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(54) **VEHICLE GUIDANCE SYSTEM AND METHOD FOR OPERATING A DRIVING FUNCTION IN DIFFERENT MODES**

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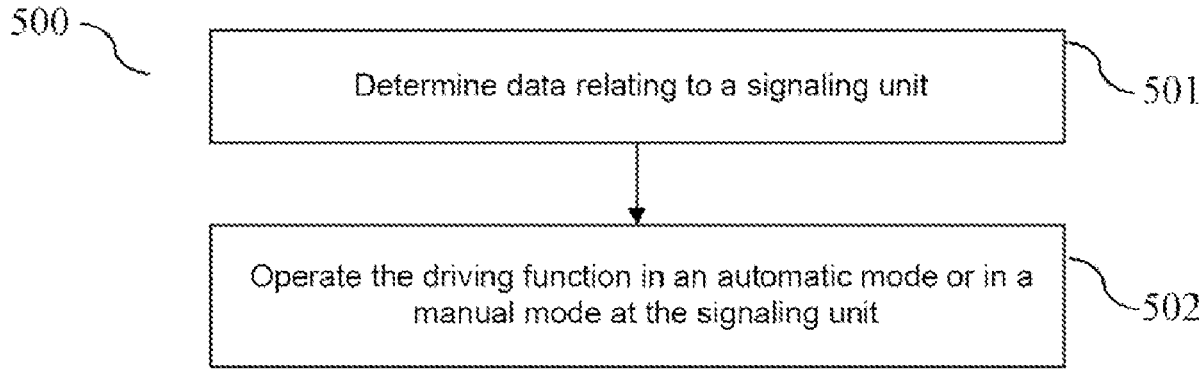
(57) **ABSTRACT**

A vehicle guidance system provides a driving function for automated longitudinal guidance of a vehicle. The vehicle guidance system is designed to determine data relating to a first signaling unit located ahead in the travel direction of the vehicle. Furthermore, the vehicle guidance system is designed to operate the driving function in an automatic mode or in a manual mode at the first signaling unit depending upon the data relating to the first signaling unit, and in the automated longitudinal guidance of the vehicle the first signaling unit is taken into account automatically in the automatic mode, and in the manual mode only after confirmation by a user.



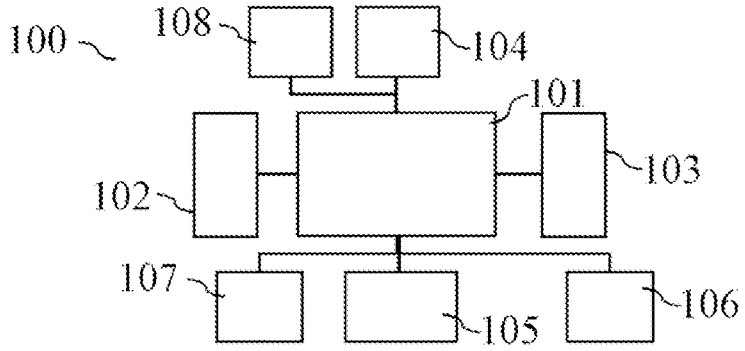


Fig. 1

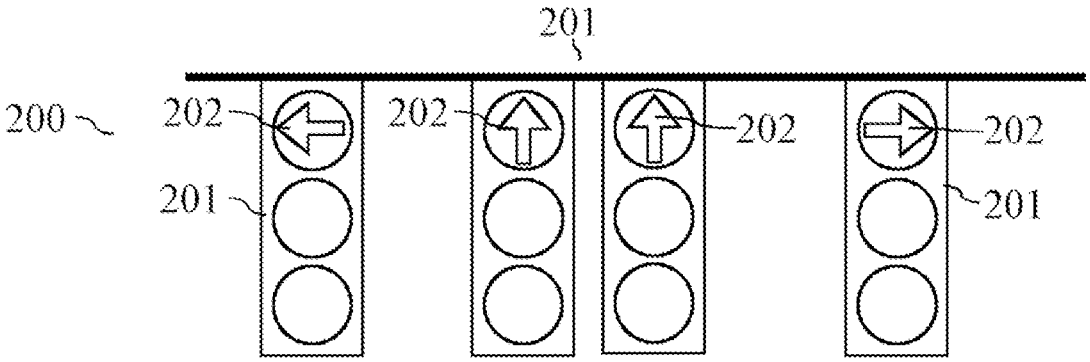


Fig. 2a

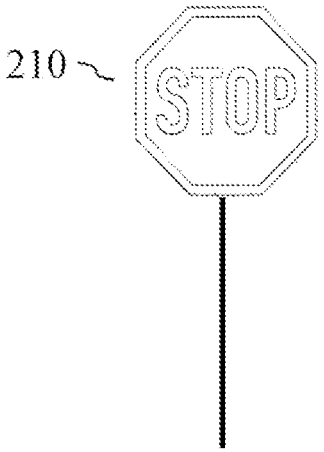


Fig. 2b

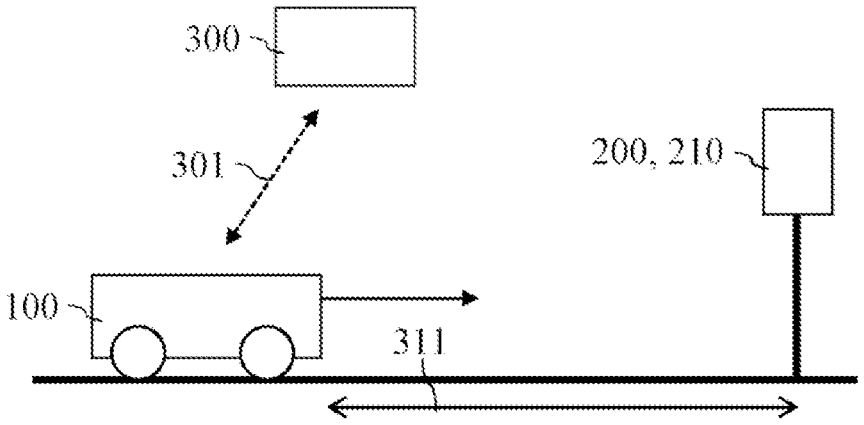


Fig. 3

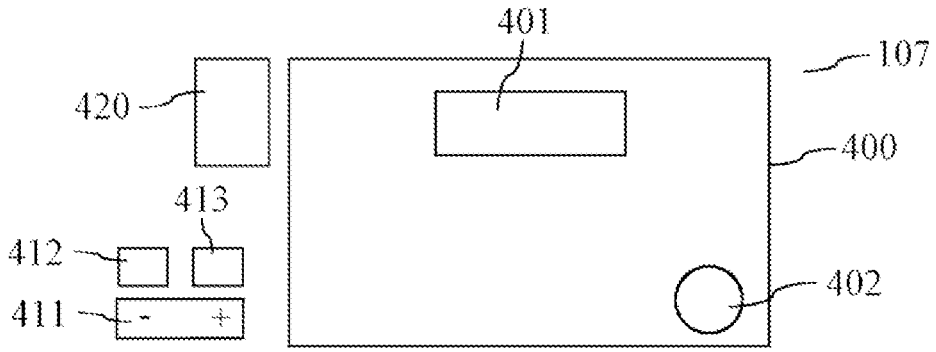


Fig. 4

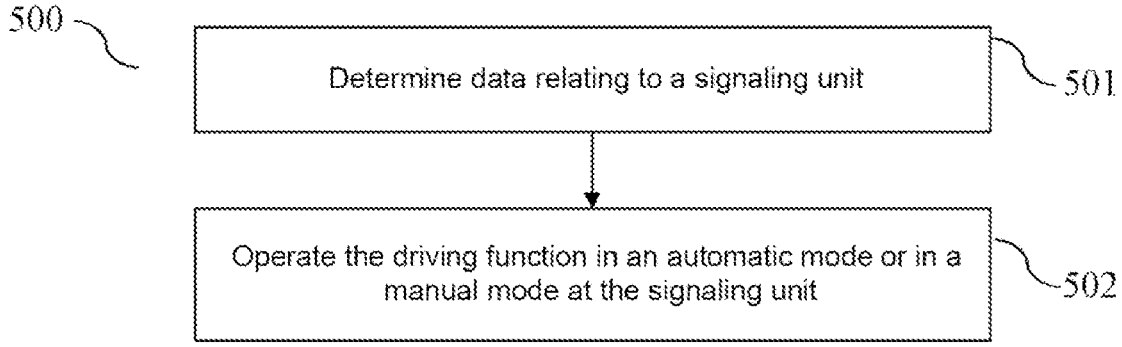


Fig. 5a

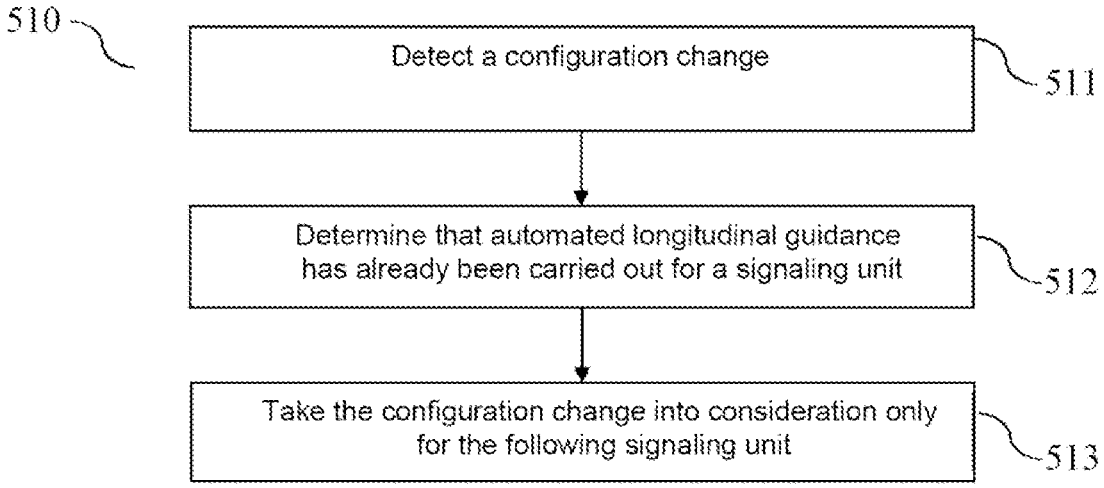

510
Detect a configuration change
511
Determine that automated longitudinal guidance has already been carried out for a signaling unit
512
Take the configuration change into consideration only for the following signaling unit
513

Fig. 5b

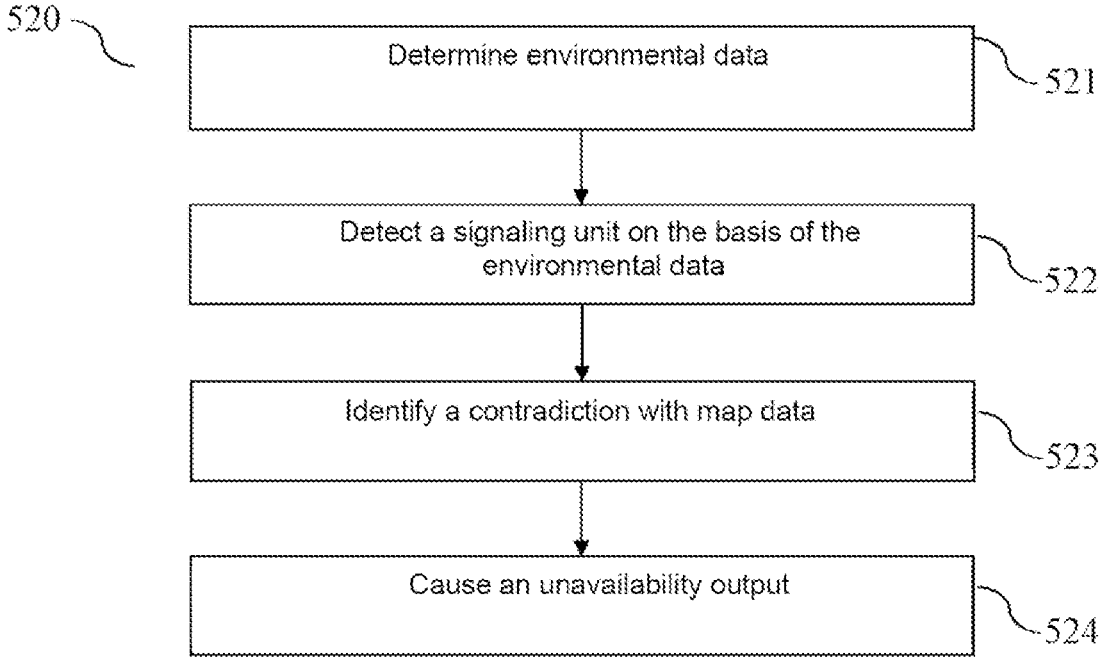

520
Determine environmental data
521
Detect a signaling unit on the basis of the environmental data
522
Identify a contradiction with map data
523
Cause an unavailability output
524

Fig. 5c

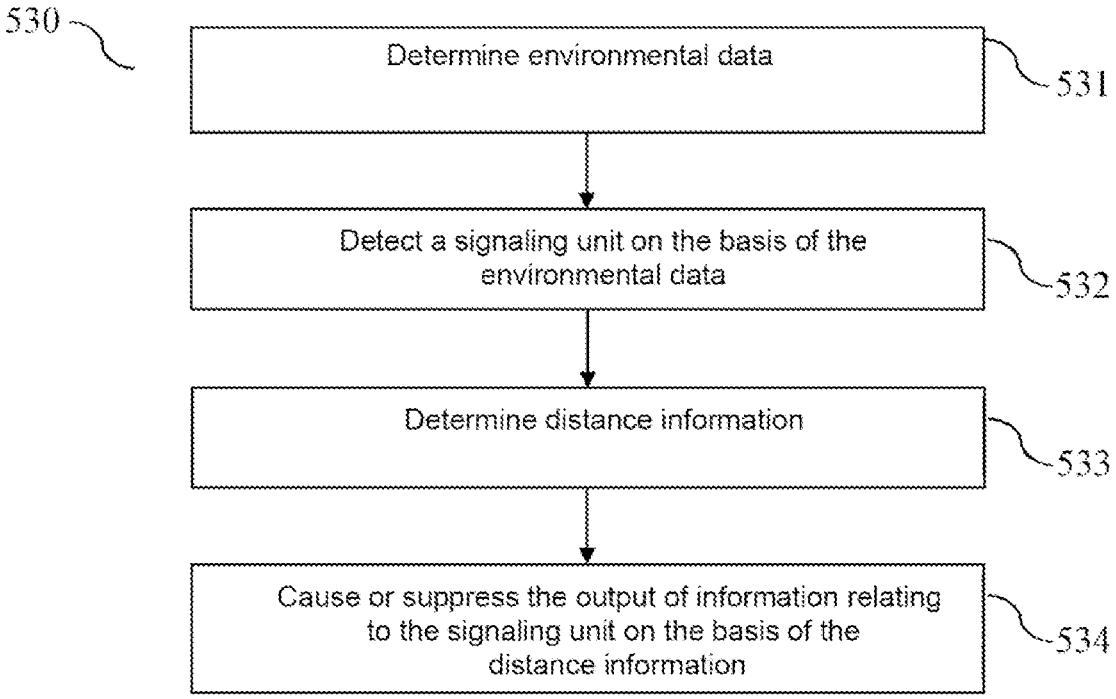

530
Determine environmental data
531
Detect a signaling unit on the basis of the environmental data
532
Determine distance information
533
Cause or suppress the output of information relating to the signaling unit on the basis of the distance information
534

