/1, 700/90
CPC-G01C 21/20, G01C 21/26, G09B 29/2016, G01C 21/00, G01C 21/22; IPC(8)-G06F 17/00 (2015.01), G06G 7/78 (2015.01)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PatBase, Google Web, Google Scholar, Google Patents
Search Terms Used: lane, driver, collision, vehicle, lane change, merge

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 8,466,806 B2 (Schofield) 18 June 2013 (18.06.2013); entire document especially abstract; col 5, ln 4-col 8, ln 35.	1-3, 16-18
A	US 2014/0074356 A1 (Bone et al.) 13 March 2014 (13.03.2014); entire document.	1-3, 16-18
A	US 8,452,535 B2 (Zeng et al.) 28 May 2013 (28.05.2013); entire document.	1-3, 16-18

Further documents are listed in the continuation of Box C.

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent but published on or after the international filing date	"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
"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)	"&" document member of the same patent family
"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	

Date of the actual completion of the international search 31 July 2015 (31.07.2015)	Date of mailing of the international search report 31 AUG 2015
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Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 15/33687

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos.: 4-15 and 19-20
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.