Fig. 5d

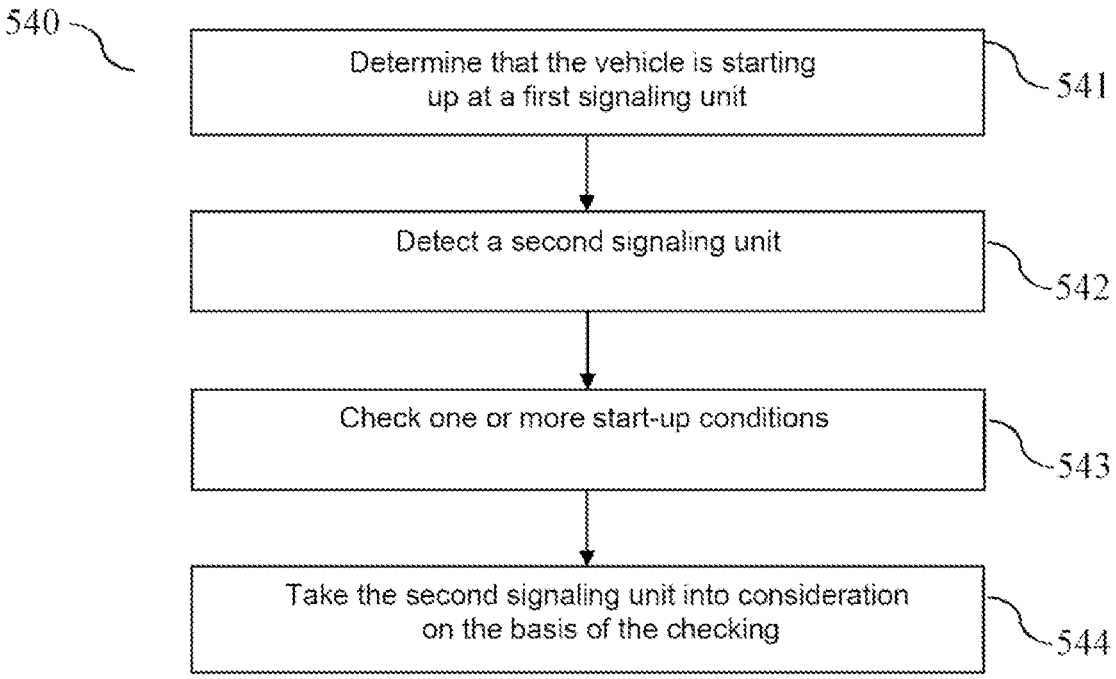

540
Determine that the vehicle is starting up at a first signaling unit
541
Detect a second signaling unit
542
Check one or more start-up conditions
543
Take the second signaling unit into consideration on the basis of the checking
544

Fig. 5e

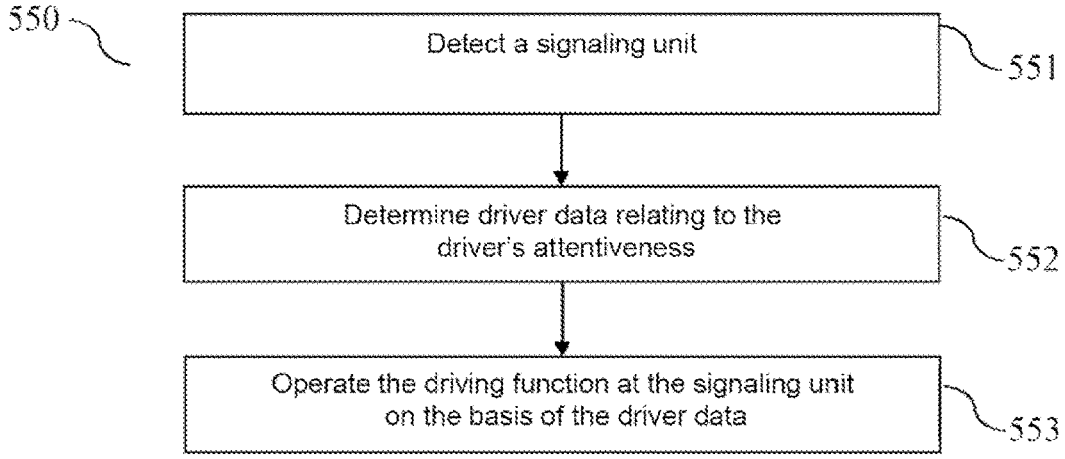


Fig. 5f

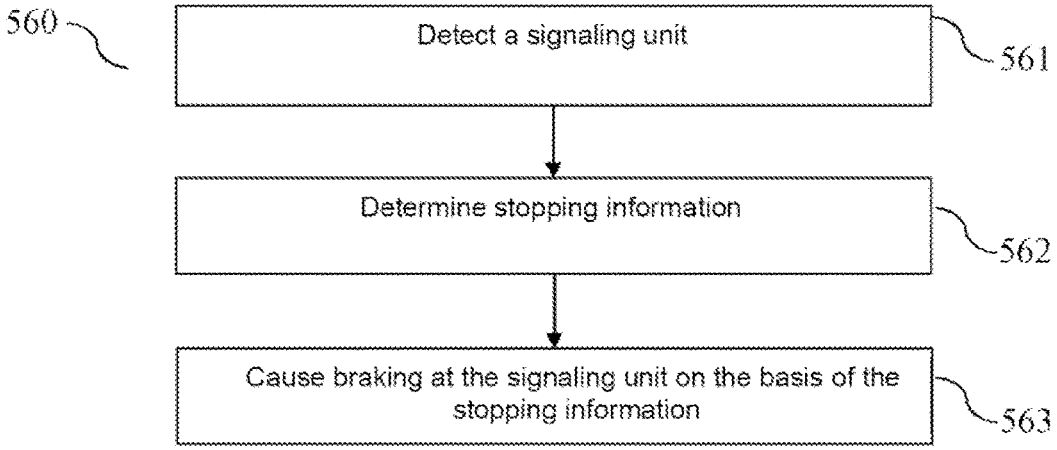


Fig. 5g

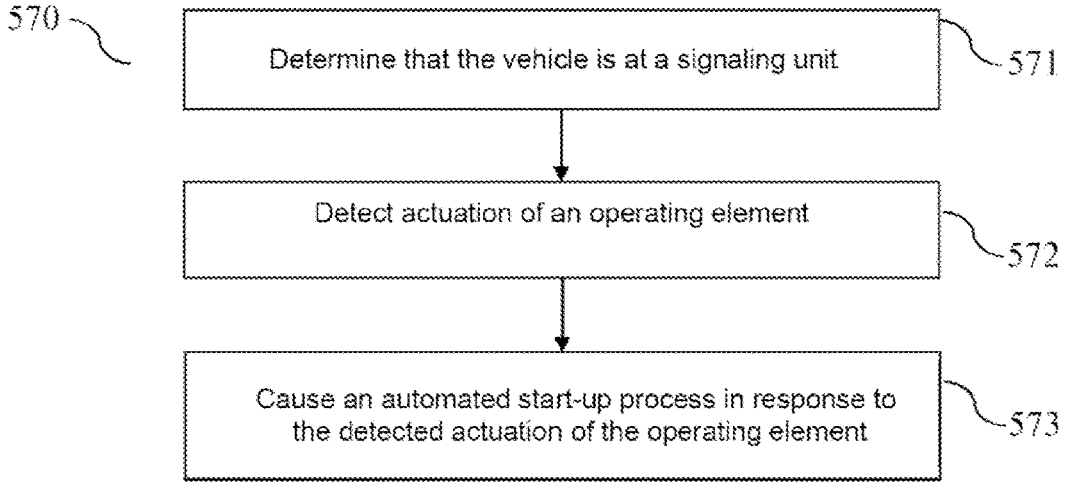


Fig. 5h

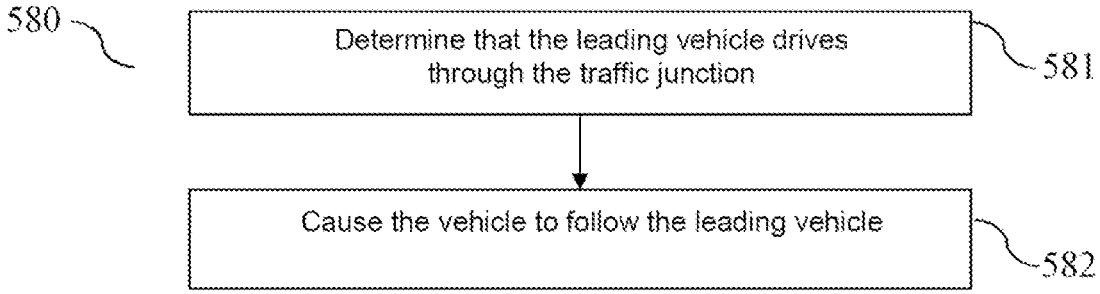


Fig. 5i

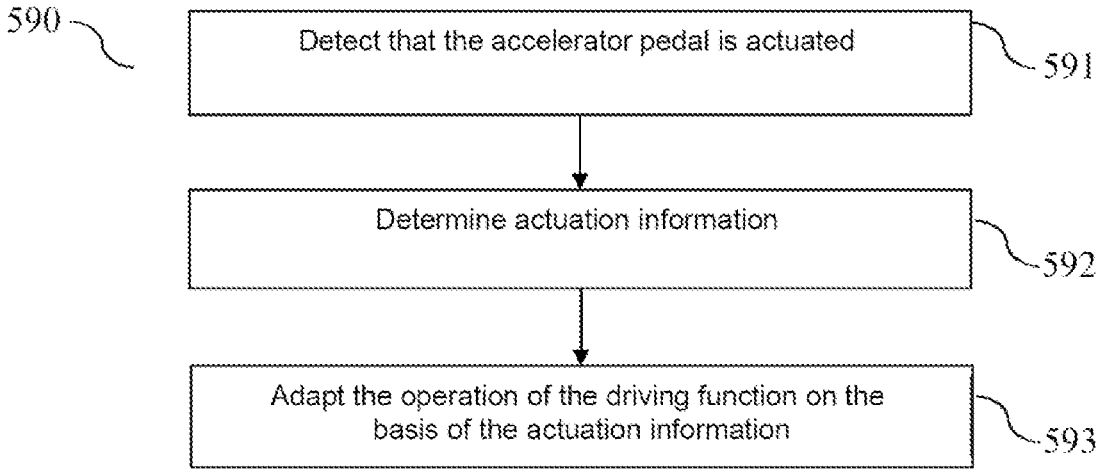


Fig. 5j

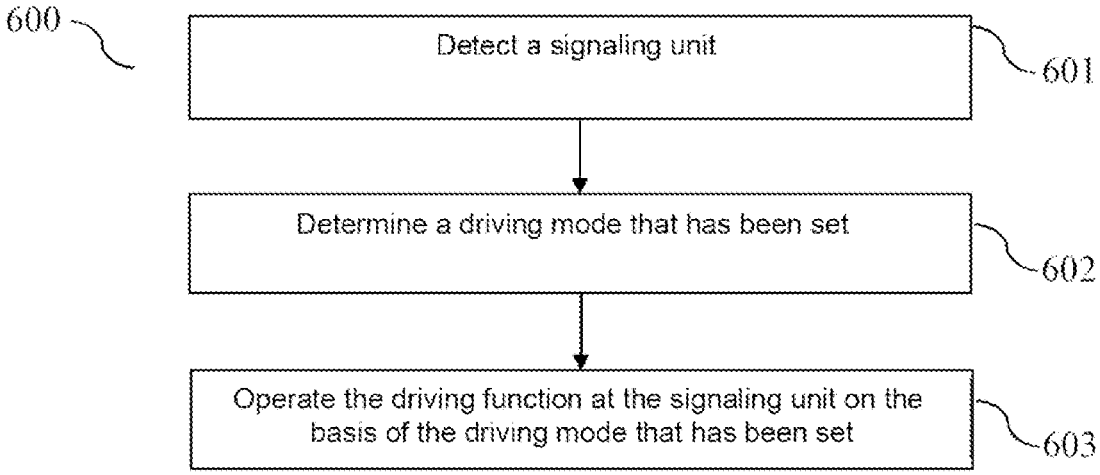


Fig. 6

VEHICLE GUIDANCE SYSTEM AND METHOD FOR OPERATING A DRIVING FUNCTION IN DIFFERENT MODES

BACKGROUND AND SUMMARY

[0001] The invention relates to a vehicle guidance system and to a corresponding method for operating a driving function, in particular a driver assistance function, of a vehicle in connection with a signaling unit.

[0002] A vehicle may have one or more driving functions which assist the driver of the vehicle with the guidance, in particular the longitudinal guidance, of the vehicle. An exemplary driving function for assisting with the longitudinal guidance of a vehicle is the Adaptive Cruise Control (ACC) function which can be used, for example on a highway or freeway, to longitudinally guide the vehicle at a defined set or target driving speed and/or at a defined target distance from a leading vehicle driving in front of the vehicle.

[0003] In urban areas, when driving on a street, a vehicle often encounters junctions between the street being used by the vehicle and one or more other traffic routes (for example another street, a pedestrian walkway, etc.). A light signal installation and/or a traffic sign (for instance a stop sign) may be arranged at a junction and is/are used to control the right of way at the junction. A light signal installation and/or a traffic sign for defining the right of way at, and/or the permission to enter or drive across, a junction is/are generally referred to as a signaling unit in this document.

[0004] The present document deals with the technical object of providing a driving function, in particular a driver assistance function, for the automated longitudinal guidance of a vehicle, which is configured to take signaling units into consideration in a reliable and robust manner, in particular in order to increase the availability and/or the safety and/or the comfort of the driving function.

[0005] The object is achieved by each individual independent claim. Advantageous embodiments are described, inter alia, in the dependent claims. It is pointed out that additional features of a patent claim dependent on an independent patent claim may form, without the features of the independent patent claim or only in combination with a subset of the features of the independent patent claim, a separate invention which is independent of the combination of all features of the independent patent claim and can be made into the subject matter of an independent claim, a divisional application or a subsequent application. This applies in the same manner to technical teachings which are described in the description and may form an invention that is independent of the features of the independent patent claims.

[0006] One aspect describes a vehicle guidance system for providing a driving function for the automated longitudinal guidance of a vehicle. The driving function may be designed, in particular, to longitudinally guide the vehicle in an automated manner at and/or in connection with a signaling unit. In this case, the driving function may be designed according to SAE level 2. In other words, the driving function may possibly provide automated driving and/or driver assistance (in relation to the longitudinal guidance) according to SAE level 2. The driving function may be restricted to the longitudinal guidance of the vehicle. The lateral guidance of the vehicle may be provided manually by the driver or by a further and/or separate driving function (for example by a lane-keeping assistant) during operation.

[0007] The vehicle guidance system may be configured to longitudinally guide the vehicle in an automated manner according to a set or target speed and/or according to a target distance from a leading vehicle driving (directly) in front of the vehicle. For this purpose, the vehicle guidance system may provide a speed controller which sets, in particular controls, the actual driving speed of the vehicle according to the set or target speed. Alternatively or additionally, it is possible to provide a distance controller which sets, in particular controls, the actual distance of the vehicle from the leading vehicle according to the target distance. If there is no relevant leading vehicle or if the leading vehicle is driving faster than the set or target speed, the driving speed of the vehicle can be controlled. Alternatively or additionally, if the leading vehicle is driving more slowly than the set or target speed, the distance of the vehicle from the leading vehicle can be controlled. The vehicle guidance system may therefore be configured to provide an Adaptive Cruise Control (ACC) driver assistance function.

[0008] The vehicle and the vehicle guidance system may comprise a user interface for interacting with a user, in particular with the driver, of the vehicle. The user interface may comprise one or more operating elements which make it possible for the user to define the set or target speed and/or the target distance. Alternatively or additionally, the one or more operating elements may make it possible for the user to confirm a previously defined set and/or target speed and/or a previously designed target distance of the vehicle for the operation of the driving function. The one or more operating elements may be designed to be actuated using a hand and/or a finger of the driver. Alternatively or additionally, the one or more operating elements may be arranged on a steering means (in particular on a steering wheel or a steering handle) of the vehicle.

[0009] An exemplary operating element (in particular a plus/minus operating element) is a button and/or a rocker which can be used to increase or reduce the set and/or target speed or the target distance. A further exemplary operating element (in particular a set operating element) is a button which can be used to define a current driving speed of the vehicle as a set and/or target speed and can be used to define a current distance of the vehicle from the leading vehicle as a target distance. A further exemplary operating element (in particular a resume operating element) is a button which can be used to reconfirm or reactivate a set and/or target speed that has previously been set or a target distance which has previously been set.

[0010] The user interface may also comprise one or more output elements (for example a screen and/or a loudspeaker and/or a vibration element) which can be used to effect outputs to the user of the vehicle.

[0011] Furthermore, the vehicle guidance system may be configured to take into consideration one or more signaling units on the road (in particular street) and/or travel route used by the vehicle during the automated longitudinal guidance. A signaling unit may be provided for the purpose of defining the right of way at a junction (in particular an intersection) of the road network used by the vehicle. In this case, the definition of the right of way may be variable over time (like, for example, in the case of a light signal installation, for instance a traffic light system, having one or more different signal groups for one or more different directions of

travel of the vehicle at the junction) or may be permanently specified (like, for example, in the case of a traffic sign, for instance a stop sign).

[0012] The vehicle guidance system may be configured to determine data relating to a signaling unit located ahead in the direction of travel of the vehicle. The data may comprise map data relating to signaling units in the road network used by the vehicle. The map data may each comprise one or more attributes for a signaling unit. The one or more attributes for a signaling unit may indicate or comprise:

[0013] a type of the signaling unit, in particular whether the signaling unit is a light signal installation or a traffic sign; and/or

[0014] a number of different signal groups of the signaling unit for different directions of travel at the junction of the road network at which the signaling unit is arranged or with which the signaling unit is associated; and/or

[0015] a position (for example the GPS coordinates) of the signaling unit and/or of the stop line of the signaling unit within the road network; and/or

[0016] a relative distance of the stop line from the associated signaling unit.

[0017] The vehicle guidance system may be configured to determine the actual position (for example the current GPS coordinates) of the vehicle within the road network using a position sensor (for example a GPS receiver) of the vehicle. A (for example the next) signaling unit on the travel route of the vehicle can then be detected on the basis of the map data. One or more attributes relating to the detected signaling unit may also be determined.

[0018] Alternatively or additionally, the data relating to a signaling unit located ahead in the direction of travel of the vehicle may comprise environmental data relating to the signaling unit or may be determined on the basis of environmental data. The environmental data may be captured by one or more environmental sensors of the vehicle. Exemplary environmental sensors are a camera, a radar sensor, a lidar sensor, etc. The one or more environmental sensors may be configured to capture sensor data (that is to say environmental data) relating to the environment in front of the vehicle in the direction of travel.

[0019] The vehicle guidance system may be configured to detect, on the basis of the environmental data (in particular on the basis of the sensor data from a camera), that a signaling unit is arranged in front of the vehicle in the direction of travel. An image analysis algorithm, for example, can be used for this purpose. Furthermore, the vehicle guidance system may be configured to determine the type of the signaling unit (for example light signal installation or traffic sign) on the basis of the environmental data. The vehicle guidance system may also be configured to determine, on the basis of the environmental data, the (signaling) state of the signaling unit with respect to the permission to drive cross the junction associated with the signaling unit. In particular, the colors (green, amber or red) of the one or more signal groups of a light signal installation can be determined.

[0020] The vehicle guidance system may be configured to take a detected signaling unit into consideration during the automated longitudinal guidance of the vehicle. In particular, the vehicle guidance system may be configured to determine whether or not the vehicle must stop at the signaling unit, in particular at the stop line of the signaling unit, on the basis of the data relating to the detected signaling unit, in particular on the basis of the color of a light signal from or of a signal group of the signaling unit that is indicated by the data. For example, it is possible to identify that the vehicle must stop since the signal group relevant to the vehicle is read. Alternatively, it is possible to identify that the vehicle need not stop since the signal group relative to the vehicle is green. In a further example, it is possible to identify that the vehicle must stop since the signaling unit is a stop sign.

[0021] The vehicle guidance system may also be configured to cause the vehicle to be stopped in an automated manner at the detected signaling unit if it is determined that the vehicle must stop at the signaling unit. An automated deceleration process (to a standstill) can be effected for this purpose. In this case, the vehicle can be guided in an automated manner up to or in front of the stop line of the signaling unit. During the automated deceleration process, the vehicle guidance system can control one or more wheel brakes (for example one or more friction brakes or one or more regenerative brakes) in an automated manner in order to brake the vehicle (to a standstill). In this case, the temporal profile of the effected deceleration may depend on the available braking distance to the detected signaling unit.

[0022] Alternatively or additionally, the vehicle guidance system may be configured to cause the vehicle to be longitudinally guided in an automated manner past the detected signaling unit, in particular across the stop line of the signaling unit, if it is determined that the vehicle need not stop at the signaling unit. In this case, the speed and/or distance control according to the set or target speed and/or according to the target distance from the leading vehicle can be continued.

[0023] The vehicle guidance system may therefore be configured to provide an ACC driving function, taking signaling units into consideration. In this document, the driving function is also referred to as an Urban Cruise Control (UCC) driving function.

[0024] As already explained further above, the vehicle guidance system may be configured to longitudinally guide the vehicle within the scope of the driving function in an automated manner on the basis of a target speed and/or on the basis of a target distance from a leading vehicle driving in front of the vehicle. The vehicle guidance system may also be configured, if a (possibly detected) signaling unit is not taken into consideration in the driving function, to longitudinally guide the vehicle in an automated manner past the signaling unit, in particular beyond the stop line of the signaling unit, on the basis of the target speed and/or on the basis of the target distance, in particular irrespective of the color of a light signal from the signaling unit. The driving function may therefore possibly be operated (if a signaling unit is not taken into consideration) as if the signaling unit (and the associated junction) did not exist.

[0025] The vehicle guidance system may possibly make it possible for the user of the vehicle to configure the driving function via the user interface (for example in a configuration menu). In this case, it is possible to set, if appropriate, whether the driving function is intended to be operated in an automatic mode or is intended to be operated in a manual mode.

[0026] In the automatic mode, the driving function can be operated in such a manner that a signaling unit that is detected by the vehicle guidance system and is located ahead

in the direction of travel is automatically taken into consideration during operation of the driving function (and possibly results in automated deceleration of the vehicle). In particular, the vehicle guidance system in the automated mode may be configured to take into consideration a signaling unit, which is detected on the basis of map data and/or environmental data, automatically, in particular without confirmation by the user of the vehicle, during the automated longitudinal guidance of the vehicle (for example in order to cause automated deceleration of the vehicle at the detected signaling unit if necessary).

[0027] On the other hand, the driving function can be operated in the manual mode in such a manner that the detected signaling unit is taken into consideration during the automated longitudinal guidance of the vehicle only after confirmation by the user of the vehicle (and possibly results in automated deceleration of the vehicle). In particular, the vehicle guidance system in the manual mode may be configured to output an offer relating to the consideration of the detected signaling unit to the user of the vehicle (via the user interface of the vehicle). For example, it can be displayed on the screen that a signaling unit has been detected and feedback from the user is required (in order to cause the signaling unit to be taken into consideration during the automated longitudinal guidance of the vehicle). The detected signaling unit (in particular the signaling state of the signaling unit) can then (in particular only then) be taken into consideration during the automated longitudinal guidance of the vehicle at the signaling unit when the offer is accepted by the user (for example by actuating an operating element, in particular the set operating element). Automated deceleration of the vehicle at the detected signaling unit is then carried out, if necessary. On the other hand, the vehicle guidance system may be configured to not take the detected signaling unit (in particular the signaling state of the signaling unit) into consideration and/or to ignore it during the automated longitudinal guidance of the vehicle at the signaling unit if the offer is not accepted by the user. In this case, the speed and/or distance control can be continued (without taking the signaling unit into consideration, in particular as if the signaling unit were not present).

[0028] The comfort of the driving function can be increased further by providing different (settable) modes for operating the driving function (in particular the UCC driving function).

[0029] The vehicle guidance system may be designed to inform the user of the driving function about the status of the driving function using the user interface. In particular, the user of the driving function can be informed about whether or not a signaling unit, which is detected by the vehicle guidance system and is located ahead in the direction of travel, is taken into consideration during operation of the driving function, in particular during the automated longitudinal guidance of the vehicle.

[0030] In particular, the vehicle guidance system may be configured to determine (for example on the basis of the map data and/or the environmental data), whether or not a signaling unit that is located ahead in the direction of travel is or can be taken into consideration during operation of the driving function. If the signaling unit is or can be taken into consideration, an availability output, in particular an availability display, can possibly be output in order to inform the user that the signaling unit located ahead is taken into consideration during the automated longitudinal guidance of the vehicle (and therefore there is automated deceleration of the vehicle at the signaling unit if necessary).

[0031] Alternatively or additionally, the vehicle guidance system may be configured (if it is determined that the signaling unit located ahead is not or cannot be taken into consideration in the driving function) to effect an unavailability output, in particular an unavailability display, (via the user interface) in order to inform the user of the vehicle that the signaling unit located ahead is not taken into consideration during the automated longitudinal guidance of the vehicle (and therefore there is also no automated deceleration of the vehicle on the basis of the signaling state of the signaling unit).

[0032] The comfort and the safety of the driving function can be increased further by outputting an availability and/or unavailability output. The availability and/or unavailability outputs may each comprise an optical, acoustic and/or haptic output.

[0033] The vehicle guidance system may be configured to determine that the signaling state of that signal group of the signaling unit which is relevant to the direction of travel of the vehicle changes (for example while the vehicle is moving toward the signal group or while the vehicle is at the signal group). For example, it is possible to detect that a phase changes from red to green.

[0034] The vehicle guidance system may also be configured (in response to the detected phase change) to cause information relating to the changed signaling state of the signal group of the signaling unit to be communicated to the driver of the vehicle. For example, it is possible to cause a symbol of the signaling unit that is detected (and is possibly taken into consideration during the automated longitudinal guidance) to be displayed via an output element (in particular on a screen) of the user interface as long as the signal group has the color red. After a detected phase change to green, the displayed symbol can then be withdrawn if appropriate and the output can be ended. It is therefore possible to reliably communicate to the driver of the vehicle that a (possibly automated) start-up process can be effected (for example by actuating an operating element of the user interface), for example after the vehicle has been at a standstill at the signaling unit. In this case, the display can be consistently withdrawn in the automatic mode and/or in the manual mode of the driving function.

[0035] The vehicle guidance system may be configured to output a takeover request to the driver of the vehicle if the driving function is aborted. For example, it is possible to identify that the automated longitudinal guidance (on the basis of the set and/or target speed and/or on the basis of the target distance) cannot be continued or is not continued. The driving function can be aborted, for example, if the driver of the vehicle (substantially) intervenes in the longitudinal guidance of the vehicle (for example by virtue of the driver of the vehicle actuating the brake pedal or the accelerator pedal). A takeover request (TOR) can then be output to the driver of the vehicle. The longitudinal guidance must then be effected by the driver again. The safety of the operation of the vehicle can be increased by outputting a takeover request.

[0036] Alternatively or additionally, a takeover request can be output if manual intervention by the driver in the longitudinal guidance of the vehicle is expected. For example, it is possible to identify that the vehicle guidance system can no longer automatically carry out the longitudi-

nal guidance (for example in order to reach a particular destination, for instance at a signaling unit). A takeover request can then be output to the driver of the vehicle in response to this.

[0037] As already explained above, the vehicle guidance system may be configured to determine data (in particular map data and/or environmental data) relating to a signaling unit located ahead in the direction of travel of the vehicle (which is also referred to as a "first" signaling unit below). The vehicle guidance system may also be configured to operate the driving function in the automatic mode or in the manual mode at the first signaling unit on the basis of the data relating to the first signaling unit. In particular, the vehicle guidance system may be configured to selectively operate the driving function (if necessary) in the manual mode at the first signaling unit even if a user setting regarding the configuration of the driving function reveals that the driving function is intended to be operated in the automatic mode.

[0038] In other words, the vehicle guidance system may be configured to determine a user setting, which is possibly effected by the user of the vehicle, with regard to whether the driving function is intended to be operated (as standard) in the automatic mode or in the manual mode. The driving function can then possibly be operated in the manual mode at the first signaling unit on the basis of the data relating to the first signaling unit even if the user setting indicates that the driving function is intended to be operated in the automatic mode. On the other hand, if the user setting indicates that the driving function is intended to be operated in the manual mode, the vehicle guidance system may be configured to operate the driving function in the manual mode at the first signaling unit even if operation of the driving function in the automatic mode would be possible on the basis of the data relating to the first signaling unit.

[0039] The vehicle guidance system may therefore be configured to use the manual mode of the driving function if necessary even if the user setting indicates that the driving function is intended to be operated in the automatic mode. The unavailability of the consideration of a signaling unit can possibly be avoided by selectively using the manual mode. The availability, the safety and the comfort of the driving function can therefore be increased.

[0040] The vehicle guidance system may be configured to determine a decision time and/or a decision position before reaching the first signaling unit, at which an offer relating to the consideration of the first signaling unit should or must be output to the user of the vehicle at the latest. In this case, the decision time and/or the decision position may depend on the required intervention duration (in particular the required automated deceleration duration) in relation to the first signaling unit and/or on the (typical) reaction speed of the user to an offer.

[0041] In particular, the vehicle guidance system may be configured to determine an intervention time or an intervention position before reaching the first signaling unit, at which the first signaling unit should or must be taken into consideration at the latest during the automated longitudinal guidance of the vehicle (for example in order to be able to still decelerate the vehicle to a standstill in an automated manner). Alternatively or additionally, the vehicle guidance system may be configured to determine a reaction period or a reaction distance which is granted to the user in order to react to an offer relating to the consideration of the first signaling unit. The decision time and/or the decision position can then be determined on the basis of the intervention time or the intervention position and/or on the basis of the reaction period or the reaction distance.

[0042] The vehicle guidance system may also be configured to determine whether there is a contradiction between the map data and the environmental data with regard to a property of the first signaling unit at the decision time or at the decision position. Exemplary properties are: the type of the signaling unit and/or the number of different signal groups.

[0043] In particular, the vehicle guidance system may be configured to determine a map-based number of different signal groups of the first signaling unit as a property of the first signaling unit on the basis of the map data. The vehicle guidance system may also be configured to determine a sensor-based number of different signal groups of the first signaling unit as a property of the first signaling unit on the basis of the environmental data. It is then possible to determine that there is a contradiction between the map data and the environmental data if the map-based number of signal groups differs from the sensor-based number of signal groups, in particular if the sensor-based number of signal groups is greater than the map-based number of signal groups. For example, there may be a contradiction if different signal colors are detected on the basis of the environmental data, but the map data indicate that the signaling unit, in particular the light signal installation, has only one signal group.

[0044] The driving function can then be operated in the automatic mode or in the manual mode at the first signaling unit on the basis of whether it is determined that there is or is not a contradiction between the map data and the environmental data at the decision time or at the decision position. In particular, the vehicle guidance system may be configured to operate the driving function in the automated mode at the first signaling unit if it is determined that there is no contradiction between the map data and the environmental data at the decision time. Alternatively or additionally, the vehicle guidance system may be configured to operate the driving function in the manual mode at the first signaling unit if it is determined that there is a contradiction between the map data and the environmental data at the decision time. The availability, the safety and the comfort of the driving function can therefore be increased in a particularly pronounced manner.

[0045] The vehicle guidance system may be configured to already determine before the decision time or the decision position that there is a contradiction between the map data and the environmental data with regard to at least one property of the first signaling unit. In response to this, it can then make a decision relating to whether the driving function is operated in the automatic mode or in the manual mode at the first signaling unit dependent on a renewed check for the presence of a contradiction at the decision time or at the decision position.

[0046] In other words, the vehicle guidance system may be configured, after a prematurely detected contradiction with respect to a signaling unit, to first of all wait and see whether the contradiction is possibly resolved at a later time or whether the contradiction is confirmed at a later time. In this case, it is possible to carry out a repeated check until the (last possible) decision time or the (last possible) decision position. If the contradiction is resolved, the driving function

can be operated in the automatic mode. If the contradiction is not resolved, the driving function can possibly be operated in the manual mode. Detection errors (in particular false positives) can be reduced or avoided by repeatedly checking a detected contradiction. The availability, the safety and the comfort of the driving function can therefore be increased further.

[0047] The vehicle guidance system may be configured to determine a degree of complexity for the complexity of the junction arranged at the first signaling unit on the basis of the data (in particular the map data and/or the environmental data) relating to the first signaling unit. In this case, the junction may be a junction between the road used by the vehicle and one or more other traffic routes (for example at least one other road, at least one crosswalk, etc.). The degree of complexity and/or the complexity may depend, for example, on the number of different signal groups of the first signaling unit.

[0048] The driving function at the first signaling unit can then be operated in the automatic mode or in the manual mode on the basis of the determined degree of complexity. In particular, the driving function may possibly be operated in the automatic mode if the degree of complexity indicates relatively low complexity (for example only a single signal group). On the other hand, the driving function may possibly be operated only in the manual mode if the degree of complexity indicates relatively high complexity (for example a plurality of different signal groups). The availability, the safety and the comfort of the driving function can be increased further by determining and taking into consideration a degree of complexity.

[0049] The vehicle guidance system may be configured to determine a number of different signal groups for different directions of travel of the vehicle on the basis of the data (in particular the environmental data and/or the map data) relating to the first signaling unit. The driving function can then be operated in the automatic mode or in the manual mode at the first signaling unit on the basis of the determined number of different signal groups. In particular, the driving function may possibly be operated only in the manual mode at the first signaling unit if the determined number of different signal groups is greater than one. Alternatively or additionally, the driving function may possibly be operated in the automatic mode at the first signaling unit if the determined number of different signal groups is equal to one. The availability, the safety and the comfort of the driving function can therefore be increased further.

[0050] A further aspect describes a method for providing a driving function for the automated longitudinal guidance of a vehicle. The method comprises determining data relating to a first signaling unit that is located ahead in the direction of travel of the vehicle. The method also comprises operating the driving function in an automatic mode or in a manual mode at the first signaling unit on the basis of the data relating to the first signaling unit. In this case, the first signaling unit can be taken into consideration automatically in the automatic mode and only after confirmation by a user of the vehicle in the manual mode during the automated longitudinal guidance of the vehicle.

[0051] A further aspect describes a (road) motor vehicle (in particular an automobile or a truck or a bus or a motorcycle) which comprises at least one of the vehicle guidance systems described in this document.

[0052] A further aspect describes a software (SW) program. The SW program may be configured to be executed on a processor (for example on a control device of a vehicle) and to thereby carry out at least one of the methods described in this document.

[0053] A further aspect describes a storage medium. The storage medium may comprise a SW program which is configured to be executed on a processor and to thereby carry out at least one of the methods described in this document.

[0054] Within the context of the document, the term "automated driving" can be understood as meaning driving with automated longitudinal or lateral guidance or autonomous driving with automated longitudinal and lateral guidance. Automated driving can involve for example driving for a relatively long time on the freeway or driving for a limited time in the context of parking or maneuvering. The term "automated driving" encompasses automated driving with an arbitrary degree of automation. Exemplary degrees of automation are assisted, partly automated, highly automated or fully automated driving. These degrees of automation were defined by the German Federal Highway Research Institute (BASt) (see BASt publication "Forschung kompakt", issue 11/2012). In the case of assisted driving, the driver permanently carries out the longitudinal or lateral guidance, while the system performs the respective other function within certain limits. In the case of partly automated driving, the system performs the longitudinal and lateral guidance for a certain period of time and/or in specific situations, wherein the driver must permanently monitor the system as in the case of assisted driving. In the case of highly automated driving, the system performs the longitudinal and lateral guidance for a certain period of time, without the driver having to permanently monitor the system; however, the driver must be able to take over guidance of the vehicle within a certain time. In the case of fully automated driving, the system can automatically manage driving in all situations for a specific application; a driver is no longer required for this application. The four degrees of automation mentioned above correspond to SAE levels 1 to 4 of the SAE J3016 standard (SAE— Society of Automotive Engineering). For example, highly automated driving corresponds to level 3 of the SAE J3016 standard. Furthermore, SAE J3016 also provides SAE level 5 as the highest degree of automation, which is not contained in the definition by the BASt. SAE level 5 corresponds to driverless driving, during which the system can automatically manage all situations like a human driver during the entire journey; a driver is generally no longer required. The aspects described in this document relate, in particular, to a driving function and a driver assistance function which are designed according to SAE level 2.

[0055] It should be noted that the methods, apparatuses and systems described in this document can be used both alone and in combination with other methods, apparatuses and systems described in this document. Furthermore, any aspects of the methods, apparatuses and systems described in this document can be combined with one another in various ways. In particular, the features of the claims can be combined with one another in various ways.

[0056] The invention is described in more detail below on the basis of exemplary embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

[0057] FIG. **1** shows exemplary components of a vehicle;

[0058] FIG. **2***a* shows an exemplary light signal installation;

[0059] FIG. **2***b* shows an exemplary traffic sign;

[0060] FIG. **3** shows an exemplary traffic situation;

[0061] FIG. **4** shows an exemplary user interface; and

[0062] FIGS. **5***a* to **5***j* and FIG. **6** show flowcharts of exemplary methods for providing a driving function for the automated longitudinal guidance of a vehicle at a signaling unit.

DETAILED DESCRIPTION OF THE DRAWINGS

[0063] As explained at the outset, the present document deals with increasing the reliability, the availability and the comfort of a driving function, in particular a driver assistance system, of a vehicle in connection with a signaling unit at a junction between the road or street used by the vehicle and another traffic route.

[0064] FIG. **1** shows exemplary components of a vehicle **100**. The vehicle **100** comprises one or more environmental sensors **103** (for example one or more imaging cameras, one or more radar sensors, one or more lidar sensors, one or more ultrasonic sensors, etc.) which are configured to capture environmental data relating to an environment of the vehicle **100** (in particular relating to the environment in front of the vehicle **100** in the direction of travel). The vehicle **100** also comprises one or more actuators **102** which are configured to act on the longitudinal and/or lateral guidance of the vehicle **100**. Exemplary actuators **102** are: a brake system, a drive motor, a steering system, etc.

[0065] The control unit **101** may be configured to provide a driving function, in particular a driver assistance function, on the basis of the sensor data from the one or more environmental sensors **103** (that is to say on the basis of the environmental data). For example, an obstacle on the driving trajectory of the vehicle **100** may be detected on the basis of the sensor data. The control unit **101** can then control one or more actuators **102** (for example the brake system) to decelerate the vehicle **100** in an automated manner and to thereby prevent a collision between the vehicle **100** and the obstacle.

[0066] Within the scope of the automated longitudinal guidance of a vehicle **100** in particular, in addition to a leading vehicle, one or more signaling units (for example a light signal installation and/or a traffic sign) on the road or street used by the vehicle **100** may be taken into consideration. In this case, the status of a light signal installation or traffic light system may be taken into consideration, in particular, with the result that the vehicle **100** causes deceleration to the stop line of the traffic light in an automated manner at a red traffic light relevant to the vehicle's own (planned) direction of travel and/or accelerates (possibly again) in the case of a green traffic light.

[0067] Light signal installations may be designed in a very heterogeneous manner in different countries and may also be of varying complexity with regard to the direction of travel/light signal assignment. Different directions of travel may therefore be controlled in a bundled manner by means of a first group of signals or by means of one signal group and another direction may be controlled by means of another signal group. The repeating signals from a signal group may also be geographically located at different points of an intersection. It may therefore be difficult for a control unit **101** (also referred to as a vehicle guidance system in this document) to identify, on the basis of the sensor data, which one or more signals from a light signal installation at an intersection are relevant to the planned direction of travel of the vehicle **100** and which are not (in particular if the vehicle **100** is still relatively far away from the light signal installation).

[0068] FIG. **2***a* shows an exemplary light signal installation **200**. The light signal installation **200** illustrated in FIG. **2***a* has four different signal generators **201** which are arranged at different positions at an entrance to an intersection. The left-hand signal generator **201** has an arrow **202** to the left and therefore indicates that this signal generator **201** applies to traffic turning left. The two middle signal generators **201** have an upward arrow **202** (or no arrow **202**) and therefore indicate that these two signal generators **201** apply to driving straight ahead. The individual light signals from these two signal generators **201** form signal groups. Furthermore, the right-hand signal generator **201** has an arrow **202** to the right and therefore indicates that this signal generator **201** applies to traffic turning right.

[0069] The light signal installation **200** illustrated in FIG. **2***a* is only one example of many different possible configurations of a light signal installation **200**. A light signal installation **200** may have a relatively large number of different forms of features. Exemplary features are

[0070] the number of signal generators **201** and/or signal groups;

[0071] the positions of the one or more signal generators **201**; and/or

[0072] the assignment of a signal generator **201** to a possible direction of travel across an intersection.

[0073] FIG. **2***b* shows an exemplary stop sign as a traffic sign **210** which controls the right of way at a traffic junction, in particular at an intersection. The control unit **101** of the vehicle **100** may be configured to detect a traffic sign **210** relevant to the right of way of the vehicle **100** on the street or road used by the vehicle **100** on the basis of the sensor data from the one or more environmental sensors **103** (that is to say on the basis of the environmental data) and/or on the basis of digital map information (that is to say map data).

[0074] FIG. **3** shows, by way of example, a vehicle **100** which is moving toward a signaling unit **200**, **210** (in particular a light signal installation **200** and/or a traffic sign **210**) on a road. The one or more environmental sensors **103** of the vehicle **100** may be configured to capture sensor data (in particular image data) relating to the signaling unit **200**, **210**. The sensor data can then be analyzed (for example by means of an image analysis algorithm) in order to determine forms of one or more features of the signaling unit **200**, **210**. In particular, it is possible to determine, on the basis of the sensor data, whether the signaling unit **200**, **210** is a light signal installation **200** or a traffic sign **210**. It is also possible to determine which signal generator **201** of the light signal installation **200** is relevant to the (planned) direction of travel of the vehicle **100**. Furthermore, the (signaling) state of the relevant signal generator **201** (for example the color, for instance red, amber or green) can be determined.

[0075] The quality and/or the reliability with which the form of a feature of a signaling unit **200**, **210** can be determined on the basis of the environmental data is/are typically dependent on the distance **311** of the vehicle **100** from the signaling unit **200**, **210**. Furthermore, current

weather conditions typically also have a significant influence on the quality and/or the reliability of the determined form of a feature. In addition, the quality and/or reliability may be different for different features.

[0076] The vehicle **100** may have a storage unit **104** which stores digital map information (that is to say map data) relating to the street network used by the vehicle **100**. The map data may indicate, as attributes, forms of one or more features of one or more signaling units **200**, **210** in the road network. In particular, the map data may indicate, for a light signal installation **200**, the assignment of the one or more signal generators **201** or signal groups **201** to different possible directions of travel. In other words, the map data may indicate which signal generator or which signal group **201** is responsible for enabling which direction of travel. The map data may possibly be received at the vehicle **100** by means of a communication unit **105** of the vehicle **100** via a wireless communication connection (for example a WLAN or LTE communication connection).

[0077] The control unit **101** of the vehicle **100** may be configured to determine (for example on the basis of the current position of the vehicle **100** and on the basis of a planned travel route and/or on the basis of the environmental data from the one or more environmental sensors **103**) that the vehicle **100** is heading for a signaling unit **200**, **210** that is located ahead. Furthermore, the control unit **101** may determine the forms of one or more features of the signaling unit **200**, **210** located ahead on the basis of the (stored and/or received) map data. In particular, it is possible to determine, on the basis of the map data, which signal generator or which signal group **201** of a light signal installation **200** is assigned to the current or planned direction of travel of the vehicle **100**. In addition, the current status of the assigned signal generator or of the assigned signal group **201** can be determined on the basis of the environmental data. An automated driving function (for example automated longitudinal guidance of the vehicle **100**) may then be performed in a reliable and comfortable manner on the basis thereof. In particular, the forms of the one or more relevant features of a signaling unit **200** may already be determined in the case of a relatively great distance **311** of the vehicle **100** from the signaling unit **200** by taking the map data into consideration, thus making it possible to increase the reliability, the availability and the comfort of an automated driving function.

[0078] A vehicle **100** may be configured to use information relating to a signaling unit **200**, **210**, which is being or has been passed by the vehicle **100**, to create and/or supplement the map data. The map data may be created and/or supplemented locally by the vehicle **100** and/or centrally by a central unit **300** (for example by a backend server) (see FIG. **3**). In the immediate vicinity of a signaling unit **200**, **210**, the one or more environmental sensors **103** of a vehicle **100** can typically capture environmental data which precisely indicate the form of one or more features of the signaling unit **200**, **210**. In particular, in the immediate vicinity, the assignment between signal generators or signal groups **201** and possible directions of travel may be determined in a precise and reliable manner on the basis of the captured environmental data.

[0079] The vehicle **100** may be configured to transmit the determined information (for example the environmental data and/or the determined forms of the one or more features) to the central unit **300** via a wireless communication connection **301** (in conjunction with an identifier for the respective signaling unit **200**, **210**, for instance in conjunction with the position of the signaling unit **200**, **210**). The central unit **300** can then create and/or update, on the basis of the information provided by a multiplicity of vehicles **100**, map data respectively indicating, as attributes, the forms of one or more features for a multiplicity of different signaling units **200**, **210**. The map data may then be made available to the individual vehicles **100** in order to (as explained above) assist with the operation of an automated driving function.

[0080] The vehicle **100** typically comprises a user interface **107** having one or more operating elements and/or one or more output elements. FIG. **4** shows an exemplary user interface **107** having a display unit **400**, in particular a screen, for outputting optical information. A suggestion for the automatic guidance of the vehicle **100** at a signaling unit **200**, **210** located ahead may be output on the display unit **400**, for example using a display element **401**. Alternatively or additionally, it may be possible to possibly provide a display element **402** which is used to display the status of the driving function (for example active or inactive).

[0081] Alternatively or additionally, the user interface **107** may comprise, as an output element, at least one loudspeaker **420** which can be used to output an acoustic output (for example a warning tone) to the driver of the vehicle **100**.

[0082] Furthermore, the user interface **107** may comprise one or more operating elements **411**, **412**, **413** which make it possible for the driver of the vehicle **100** to activate and/or parameterize the driving function. An exemplary operating element is a rocker **411** which makes it possible for the driver to define, in particular increase or reduce, a set speed (that is to say a target driving speed) for the vehicle **100**. A further exemplary operating element is a set operating element **412** which makes it possible for the driver to define the current driving speed as a set speed and/or to accept a suggestion for the automatic guidance of the vehicle **100** at a signaling unit **200**, **210** located ahead. Furthermore, the user interface **107** may comprise a resume operating element **413** which makes it possible for the driver, for example, to reactivate the driving function with a previously defined set speed.

[0083] The control unit **101** of the vehicle **100** may be designed to provide automated longitudinal guidance of the vehicle **100** in urban areas. This driving function can be referred to, for example, as an Urban Cruise Control (UCC) driving function. In this case, the driving function may be provided in an automatic mode (aUCC) and/or in a manual mode (mUCC). In this case, it may be possible for the driver to define, via the user interface **107**, whether the driving function is intended to be operated in the automatic mode or in the manual mode.

[0084] The control unit **101** of the vehicle **100** may be configured to detect a signaling unit **200**, **210** located ahead on the travel route of the vehicle **100** on the basis of the environmental data from the one or more environmental sensors **103** and/or on the basis of the map data (in conjunction with the position data from the position sensor **106** of the vehicle **100**). In the manual mode of the UCC driving function, a suggestion or a request relating to whether or not the signaling unit **200**, **210** is intended to be taken into consideration during the automated longitudinal guidance of the vehicle **100** can then be output via the user interface **107**. The driver of the vehicle **100** can then accept or reject or ignore the suggestion, for example by actuating the set operating element **412**. On the other hand, in the automatic

mode of the UCC driving function, the detected signaling unit **200**, **210** may possibly be taken into consideration automatically (that is to say without the required feedback from the driver) during the automated longitudinal guidance of the vehicle **100**.

[0085] If the detected signaling unit **200**, **210** is taken into consideration during the automated longitudinal guidance of the vehicle **100**, automatic deceleration can be effected (depending on the type and/or (signaling) state of the signaling unit **200**, **210**) in order to change the vehicle **100** to a standstill in an automated manner (for example in the case of a red traffic light or a stop sign). Furthermore, the vehicle **100** may be automatically started up (for example after the (signaling) state of the signaling unit **200**, **210** changes, for instance after a change to green). The vehicle **100** can then be accelerated in an automated manner to the set speed again (taking into consideration a defined minimum or target distance to a leading vehicle).

[0086] The UCC driving function can therefore make it possible for the driver of a vehicle **100** to also use the ACC driving function on a street with one or more signaling units **200**, **210** (without having to deactivate and reactivate the ACC function in each case at the individual signaling units **200**, **210**).

[0087] The control unit **101** may be configured to determine whether or not a signaling unit **200**, **210** located ahead can be taken into consideration during the automated longitudinal guidance on the basis of the environmental data and/or on the basis of the map data. If it is determined that the signaling unit **200**, **210** located ahead cannot be taken into consideration during the automated longitudinal guidance, it is possible to effect an output (for example an optical output via a display unit **400**, **402**) to the driver of the vehicle **100** in order to inform the driver of the vehicle **100** that the signaling unit **200**, **210** located ahead cannot be taken into consideration during the automated longitudinal guidance. This display may be referred to as an "unavailability display". The task of the driver of the vehicle **100** is then to decelerate the vehicle **100** if necessary before the signaling unit **200**, **210** (for example because the traffic light changes to red or because the signaling unit **200**, **210** is a stop sign).

[0088] Furthermore, the control unit **101** may be configured to identify, during operation of the UCC driving function, that the vehicle **100** cannot be longitudinally guided (any longer) in an automated manner (for example because the driver has manually intervened in the longitudinal guidance of the vehicle **100**). In this case, a takeover request (TOR) can be output to the driver of the vehicle **100** in order to prompt the driver to manually take over the longitudinal guidance of the vehicle **100**.

[0089] The vehicle **100** may comprise one or more driver sensors **108** which are configured to capture sensor data relating to the driver of the vehicle **100** (these sensor data are also referred to as driver data in this document). An exemplary driver sensor **108** is a camera aimed at the driver's position in the vehicle **100**. The control unit **101** may be configured to determine, on the basis of the driver data, whether or not the driver has sufficiently high attentiveness with respect to the driving task or with respect to the monitoring of the driving function. Alternatively or additionally, the degree of attentiveness of the driver with respect to the driving task or with respect to the monitoring of the driving function can be determined. Furthermore, the control unit **101** may be configured to operate the driving function, in particular the UCC driving function, on the basis of the determined degree of attentiveness of the driver. The comfort and the safety of the driving function can therefore be increased further.

[0090] As already explained above, the control unit **101** may be configured to identify or detect a signaling unit **200**, **210** located ahead on the basis of map data (in conjunction with position data relating to the current position of the vehicle **100**). Furthermore, the control unit **101** may be configured to identify or detect the signaling unit **200**, **210** located ahead on the basis of environmental data from one or more environmental sensors **103** (in particular from a camera) of the vehicle **100**. The automated (UCC) driving function can be operated at the detected signaling unit **200**, **210** on the basis of

[0091] whether the signaling unit **200**, **210** has been detected on the basis of the map data and/or on the basis of the environmental data;

[0092] the detection time at or from which the signaling unit **200**, **210** was detected on the basis of the map data and/or on the basis of the environmental data; and/or

[0093] the configuration time at which a configuration change of the UCC function (for example between the automatic mode and the manual mode) was made relative to the detection time of the signaling unit **200**, **210**.

[0094] In particular, the control unit **101** may be configured to inform the driver about the unavailability of the automated assistance with the longitudinal guidance at the detected signaling unit **200**, **210** (for example by means of an optical, haptic and/or acoustic output via the user interface **107**) if the signaling unit **200**, **210** was detected only on the basis of the environmental data, but not on the basis of the map data.

[0095] The control unit **101** may therefore be configured to offer and/or provide automated assistance with the longitudinal guidance at the detected signaling unit **200**, **210** possibly only when the signaling unit **200**, **210** is detected not only on the basis of environmental data but also on the basis of map data. If the automated assistance with the longitudinal guidance cannot be provided at the detected signaling unit **200**, **210**, the driver can be informed about the unavailability of the automated assistance via the user interface **107** (by means of an unavailability output). Safe operation of the UCC driving function can therefore be enabled. In particular, it is therefore possible to reliably avoid the stop line of a detected signaling unit **200**, **210** being driven across in an impermissible manner because the driver incorrectly assumes that he is being assisted with the longitudinal guidance at the detected signaling unit **200**, **210**.

[0096] In the case of a signaling unit **200**, in particular in the case of a light signal installation **200**, having a plurality of signal groups **201**, it is often not possible to reliably identify which traffic light color is relevant to the vehicle **100**. In this case, a signal group **201** may comprise all synchronized traffic lights or signal generators of a light signal installation **200**. Entry with two different signal groups **201** is therefore available at an intersection having separately switched traffic lights for traffic turning left, on the one hand, and for driving straight ahead or traffic turning right, on the other hand.

[0097] The control unit **101** may be configured to provide the automatic mode of the UCC driving function, that is to

say aUCC, possibly only at a light signal installation **200** having a single signal group **201**. The manual mode of the UCC driving function, that is to say mUCC, can be provided to that effect at a light signal installation **200** having a plurality of different signal groups **201**. In this case, the driver receives a suggestion for assistance with the longitudinal guidance via the user interface **107**, which can then be accepted by the driver, possibly by actuating an operating element **412** of the user interface **107** (which results in automated braking at a red signal group **201**, for example).

[0098] So that the driving function knows, when heading for a light signal installation **200**, how many different signal groups **201** the light signal installation **200** has and which function form (aUCC or mUCC) can be used to react to the light signal installation **200**, the number of signal groups **201** can be stored as a map attribute in the map data (that is to say in the digital map information). Since these map data may be erroneous in individual cases or the number of signal groups **201** may change as a result of conversion measures, a situation may arise in which the UCC driving function (on the basis of the map data) assumes a light signal installation **200** with only one signal group **201** for a signaling unit **200**, **210** located ahead, but two different traffic light colors are detected on the basis of the environmental data.

[0099] If the map attributes relating to a signaling unit **200**, **210** differ from that which is detected on the basis of the environmental data captured by the vehicle **100**, this may be due to the fact that the map attributes are not correct or the environmental data are interpreted incorrectly (false positive). A false positive of the environmental data is often present only for a relatively short period.

[0100] In order to be able to exclude a false positive, the control unit **101** may be configured to repeatedly check the situation, in response to a detected difference or in response to a detected contradiction between environmental data and map data, before a vehicle reaction is given (in particular before an unavailability output is effected or before the driving function is operated in the manual mode). Repeated checking may possibly mean that the contradiction is resolved and an improved reaction of the driving function to the situation is therefore possible. This delayed reaction may be postponed until a decision time or until a decision position which is as close as possible to the detected signaling unit **200**, **210** but still leaves sufficient time to still be able to safely react to the signaling unit **200**, **210** in an automated manner and/or manually even after the delayed reaction.

[0101] If, when heading for a light signal installation **200** which has only one signal group **201** according to map data, the UCC driving function detects a plurality of different traffic light colors on the basis of the environmental data, the decision relating to whether braking can be carried out manually or automatically to the light signal installation **200** (that is to say whether mUCC or aUCC is carried out) can therefore be delayed. This is possible if the signal group difference is detected so early that it is still possible to safely react to the light signal installation **200** even after a delayed reaction. If a signal group difference is detected, there is for the time being no reaction of the driving function to the light signal installation **200** in this case. A decision regarding whether the driving function is operated in the automatic mode or in the manual mode can then be made only at the decision time or at the decision position, at which an mUCC offer would have to be output to the driver at the latest in order to comply with both a predefined minimum output duration of the offer and the necessary braking distance of the vehicle **100**, within the framework of a maximum comfortable deceleration.

[0102] An mUCC offer is preferably output at the decision time if the difference or the contradiction of environmental data and map data is still present. On the other hand, if a difference can no longer be identified at the decision time, a (temporary) false positive of the environmental data can be assumed and the driving function can automatically (in the aUCC mode) adjust to the light signal installation **200**.

[0103] The control unit **101** may therefore be configured to determine a decision time or a decision position before a detected signaling unit **200**, **210**, at which it is necessary to decide at the latest whether the UCC driving function is operated in the automatic mode or in the manual mode. If there is a contradiction between the environmental-data-based detection of the signaling unit **200**, **210** and the map-data-based detection of the signaling unit **200**, **210** at the decision time or at the decision position, the UCC driving function can be operated in the manual mode. If there is no contradiction, the UCC driving function can be operated in the automatic mode. The comfort and the safety of the UCC driving function can therefore be increased.

[0104] The control unit **101** may therefore be configured to flexibly decide whether the UCC driving function can be operated in the automatic mode or in the manual mode for a detected signaling unit **200**, **210**. The UCC driving function can therefore be operated in mixed operation with automated braking operations that are carried out automatically and with manual offers to carry out automated braking operations. In particular, automated braking can be carried out automatically on the basis of the complexity of a junction, for instance an intersection, or the need for driver confirmation before carrying out the automated braking may be identified.

[0105] In other words, the control unit **101** may be configured to flexibly decide, on the basis of the map data and on the basis of the environmental data, whether the UCC function should be operated in the automatic mode or in the manual mode at a detected signaling unit **200**, **210**. In particular, it is possible to decide whether or not a detected junction can be safely managed in an automated manner and/or whether or not the relevant signal group **201** can be determined for the vehicle **100**.

[0106] If the UCC function is operated in the automatic mode and the signal group **201** relevant to the vehicle **100** has a color relevant to braking, automated braking can be initiated automatically (without confirmation by the driver of the vehicle **100**). The automatic initiation of the automated braking can be communicated to the driver via the user interface **107**, for instance via the instrument cluster.

[0107] If the intersection cannot be safely managed, the UCC function can be operated in the manual mode and an offer to carry out automated braking can be output (possibly optically) to the driver via the user interface **107**, in particular via the instrument cluster. In particular, it is possible to indicate to the driver which traffic light color is considered to be relevant by the vehicle **100**. Furthermore, it is possible to indicate to the driver which operating element **412** can be used to accept the offer. The driver can then possibly accept the offer (for example by actuating the operating element **412**) and automated braking can then possibly be initiated and/or carried out with respect to the detected signaling unit

200, **210**. If the offer is not accepted, the vehicle **100** can be longitudinally guided across the junction possibly in an automated manner (without the detected signaling unit **200**, **210** being taken into account in the process).

[0108] The comfort, the safety and the availability of the UCC driving function can be increased by flexibly operating the UCC driving function in the automatic mode or in the manual mode (depending on the complexity of the detected signaling units **200**, **210**).

[0109] It may be possible for the driver of the vehicle **100** to configure the UCC driving function via the user interface **107**. In this case, the driver can stipulate, for example, whether the UCC driving function is intended to be operated (if possible) in the automatic mode (aUCC) or whether the UCC driving function is intended to be fundamentally operated only in the manual mode (mUCC). The configuration or the change in the configuration can be carried out, for example, at a configuration time or at a configuration position (within the road or street network).

[0110] It may be the case that a driving function, in particular the UCC driving function, is already being operated with respect to a signaling unit **200**, **210** at the configuration time or at the configuration position. The control unit **101** may be configured to take into consideration the change in the configuration of the driving function that is effected at the configuration time or at the configuration position during operation of the driving function only when the vehicle **100** is in a state in which the configuration changes do not cause an immediate vehicle reaction.

[0111] Within the scope of the UCC driving function, a configuration change, which could abort active braking to a particular signaling unit **200**, **210**, can possibly be adopted via the user interface **107** only when the active braking has been ended or when the active braking has been aborted as a result of other influences (for example as a result of an abort by the driver). The configuration change therefore affects only the next driving situation with a signaling unit **200**, **210**. If the UCC driving function is therefore deactivated (for instance by the passenger) during active traffic light braking to a traffic light **200**, the vehicle **100** still brakes until coming to a standstill in front of the traffic light **200**. The driving function is actually deactivated only after the braking.

[0112] In a further example within the context of the UCC driving function, it may be possible to possibly switch over from an automatic takeover (aUCC) to a manual takeover (mUCC) of a detected signaling unit **200**, **210**, while the function already adjusts to a particular signaling unit **200**, **210**. The change is then preferably carried out only after the adjustment which is already taking place has been completed, with the result that a manual offer is output only for a subsequently detected signaling unit **200**, **210**.

[0113] The control unit **101** may therefore be configured to check whether a signaling unit **200**, **210** has already been detected for the UCC driving function and/or whether automated longitudinal guidance has already taken place with respect to a detected signaling unit **200**, **210** at the configuration time or at the configuration position of a configuration change to the UCC driving function. If this is the case, the configuration change is possibly taken into consideration only for the directly following signaling unit **200**, **210** (and not for the signaling unit **200**, **210** which has already been detected and/or taken into consideration). In particular, the driving function can possibly be deactivated only after the automated longitudinal guidance with respect to the already detected signaling unit **200**, **210** has been completed. Particularly safe operation of the UCC driving function can therefore be achieved.

[0114] As already explained above, the control unit **101** may be configured to detect a signaling unit **200**, **210** located in front of the vehicle **100** in the direction of travel on the basis of the environmental data (and possibly on the basis of the map data). The color of a signal group **201** of the signaling unit **200**, **210** may also be determined on the basis of the environmental data.

[0115] It may be the case (for example in the case of a relatively late change of the color of a signal group **201** from green to amber) that automated and/or manual braking can no longer be carried out (with particular, defined maximum deceleration) for a detected signaling unit **200**, **210**. In such a case, an unavailability output could be output to the driver of the vehicle **100** in order to indicate to the driver that no automated braking will be carried out for the detected signaling unit **200**, **210**. However, the output of an unavailability output, in particular an unavailability display, would typically not be useful in such a situation, since manual braking can or should no longer be carried out by the driver of the vehicle **100**.

[0116] The control unit **101** may be configured to suppress an unavailability output if it is identified, only shortly before reaching the signaling unit **200**, **210**, that the signaling unit **200**, **210** cannot be taken into consideration during the automated longitudinal guidance of the vehicle **100**. In particular, the control unit **101** may be configured to check, at a time or at a position at which the unavailability of the assistance for a signaling unit **200**, **210** is identified,

[0117] whether the period before reaching the signaling unit **200**, **210** corresponds to or falls below a particular period threshold value; and/or

[0118] whether the distance **311** before reaching the signaling unit **200**, **210** corresponds to or falls below a particular distance threshold value.

[0119] The period threshold value and/or the distance threshold value may each be dependent on the speed or independent of the speed in this case. The period threshold value and/or the distance threshold value may be defined in such a manner that, for periods of longer than the period threshold value and/or for distances of greater than the distance threshold value, manual braking of the vehicle **100** by the driver in order to stop the vehicle **100** at the detected signaling unit **200**, **210** is still possible and/or useful. In this case, a maximum possible deceleration of the vehicle **100** and/or a predefined reaction time of the driver may be taken into consideration, for example.

[0120] The control unit **101** may be configured to prevent the output of an unavailability output if it is determined

[0121] that the period before reaching the signaling unit **200**, **210** corresponds to or falls below the particular period threshold value; and/or

[0122] the distance **311** before reaching the signaling unit **200**, **210** corresponds to or falls below the particular distance threshold value.

[0123] On the other hand, the unavailability output can be output.

[0124] The control unit **101** may therefore be configured to cause no unavailability display to be output as a result of a detection error and/or as a result of a traffic light that switches late to amber in a region that is not relevant to the

driver before reaching the traffic light **200** (in particular because manual braking is no longer useful), since the output of such an unavailability display would be an additional disruptive factor for the driver.

[0125] In particular, it is possible in this case to cause no unavailability display to be output at a particular distance× 311 in [m] and/or at a particular interval of time in [s] before reaching the traffic light **200**. In this case, the minimum distance x to the stopping position of the traffic light **200** may be independent of the speed and may possibly represent a lower limit. Below this distance value, the unavailability display is then possibly fundamentally not displayed. The temporal criterion may be dependent on the speed. This criterion may then cause the unavailability display to not be output, in particular in the case of relatively high speed ranges. The comfort of the driving function for the driver of the vehicle **100** can be increased by suppressing the output of the unavailability display.

[0126] As already explained above, the UCC driving function can be operated in a manual mode in which an offer to assist with the longitudinal guidance at a detected signaling unit **200**, **210** is output to the driver of the vehicle **100**. The driver of the vehicle **100** then has the opportunity to accept the offer (for example by actuating the set operating element **212**). If the offer is accepted, automated braking, for example, may be carried out if necessary at the detected signaling unit **200**, **210**.

[0127] It may be the case, for example if the vehicle **100** is driving on a straight road, that the next signaling unit **200**, **210** located ahead is already detected at a relatively great (temporal and/or spatial) distance **311** before reaching the signaling unit **200**, **210** (on the basis of the environmental data). At that moment, the detected signaling unit **200**, **210** may possibly still be irrelevant to the longitudinal guidance of the vehicle **100** and/or to the driver of the vehicle **100**. An output to the driver of the vehicle **100**, for example relating to an offer to assist with the automated longitudinal guidance at the detected signaling unit **200**, **210**, could be perceived to be disruptive and/or irritating by the driver.

[0128] It may also be the case that the signaling unit **200**, **210** is concealed at a later time and is therefore no longer detected. This could result in the offer to the driver being withdrawn and therefore in confusion of the driver.

[0129] The control unit **101** may be configured to determine whether the (spatial and/or temporal) distance **311** from a detected signaling unit **200**, **210** is equal to or greater than an output threshold value. The control unit **101** may also be configured to effect an output relating to the detected signaling unit **200**, **210** (for example an offer to take the detected signaling unit **200**, **210** into consideration during the automated longitudinal guidance) only when the (spatial and/or temporal) distance **311** from the detected signaling unit **200**, **210** is equal to or less than the output threshold value.

[0130] The control unit **101** may therefore be configured to take into consideration a required minimum output distance from a detected signaling unit **200**, **210**. A lack of a condition with respect to a minimum output distance could irritate the driver since implausible changes with respect to an offer to assist with the automated longitudinal guidance at the detected signaling unit **200**, **210** could be displayed on the screen **400** (for example in the instrument cluster and/or in the head-up display) even though the signaling unit **200**, **210** (for example a red traffic light) is not (yet) relevant to the driver. Such changes could be caused, for example, by uncertainties during camera detection (on account of the relatively great distance).

[0131] The control unit **101** may be configured to output an offer with respect to a signaling unit **200**, **210** only when a particular distance from the signaling unit **200**, **210** is undershot. In this case, there is possibly no display if the vehicle **100** is in the xth row (where x>1) in front of the signaling unit **200**, **210**. Incorrect and/or implausible displays can therefore be eliminated. The control unit **101** may therefore be configured to suppress the output of an offer as long as the predefined output distance **311** from the signaling unit **200**, **210** is not undershot. The comfort for the user can therefore be increased.

[0132] The control unit **101** may be configured, after the assistance with the longitudinal guidance of the vehicle **100** at a first signaling unit **200**, **210** has ended, to sequentially search for a (directly) following, second signaling unit **200**, **210** which can or should be taken into consideration during the longitudinal guidance of the vehicle **100**. In particular, within the scope of the mUCC driving function, after the braking process at a first signaling unit **200**, **210** has been completed, a suggestion to take into consideration a following, second signaling unit **200**, **210** can be output. Alternatively, within the scope of the aUCC driving function, after the braking process at a first signaling unit **200**, **210** has been completed, the following, second signaling unit **200**, **210** (and possibly automated braking associated therewith) can be automatically taken into consideration.

[0133] The detection of a following, second signaling unit **200**, **210** may be impaired, in particular when starting up at a traffic light (that is to say at a first signaling unit **200**, **210**) (for example because the environmental data sometimes still indicate information relating to the first signaling unit **200**, **210**). This may result in an implausible behavior of the driving function for the driver of the vehicle **100**.

[0134] The control unit **101** may be configured to determine the period and/or the spatial distance since the vehicle **100** was started up at the first signaling unit **200**, **210**. The output of an offer to take into consideration a following, second signaling unit **200**, **210** and the automatic consideration of a following, second signaling unit **200**, **210** may be suppressed as long as the period is less than or equal to a period threshold value;

[0135] and/or as long as the spatial distance of the vehicle **100** from the first signaling unit **200**, **210** is less than or equal to a distance threshold value; and/or as long as the driving speed of the vehicle **100** is less than or equal to a speed threshold value.

[0136] The control unit **101** may therefore be configured, after the vehicle **100** has been started up, to suppress all manual and/or automatic offers to take signaling units **200**, **210** into consideration for a defined period. Alternatively or additionally, it may be necessary for a minimum speed of the vehicle **100** to be exceeded in order to allow a manual and/or automatic offer.

[0137] In particular, after the vehicle **100** has been started up, it is possible to start an inhibit time which suppresses all offers until a defined time after the beginning of the "driving" state. Furthermore, no offers are possibly output until a defined speed. The comfort of the driving function can therefore be increased further.

[0138] As explained further above, the vehicle **100** may comprise one or more driver sensors **108** which are config-

ured to capture driver data (that is to say sensor data) relating to the driver of the vehicle **100**. The UCC driving function can be operated on the basis of the driver data. In particular, an output of information to the driver of the vehicle **100** may be effected or possibly prevented on the basis of the driver data.

[0139] The control unit **101** of the vehicle **100** may be configured to determine, on the basis of the driver data, whether or not the driver is sufficiently attentive with respect to the driving task or with respect to the monitoring of the driving function. The control unit **101** may also be configured to supplement an unavailability display displayed on the screen **400** of the user interface **107** by outputting an optical and/or haptic signal if it is determined that the driver is not sufficiently attentive. The comfort and the safety of the UCC driving function can therefore be increased.

[0140] The unavailability display can be output, for example, if it is identified that the driving function (for example on account of the late detection of a traffic light, on account of late switching of the traffic light to amber, on account of a concealed camera **103**, etc.) can no longer react in good time to the traffic light (and therefore automated braking at the traffic light is not available). The unavailability display can be displayed, for example, in the instrument cluster and/or in the head-up display. If the driver is inattentive at the time at which the unavailability display is output, this could result in the driver overlooking the optical indication (and still assuming that the traffic light **200** is taken into consideration during the automated longitudinal guidance).

[0141] In addition to the optical indication, an acoustic signal, for example, can therefore be output to the driver identified as inattentive in order to request the driver to be attentive. Alternatively or additionally, a steering wheel vibration and/or activation of light strips on the steering wheel can be effected. This makes it possible to ensure that the traffic light, for which the unavailability display is displayed, is not overlooked by the driver.

[0142] The state of the driver can be determined on the basis of the sensor data from an interior camera **108** by means of a driver model. If it is identified that the driver is inattentive, a sound can be output in addition to the unavailability display. Alternatively or additionally, additional haptic or further optical feedback can be effected.

[0143] During operation of a driving function, in particular a driver assistance function, there may be a change in the driving behavior of the vehicle **100**. For example, the driving function may automatically abort a braking process which has already been initiated, for example in order to accelerate the vehicle **100** again. This may be carried out, for example, within the scope of the UCC driving function if, during automated braking at a light signal installation **200** with a red signal group **201**, the signal group **201** changes to green. The change in the driving behavior of the vehicle **100**, which is caused by the driving function, may be perceived to be unsettling and/or uncomfortable by the driver of the vehicle **100**, in particular when the driver of the vehicle **100** is inattentive.

[0144] The control unit **101** may be configured to determine that the driving behavior of the vehicle **100** that is caused by the driving function of the vehicle **100** has changed substantially or will change substantially at a particular change time. Furthermore, the control unit **101** may be configured to determine, on the basis of the driver data from the one or more driver sensors **108**, that the driver of the vehicle **100** is inattentive with respect to the driving task at the change time. In response to this, it is possible to cause information relating to the change in the driving behavior to be output to the driver of the vehicle **100** (for example via an optical and/or acoustic output). The comfort for the driver of the vehicle **100** can therefore be increased.

[0145] The UCC driving function is typically designed as a driving function according to SAE level 2. In the case of such a driving function, in particular in the case of such a driver assistance system, the driver is assisted only with the (longitudinal) guidance of the vehicle **100** and must still be able to act himself at any time. The driving function may be designed such that, in a situation in which the driving function changes the driving behavior of the vehicle **100** in such a manner that the driver must react or should at least monitor the vehicle **100** with an increased level of attentiveness, information relating to the change in the driving behavior is output.

[0146] The control unit **101** may therefore be configured, if the driving function significantly changes its form, for example aborts braking and accelerates to free travel again, to optically and/or acoustically and/or haptically inform a driver identified as inattentive about the change.

[0147] If the UCC driving function automatically brakes to a traffic light **200** and the latter changes from red to green during control, the control unit **101** can cause the UCC driving function to abort the braking and to change to free travel or follow-on travel (if a vehicle driving in front is present), in particular when the driver is identified as attentive via the interior camera **108**. If the driver is not identified as attentive in this situation, the driver can be made aware of the changed conditions acoustically and/or optically, for example via a gong. For reasons of safety, the braking can then be continued despite the green traffic light until the driver is identified as attentive again. The safety of the driving function can therefore be increased further.

[0148] A further example within the context of the UCC driving function is the unavailability display. If a red traffic light **200** is only detected so late that braking is no longer possible (in an automated manner) taking into consideration the functional limits of the driving function, the driving function typically does not start braking and an unavailability display is displayed to the driver instead. If the driver does not independently brake in this situation, a red traffic light **200** could be driven through. For this reason, the driver's attentiveness can be checked (in particular via the interior camera **108**) (in particular simultaneously) with the output of the unavailability display. If the driver is detected as inattentive, it is possible to output an acoustic gong which makes the driver aware that no braking is being carried out by the UCC driving function and a driver reaction is necessary under certain circumstances. The safety and the comfort of the driving function can therefore be increased.

[0149] The control unit **101** of the vehicle **100** may be configured to adapt the deceleration and/or acceleration, in particular the temporal profile of the deceleration and/or the acceleration, of the vehicle **100** that is automatically effected within the scope of a driving function, in particular within the scope of the UCC driving function, on the basis of the driver data, in particular on the basis of the detected degree of attentiveness of the driver. The comfort and the safety of the driving function can therefore be increased.

[0150] Monitoring the driver's attentiveness makes it possible to design the profile of braking of the vehicle **100** in such a manner that the driver is made aware of the beginning of an automated braking maneuver by virtue of the resulting vehicle movement. It is therefore possible to achieve the situation in which the driver of the vehicle **100** monitors the automated braking with an increased degree of probability. For example, braking may be started with a jolt, as a result of which a haptic signal to the driver (identified as inattentive) is effected as a suggestion to focus attention on the driving task.

[0151] Alternatively or additionally, the temporal profile of a deceleration and/or acceleration of the vehicle **100** may depend on a driving mode that has been set (for example sporty, comfort and/or energy-saving). For example, it may be possible (for example in a sport mode) to start the deceleration of the vehicle **100** at a later time and/or to carry it out with an increased deceleration value if the driver of the vehicle **100** is identified as attentive. The comfort and the safety of a driving function can therefore be increased.

[0152] The control unit **101** may be configured (in particular on the basis of the environmental data and/or on the basis of the map data) to determine the type of the signaling unit **200**, **210** (from a predefined set of different types). Exemplary types are a light signal installation **200** or a traffic sign **210**. Alternatively or additionally, the control unit **101** may be configured (in particular on the basis of the environmental data and/or on the basis of the map data) to predict period information relating to the period for which the vehicle **100** must probably stop at the signaling unit **200**, **210** located ahead before the vehicle **100** can start up again. It is therefore possible to determine (on the basis of the map data and/or the environmental data) stopping information relating to the stopping of the vehicle **100** at the signaling unit **200**, **210** located ahead.

[0153] The automated deceleration of the vehicle **100** at the signaling unit **200**, **210** located ahead can then be effected on the basis of the period information and/or on the basis of the type of the signaling unit **200**, **210** (that is to say on the basis of the stopping information). In particular, the temporal profile of the deceleration and/or the total duration of the deceleration process can be adapted or defined on the basis of the period information and/or on the basis of the type of the signaling unit **200**, **210** (that is to say on the basis of the stopping information). For example, a relatively slow deceleration process may be selected at a light signal installation **200** having a red signal group **201** (since the vehicle **100** must wait until the signal group **201** changes to green). On the other hand, a relatively fast deceleration process can be selected at a stop sign **210** since the vehicle **100** can possibly drive on immediately after stopping (if the traffic on the crossing traffic route allows). The comfort of the driving function can be increased by adapting the deceleration profile.

[0154] Within the scope of the UCC driving function, control is generally effected until the vehicle **100** comes to a standstill. In this case, as explained above, a different deceleration profile can be used depending on the type of the signaling unit **200**, **210**. In particular, the automated braking to a traffic light **200** may differ in this case from the automated braking to a stop sign **210** (because the driver can possibly drive on immediately after stopping at a stop sign **210**).

[0155] Alternatively or additionally, the driving style, in particular the deceleration or the deceleration characteristic, of the vehicle **100** may be selected by the user of the vehicle **100** using a driving experience switch. At the request of the driver using the driving experience switch (for example eco, comfort, sport, etc.), the driving function can assume different deceleration profiles to traffic lights **200** and/or stop signs **210**. The different deceleration profiles can be effected by adapting one or more parameters when planning the trajectory of the vehicle **100**.

[0156] The comfort and the safety of the driving function can be increased by adapting the deceleration profile of the UCC driving function to the type of the signaling unit **200**, **210**. In particular, impairment of the following traffic can be avoided, which could arise, for example, in the case of an excessively slow deceleration in front of a stop sign **210**.

[0157] Within the scope of the UCC driving function, a signaling unit **200**, **210** which is located ahead on the road used by the vehicle **100** and at which the vehicle **100** must stop can be displayed to the driver of the vehicle **100** via the user interface **107**, in particular on the screen **400**. For example, the symbol of a red traffic light or of a stop sign may be displayed on the screen **400**. Alternatively or additionally, it is possible to effect an acoustic output with respect to the detected signaling unit **200**, **210**. An automated braking process of the vehicle **100** to a standstill at the signaling unit **200**, **210**, in particular up to the stop line of the signaling unit **200**, **210**, can then be effected automatically (aUCC) or after confirmation by the driver (mUCC).

[0158] The control unit **101** may be configured to monitor (on the basis of the captured environmental data) the (signaling) state, in particular the color, of that signal group **201** of the signaling unit **200**, **210** which is relevant to the vehicle **100**, while the vehicle **100** is at the signaling unit **200**, **210**. The control unit **101** may also be configured to change or completely delete or withdraw the display relating to the signaling unit **200**, **210** (and/or to effect an acoustic output) if a phase change of the signal group **201** from red to green is detected and/or as soon as the vehicle **100** has come to a standstill at the signaling unit **200**, **210**. The driver of the vehicle **100** can therefore be clearly informed that the signaling unit **200**, **210** is no longer relevant to the longitudinal guidance of the vehicle **100**. The display can be withdrawn in the automatic mode and/or in the manual mode of the UCC driving function.

[0159] Furthermore, it may be possible for the driver of the vehicle **100** to cause the vehicle **100** to be started up at the signaling unit **200**, **210** (in particular after a detected phase change from red to green) using an operating element **413** (for example using the resume button) of the user interface **107**. In particular, it may be possible for the driver to cause the vehicle **100** to be accelerated again to the set or target speed that has been set (taking into consideration a set target distance from a leading vehicle) by actuating the operating element **413**. The starting-up at the signaling unit **200**, **210** by actuating the (resume) operating element **413** can be enabled in the automatic mode and/or in the manual mode of the UCC driving function.

[0160] In addition, the starting-up after the standstill at the signaling unit **200**, **210** can be effected by actuating the accelerator pedal of the vehicle **100**. However, this may possibly result in the UCC driving function being aborted. The starting-up using an operating element **413** (in particular using a button) of the user interface **107** therefore makes it

possible to comfortably continue the UCC driving function at a sequence of successive signaling units **200**, **210** (in the automatic mode and/or in the manual mode of the UCC driving function).

[0161] In particular, the UCC driving function may be designed in such a manner that, in the case of a (possibly manually confirmed) traffic light **200** (mUCC), after a standstill and after a detected change to green, the display relating to the traffic light **200** is withdrawn. Furthermore, it may be possible for the driver to start up the vehicle using the button **413**. The comfort of the UCC driving function can therefore be increased. In addition, it is thus possible to achieve a consistent behavior with the ACC driving function (at a standstill without a leading vehicle). The control unit **101** may be configured, in the case of a (possibly manually confirmed) traffic light **200**, from the beginning of the detection of a phase change to green, to cause a timer to be activated, which timer causes the red display relating to the traffic light **200** to be removed after the vehicle **100** is at a standstill.

[0162] The control unit **101** of the vehicle **100** may be configured to block or prevent the vehicle **100** from being started up at a signaling unit **200**, **210** in response to the actuation of an operating element **411**, **412**, **413** of the user interface **107** if it is identified that the vehicle **100** is arranged in the first row at the signaling unit **200**, **210**. In other words, the starting-up by actuating an operating element **411**, **412**, **413** of the user interface **107** may possibly be enabled only when at least one other leading vehicle **100** is in front of the vehicle **100** at the signaling unit **200**, **210**. The safety of the UCC driving function can therefore be increased. In particular, it is therefore possible to reliably prevent the driver of the vehicle **100** from causing the starting-up at a (possibly red) traffic light **200** by unwittingly actuating an operating element **411**, **412**, **413** of the user interface **107** (in particular the rocker **411** and/or a button **412**, **413**).

[0163] It is therefore possible to reliably prevent the driver from unwittingly initiating start-up when at a standstill at a red traffic light **200** by virtue of the driver adjusting the set speed via the rocker **411** or confirming a limit offer with the set button **412**, for example. It is also possible to prevent actuation of a button by the driver resulting in the vehicle **100** starting up again and accelerating to the set speed. This can be achieved, in particular, by virtue of the fact that the transition from the state "vehicle stationary" to the state "starting-up" as a result of driver actuation of an operating element **411**, **412**, **413** is not possible or is blocked as long as the vehicle **100** is in the first row in front of a traffic light **200** relevant to stopping. Actuation of an operating element **411**, **412**, **413** is therefore ineffective.

[0164] The control unit **101** of the vehicle **100** may be configured to determine whether or not the vehicle **100** is in the first row at a signaling unit **200**, **210** on the basis of the environmental data and/or on the basis of the position data (in conjunction with the map data). In particular, the distance of the vehicle **100** from the stopping point or to the stop line of the signaling unit **200**, **210** can be determined. It is then possible to determine whether or not the vehicle **100** is in the first row on the basis of the determined distance.

[0165] It may be the case that the state of the signaling unit **200**, **210**, in particular the color of a signal group **201** of the signaling unit **200**, **210**, cannot be detected or cannot be reliably detected on the basis of the environmental data from the one or more environmental sensors **103** of the vehicle **100**. This could result in reduced availability of the UCC driving function.

[0166] The control unit **101** may be configured to detect the leading vehicle driving (directly) in front of the vehicle **100** on the basis of the environmental data. The UCC driving function, in particular the automated longitudinal guidance of the vehicle **100**, can then be carried out or provided at the signaling unit **200**, **210** on the basis of the driving behavior of the leading vehicle. The availability and therefore the comfort of the driving function can be increased by taking into consideration the driving behavior of the leading vehicle during operation of the UCC driving function.

[0167] During operation of the UCC driving function, it may be the case, for example, that it is possible to only inadequately detect the color of a traffic light **200** as a result of concealment or poor light conditions. Furthermore, in the case of a complex intersection geometry (with different signal groups **201**) it may possibly not be possible to assign the different signal groups **201** to the individual directions of travel. In order to increase the degree of automation of the longitudinal control function and consequently in order to increase the comfort for the driver, the behavior of the leading vehicle may possibly also be evaluated, in addition to the traffic light colors and/or the attributes of a signaling unit **200**, **210** from the map data, and may be taken into consideration during operation of the driving function.

[0168] If the leading vehicle drives through, for example, the traffic light **200** located ahead, which could potentially be green, the leading vehicle may possibly be followed. In particular, automated braking may possibly be canceled as long as a potentially relevant green traffic light is detected on the basis of the environmental data. In other words, the control unit **101** may be configured to detect, on the basis of the environmental data, whether at least one of the signal groups **201** of the light signal installation or traffic light **200** located ahead has a green color. If this is the case and if it is identified (on the basis of the environmental data) that the leading vehicle driving (directly) in front of the vehicle **100** drives through the light signal installation **200**, it is possible to cause the vehicle **100** to also drive through the light signal installation **200** (even though it could not be clearly determined on the basis of the environmental data and the map data whether the signal group **201** with the green color is relevant to the direction of travel of the vehicle **100**). The availability of the driving function can be safely increased by means of such consideration of the driving behavior of the leading vehicle.

[0169] Alternatively or additionally, if the traffic light **200** is lost sight of when the vehicle **100** is at a standstill and in the case of a leading vehicle starting up, the control unit **101** may be configured to assume that the traffic light **200** has changed from red to green (or is switched off in the case of pedestrian-operated traffic lights). An automated start-up process of the vehicle **100** can then be effected if appropriate. In other words, the control unit **101** may be configured to identify that the leading vehicle (directly) in front of the vehicle **100** at a signaling unit **200**, **210** is starting up. Automated starting-up of the vehicle **100** can then be effected even without detecting the (signaling) state of the signaling unit **200**, **210** (possibly only after actuation of an operating element **411**, **412**, **413** by the driver of the vehicle **100**). The availability of the UCC driving function can therefore be safely increased.

[0170] The driver of the vehicle **100** typically has the possibility of overriding the automated longitudinal guidance of the UCC driving function by actuating the accelerator pedal and/or the brake pedal. The detected actuation of the accelerator pedal and/or of the brake pedal may possibly also be used to end the UCC driving function. However, the automatic ending of the UCC driving function in response to detected actuation of the accelerator pedal and/or of the brake pedal of the vehicle **100** may result in reduced comfort and/or in reduced safety of the UCC driving function.

[0171] For example, it may be the case that the stopping position of the vehicle **100** at a signaling unit **200**, **210**, in particular at the stop line of a signaling unit **200**, **210**, is perceived by the driver of the vehicle **100** as being too far in front of the signaling unit **200**, **210** (in particular if the vehicle **100** is in the first row in front of the stop line and therefore does not have a leading vehicle). In such a case, the driver might be inclined to drive the vehicle **100** closer to the stop line by actuating the accelerator pedal, which, however, could result in the UCC driving function being aborted and/or as a result of which automated starting-up within the scope of the driving function is possibly prevented.

[0172] In a further example, the driver of the vehicle **100** might be inclined to change from the standstill in a first lane in front of a traffic light **200** to an adjacent lane (for example in order to reduce the distance to the stop line). For this purpose, the driver would actuate the accelerator pedal in order to drive the vehicle **100** to the adjacent lane. This could result in the UCC driving function being aborted and could therefore result in a lack of longitudinal guidance assistance when subsequently starting up at the traffic light **200**.

[0173] It could also be the case that a signaling unit **200**, **210** detected by the UCC driving function is not taken into consideration during the automated longitudinal guidance of the vehicle **100** (and is possibly driven through without automated braking) if the driver actuates the accelerator pedal (and therefore the assistance of the UCC driving function is ended) at the time at which the signaling unit **200**, **210** is detected.

[0174] On the other hand, it should be possible for the driver of the vehicle **100** to reliably and comfortably override (in particular by actuating the accelerator pedal) the UCC driving function, for example in the case of false braking of the driving function.

[0175] The control unit **101** may be configured to determine deflection information relating to the deflection, in particular relating to the extent of the deflection, of the accelerator pedal. The deflection information may be determined, for example, on the basis of an accelerator pedal sensor of the vehicle **100**. Alternatively or additionally, the control unit **101** may be configured to determine time information relating to the duration for which the accelerator pedal is actuated. It is then possible to determine, on the basis of the deflection information and/or on the basis of the time information, whether or not the assistance of the automated longitudinal guidance of the vehicle **100** is provided at a signaling unit **200**, **210** and/or whether or not the driving function is ended.

[0176] In particular, the control unit **101** may be configured to determine, on the basis of the deflection information, whether the deflection of the accelerator pedal is greater than or less than a deflection threshold value (for example of 25% of the maximum possible deflection of the accelerator pedal). Furthermore, the control unit **101** may be configured to determine, on the basis of the time information, whether the duration for which the accelerator pedal is deflected is greater than or less than a time threshold value (for example of 4 seconds).

[0177] The control unit **101** may be configured to allow actuation of the accelerator pedal, without ending the UCC driving function, if it is determined that

[0178] the deflection of the accelerator pedal is less than or equal to the deflection threshold value; and

[0179] the duration for which the accelerator pedal is actuated is less than or equal to the time threshold value.

[0180] On the other hand, the UCC driving function can be dropped or ended if it is determined that

[0181] the deflection of the accelerator pedal is greater than the deflection threshold value; or

[0182] the duration for which the accelerator pedal is actuated is greater than the time threshold value.

[0183] In this case, the dropping or aborting can possibly relate only to the next signaling unit **200**, **210** which follows the actuation of the accelerator pedal. The UCC driving function can therefore possibly be only temporarily dropped or temporarily ended (only for the signaling unit **200**, **210** which directly follows the actuation of the accelerator pedal).

[0184] The comfort and/or the safety of the UCC driving function can therefore be increased. In particular, it may thus be possible for the driver of the vehicle **100** to drive the vehicle **100** closer to the stop line and/or to an adjacent lane in front of a signaling unit **200**, **210** by (lightly) actuating the accelerator pedal (without the automated assistance of the UCC driving function, for instance for the subsequent starting-up of the vehicle **100**, being ended in the process). Furthermore, it is thus possible to achieve the situation in which a detected signaling unit **200**, **210** is taken into consideration during the automated longitudinal guidance of the vehicle **100** even if the driver actuates the accelerator pedal for a short time and relatively lightly (while the signaling unit **200**, **210** is detected). Furthermore, it may therefore be possible to comfortably and safely override an intervention of the UCC driving function.

[0185] The driving function can therefore be designed in such a manner that, (only) if a particular accelerator pedal angle is exceeded, the driving function in is immediately dropped. Furthermore, the driving function can be dropped if a particular time threshold value for the actuation of the accelerator pedal is exceeded (even if the deflection threshold value is not exceeded). On the other hand, the time before reaching the time threshold value can be used by the driver to cautiously approach the stop line of an intersection.

[0186] Furthermore, the driving function may be designed in such a manner that the driving function is not dropped if a traffic light **200** is detected while the accelerator pedal is depressed. Unreactive driving through the traffic light **200** can therefore be reliably prevented.

[0187] When at a standstill at a red traffic light **200**, it may be the case that the driver drives off by actuating the accelerator pedal when the traffic light **200** changes to green because the change to green has not yet been detected by the UCC driving function (for example on account of latencies and/or on account of the color change not being detected). The actuation of the accelerator pedal could result in the UCC driving function being aborted (and therefore in an

associated takeover request (TOR) being output). This can be perceived as disruptive by the driver of the vehicle **100**.

[0188] The control unit **101** may be configured to determine speed data relating to the driving speed of the vehicle **100** during a start-up process which is effected by the driver of the vehicle **100** by actuating the accelerator pedal. Furthermore, the control unit **101** may be configured to take over the automated longitudinal guidance from the driver as long as the driving speed caused by the actuation of the accelerator pedal has not yet exceeded a predefined speed threshold value. The output of a TOR and/or the aborting of the UCC driving function can therefore be suppressed and/or prevented until the speed threshold value is reached (and the longitudinal guidance can be taken over by the driving function). On the other hand, the TOR can be output and/or the UCC driving function can be aborted if (in particular as soon as) the speed threshold value (for example 10 km/h) is reached or exceeded. The comfort for the driver of the vehicle **100** can therefore be increased further.

[0189] The control unit **101** may be configured to determine a driving mode, in which the vehicle **100** is operated, from a plurality of different driving modes. Exemplary driving modes are

[0190] a sport driving mode in which the vehicle **100** has relatively high driving dynamics with relatively high acceleration and/or deceleration values;

[0191] a comfort driving mode in which the vehicle **100** has a particularly comfortable driving style with relatively low acceleration and/or deceleration values; and/or

[0192] an eco driving mode in which the vehicle **100** has a particularly energy-saving driving style.

[0193] The driving mode can be set by the user of the vehicle **100**, for example via the user interface **107**, for example using one or more operating elements of the user interface **107**.

[0194] The control unit **101** may also be configured to operate the UCC driving function on the basis of the driving mode that has been set. In particular, the driving behavior, for instance the deceleration behavior, of the vehicle **100** in relation to a signaling unit **200**, **210** located ahead can be adapted on the basis of the driving mode. For example, the time from which the vehicle **100** reacts to a detected signaling unit **200**, **210** (at which the vehicle **100** is intended to stop) can be adapted on the basis of the driving mode. In the eco driving mode, a particularly early reaction of the vehicle **100** can be effected, for example, whereas, in the comfort driving mode, a reaction is effected only later and, in the sport driving mode, the reaction is effected even later.

[0195] Alternatively or additionally, the type or kind of reaction of the vehicle **100** to a detected signaling unit **200**, **210** to be taken into consideration can be adapted on the basis of the driving mode that has been set. Exemplary types or kinds of reaction are:

[0196] coasting operation of the vehicle **100**, in which the wheels of the vehicle **100** are decoupled from the drive motor of the vehicle **100**. If appropriate, the drive motor can then be deactivated;

[0197] towing operation of the vehicle **100**, in which the wheels of the vehicle **100** drag the drive motor along, which results in a towing deceleration of the vehicle **100**;

[0198] and/or

[0199] active (friction and/or regenerative) braking operation, in which a braking torque on one or more wheels of the vehicle **100** is actively effected (for example by means of a friction brake and/or by means of an electric machine).

[0200] In the eco driving mode, for example when approaching a signaling unit **200**, **210**, it is possible to change first of all to coasting operation, then to towing operation and finally to braking operation. In the comfort driving mode, it may be possible to possibly dispense with coasting operation and for towing operation to be initiated directly and subsequently braking operation. In the sport driving mode, it may be possible to possibly dispense with coasting operation and towing operation and for braking operation to be initiated directly.

[0201] The deceleration behavior of the vehicle **100** when approaching a signaling unit **200**, **210** can consequently be adapted to the driving mode that has been set. The comfort of the vehicle **100** can therefore be increased further.

[0202] The control unit **101** may therefore be configured to vary the (output) time for the reaction to a traffic light on the basis of the driving mode that has been set. In the eco driving mode, the traffic light control can be started relatively early, for example with an operation sequence: coasting operation, towing operation and braking operation. In the comfort driving mode, a middle starting time can be selected for the traffic light control, for example with an operation sequence: towing operation and braking operation. In the sport driving mode, the traffic light control can begin relatively later, for example directly with braking operation.

[0203] The traffic light control (in particular the deceleration profile of the vehicle **100**) can be made particularly comfortable by adapting it to the driving mode. Furthermore, an anticipatory driving style can be represented "by reducing speed early", which, inter alia, reduces the dynamics to a stationary target object in advance. A gain in comfort and safety can therefore be achieved for the driver of the vehicle **100**. A (driving and/or deceleration) characteristic respectively adapted to the driving mode can be set on the basis of the driving mode (for example eco, comfort and sport). This may enable particularly harmonious interaction between the ACC function and the UCC driving function.

[0204] Different aspects of the vehicle guidance system **101** described in this document are described below on the basis of methods. It should be pointed out that the different features of the different methods can be combined with one another in any desired manner.

[0205] FIG. **5***a* shows a flowchart of an exemplary (possibly computer-implemented) method **500** for providing a driving function (in particular the UCC driving function) for the automated longitudinal guidance of a vehicle **100**.

[0206] During operation of the driving function, the method **500** comprises determining **501** data relating to a first signaling unit **200**, **210** located ahead in the direction of travel of the vehicle **100**. In particular, environmental data from one or more environmental sensors **103** of the vehicle **100** and/or map data relating to the road network used by the vehicle **100** can be determined as data.

[0207] Furthermore, the method **500** comprises operating **502** the driving function in an automatic mode or in a manual mode at the first signaling unit **200**, **210** on the basis of the data relating to the signaling unit **200**, **210**. In this case, the first signaling unit **200**, **210** can be taken into

consideration possibly automatically in the automatic mode and possibly only after confirmation by a user of the vehicle **100** in the manual mode during the automated longitudinal guidance of the vehicle **100**.

[0208] For example, the driving function may be operated in the automatic mode if the color of a signal group **201** of the signaling unit **200**, **210** that is relevant to the direction of travel of the vehicle **100** can be clearly determined on the basis of the data. If the color of the relevant signal group **201** cannot be clearly determined, the manual mode may be used if appropriate. The automatic mode or the manual mode of the driving function can therefore be flexibly used on the basis of the available data for a signaling unit **200**, **210**. The availability and therefore the comfort of the driving function can be increased by flexibly changing between the automatic mode and the manual mode.

[0209] FIG. **5***b* shows a flowchart of an exemplary (possibly computer-implemented) method **510** for providing a driving function (in particular the UCC driving function) for the automated longitudinal guidance of a vehicle **100** at a signaling unit **200**, **210**.

[0210] During operation of the driving function, the method **510** comprises detecting **511** that a configuration change to a property of the driving function is effected by a user of the vehicle **100** at a configuration time or at a configuration position of the vehicle **100** (for example a change from the automatic mode to the manual mode or deactivation of the driving function).

[0211] The method **510** also comprises determining **512** that a first signaling unit **200**, **210** located ahead in the direction of travel of the vehicle **100** has already been taken into consideration during the automated longitudinal guidance of the vehicle **100** at the configuration time or at the configuration position. The method **510** also comprises taking into consideration **513** the configuration change only for the signaling unit **200**, **210**, which follows the first signaling unit **200**, **210**, during the automated longitudinal guidance of the vehicle **100** and/or only after the automated longitudinal guidance of the vehicle **100** has been ended or completed at the first signaling unit **200**, **210** (for example only after braking the vehicle **100** to a standstill at the first signaling unit **200**, **210**). The automated longitudinal guidance for the first signaling unit **200**, **210** may also be effected in this case without taking the configuration change into consideration. Particularly safe operation of the driving function can therefore be enabled.

[0212] FIG. **5***c* shows a flowchart of an exemplary (possibly computer-implemented) method **520** for providing a driving function (in particular the UCC driving function) for the automated longitudinal guidance of a vehicle **100** at a signaling unit **200**, **210**.

[0213] During operation of the driving function, the method **520** comprises determining **521** environmental data relating to the environment of the vehicle **100** in front of the vehicle **100** in the direction of travel. In this case, the environmental data may have been captured by one or more environmental sensors **103** of the vehicle **100**. The method **520** also comprises detecting **522**, on the basis of the environmental data, a first signaling unit **200**, **210** which is in front of the vehicle **100** in the direction of travel on the road used by the vehicle **100**.

[0214] The method **520** also comprises determining **523** that there is a contradiction between the first signaling unit **200**, **210** detected on the basis of the environmental data and the map data relating to the road network used by the vehicle **100**. For example, it is possible to identify that the first signaling unit **200**, **210** detected on the basis of the environmental data has a different (in particular higher) number of different signal groups **201** than recorded in the map data.

[0215] In response to the detected contradiction, the method **520** also comprises causing **524** an unavailability output, in particular an unavailability display, to the user of the vehicle **100** in order to inform the user that the first signaling unit **200**, **210** detected on the basis of the environmental data is not taken into consideration in the driving function for the automated longitudinal guidance of the vehicle **100**. The safety of the driving function can therefore be increased further.

[0216] FIG. **5***d* shows a flowchart of an exemplary (possibly computer-implemented) method **530** for providing a driving function (in particular the UCC driving function) for the automated longitudinal guidance of a vehicle **100** at a signaling unit **200**, **210**.

[0217] During operation of the driving function, the method **530** comprises determining **531** environmental data relating to the environment of the vehicle **100** in front of the vehicle **100** in the direction of travel. The method **530** also comprises detecting **532**, on the basis of the environmental data, a first signaling unit **200**, **210** which is arranged in front of the vehicle **100** in the direction of travel on the road used by the vehicle **100**.

[0218] The method **530** also comprises determining **533** distance information relating to the temporal and/or spatial distance **311** of the vehicle **100** to the first signaling unit **200**, **210**. The method **530** also comprises causing or suppressing **534** an output of information relating to the first signaling unit **200**, **210** on the basis of the distance information. In particular, the output (in particular an offer for the automated longitudinal guidance at the first signaling unit **200**, **210**) can be suppressed if the vehicle **100** is still too far away from the first signaling unit **200**, **210**. Alternatively or additionally, an output (in particular an unavailability output) can be suppressed if the vehicle **100** is already too close to the first signaling unit **200**, **210**. The relevance of the output and therefore the comfort of the driving function can therefore be increased.

[0219] FIG. **5***e* shows a flowchart of an exemplary (possibly computer-implemented) method **540** for providing a driving function (in particular the UCC driving function) for the automated longitudinal guidance of a vehicle **100** at a signaling unit **200**, **210**.

[0220] During operation of the driving function, the method **540** comprises determining **541** that the vehicle **100** carries out a start-up process at a first signaling unit **200**, **210**. The method **540** also comprises detecting **542**, on the basis of the environmental data from one or more environmental sensors **103** of the vehicle **100**, a second signaling unit **200**, **210** which follows the first signaling unit **200**, **210** and is arranged in front of the vehicle **100** in the direction of travel on the road used by the vehicle **100**.

[0221] The method **540** also comprises checking **543** whether or not one or more start-up process conditions with respect to the start-up process are met (for example one or more start-up process conditions with respect to the driving speed of the vehicle **100** and/or with respect to the temporal or spatial distance of the vehicle **100** from the first signaling unit **200**, **210**).

[0222] The method **540** also comprises taking into consideration **544** the second signaling unit **200**, **210** during the automated longitudinal guidance of the vehicle **100** on the basis of whether or not the one or more start-up process conditions are met. In particular, a second signaling unit **200**, **210** which is detected in the immediate temporal or spatial vicinity of the first signaling unit **200**, **210** may not be taken into consideration in this case. The reliability and the comfort of the driving function can therefore be increased (for example since the output of incorrectly detected signaling units **200**, **210** is avoided).

[0223] FIG. **5***f* shows a flowchart of an exemplary (possibly computer-implemented) method **550** for providing a driving function (in particular the UCC driving function) for the automated longitudinal guidance of a vehicle **100** at a signaling unit **200**, **210**.

[0224] During operation of the driving function, the method **550** comprises detecting **551**, on the basis of the environmental data from one or more environmental sensors **103** of the vehicle **100**, a first signaling unit **200**, **210** which is arranged in front of the vehicle **100** in the direction of travel on the road used by the vehicle **100**. The method **550** also comprises determining **552** driver data relating to the attentiveness of the driver of the vehicle **100** when monitoring the driving function. The method **550** also comprises operating **553** the driving function with respect to the automated longitudinal guidance of the vehicle **100** at the first signaling unit **200**, **210** on the basis of the driver data. In particular, the driving function may be operated in the automatic mode or in the manual mode on the basis of the driver data. The safety and/or the comfort of the driving function can therefore be increased.

[0225] FIG. **5***g* shows a flowchart of an exemplary (possibly computer-implemented) method **560** for providing a driving function (in particular the UCC driving function) for the automated longitudinal guidance of a vehicle **100** at a signaling unit **200**, **210**.

[0226] During operation of the driving function, the method **560** comprises detecting **561** a first signaling unit **200**, **210** which is arranged in front of the vehicle **100** in the direction of travel on the road used by the vehicle **100**. The method **560** also comprises determining **562** stopping information relating to the expected stopping period of the vehicle **100** at the first signaling unit **200**, **210** and/or relating to the type of the first signaling unit **200**, **210** (and the associated expecting stopping period).

[0227] The method **560** also comprises causing **563** automated deceleration of the vehicle **100** at the first signaling unit **200**, **210** on the basis of the stopping information. In particular, the temporal profile of the deceleration can be adapted on the basis of the stopping information. The comfort and/or the safety of the driving function can therefore be increased.

[0228] FIG. **5***h* shows a flowchart of an exemplary (possibly computer-implemented) method **570** for providing a driving function (in particular the UCC driving function) for the automated longitudinal guidance of a vehicle **100** at a signaling unit **200**, **210**. During operation of the driving function, the method **570** comprises determining **571** that the vehicle **100** is at a signaling unit **200**, **210** (in particular at a red traffic light). The method **570** also comprises detecting **572** that the driver of the vehicle **100** actuates an operating element **411**, **412**, **413** (in particular a button or a rocker) of the user interface **107** of the vehicle **100** in order to control the driving function. The method **570** also comprises causing **573** automated starting-up of the vehicle **100** in response to the detected actuation of the operating element **411**, **412**, **413**. It is therefore possible to enable comfortable and safe starting-up at a signaling unit **200**, **210**.

[0229] FIG. **5***i* shows a flowchart of an exemplary (possibly computer-implemented) method **580** for providing a driving function (in particular the UCC driving function) for the automated longitudinal guidance of a vehicle **100** at a signaling unit **200**, **210**.

[0230] During operation of the driving function, the method **580** comprises determining **581**, on the basis of environmental data relating to a leading vehicle driving (possibly directly) in front of the vehicle **100**, that the leading vehicle drives through a traffic junction (in particular an intersection) associated with a signaling unit **200**, **210**. In this case, the leading vehicle may be arranged in the same lane as the vehicle **100**.

[0231] In response to the detected driving of the leading vehicle, the method **580** also comprises causing **582** the vehicle **100** to be guided in an automated manner behind the leading vehicle across the traffic junction even if the state of the signaling unit **200**, **210** (in particular the color of the relevant signal group **201**) cannot be clearly determined with respect to the permission for driving through the traffic junction. The availability and therefore the comfort of the driving function can be increased by taking the behavior of the leading vehicle into consideration.

[0232] FIG. **5***j* shows a flowchart of an exemplary (possibly computer-implemented) method **590** for providing a driving function (in particular the UCC driving function) for the automated longitudinal guidance of a vehicle **100** at a signaling unit **200**, **210**.

[0233] During operation of the driving function, the method **590** comprises detecting **591** that the accelerator pedal of the vehicle **100** is actuated. The method **590** also comprises determining **592** actuation information relating to the actuation of the accelerator pedal and/or relating to a reaction of the vehicle **100** that is caused by the actuation of the accelerator pedal. The method **590** also comprises adapting **593**, in particular continuing or aborting, the operation of the driving function on the basis of the actuation information. In this case, in particular, the actuation of the accelerator pedal selectively (for each signaling unit **200**, **210**) may mean that a detected signaling unit **200**, **210** located ahead is not taken into consideration during the automated longitudinal guidance of the vehicle **100** (and the vehicle **100** is therefore guided past the detected signaling unit **200**, **210** with distance and/or speed control, in particular using the ACC driving function). The availability and the comfort of the driving function can be safely increased by taking actuation information into consideration. In particular, the driving function can thus be comfortably overwritten (selectively for each signaling unit **200**, **210**).

[0234] FIG. **6** shows a flowchart of a further exemplary (possibly computer-implemented) method **600** for providing a driving function for the automated longitudinal guidance of a vehicle **100** at a signaling unit **200**, **210**. During operation of the driving function, the method **600** comprises detecting **601** a first signaling unit **200**, **210** which is arranged in front of the vehicle **100** in the direction of travel on a road used by the vehicle **100**. The signaling unit **200**, **210** can be detected on the basis of environmental data and/or on the basis of map data, for example.

[0235] The method **600** also comprises determining **602** a driving mode that has been set from a plurality of different driving modes of the vehicle **100**. In this case, the driving mode may have been set by a user, in particular the driver, of the vehicle (for example using an operating element of the vehicle). The plurality of driving modes may comprise, for example, an eco driving mode, a comfort driving mode and/or a sport driving mode. The different driving modes may be designed to cause different driving dynamics of the vehicle. In this case, the driving dynamics in the eco driving mode may be lower than in the comfort driving mode and may be lower in the comfort driving mode than in the sport driving mode.

[0236] The method **600** also comprises causing **603** the automated longitudinal guidance of the vehicle **100** when approaching the first signaling unit **200**, **210**, in particular in the case of a deceleration process at the first signaling unit **200**, **210**, on the basis of the driving mode which has been set. The safety and the comfort of the driving function can be increased by taking into consideration the driving mode that has been set during operation of the UCC driving function.

[0237] This document describes different aspects of an Urban Cruise Control (UCC) driving function which provides comfortable and safe automated longitudinal guidance (according to SAE level 2) while taking signaling units **200**, **210** into consideration.

[0238] The present invention is not restricted to the exemplary embodiments shown. In particular, it should be noted that the description and the figures are intended to illustrate only the principle of the proposed methods, apparatuses and systems.

1-14. (canceled)

15. A vehicle system for providing a driving function for automated longitudinal guidance of a vehicle, comprising:

a vehicle guidance system configured to:

determine data relating to a first signaling unit that is located ahead in a direction of travel of the vehicle; and

operate the driving function in an automatic mode or in a manual mode at the first signaling unit on the basis of the data relating to the first signaling unit, wherein

the first signaling unit is taken into consideration automatically in the automatic mode and only after confirmation by a user of the vehicle in the manual mode during the automated longitudinal guidance of the vehicle.

16. The vehicle system according to claim **15**, wherein the vehicle guidance system is configured to determine, as data relating to the first signaling unit,

(i) map data relating to signaling units in a road network used by the vehicle; and/or

(ii) environmental data relating to the first signaling unit which have been captured by one or more environmental sensors of the vehicle.

17. The vehicle system according to claim **16**, wherein

the map data comprise one or more attributes for the first signaling unit; and

the one or more attributes indicate:

a type of the first signaling unit; and/or

a number of different signal groups of the first signaling unit for different directions of travel at a junction of the road network at which the first signaling unit is arranged; and/or

a position of the first signaling unit and/or of a stop line of the first signaling unit within the road network; and/or

a relative distance of the stop line of the signaling unit from the signaling unit.

18. The vehicle system according to claim **17**, wherein the type is whether the first signaling unit is a light signal installation or a traffic sign.

19. The vehicle system according to claim **16**, wherein the vehicle guidance system is configured to:

determine a decision time and/or a decision position before reaching the first signaling unit, at which an offer relating to the consideration of the first signaling unit should be output to the user of the vehicle at the latest;

determine whether there is a contradiction between the map data and the environmental data relating to a property of the first signaling unit at the decision time or at the decision position; and

operate the driving function in the automatic mode or in the manual mode at the first signaling unit on the basis of whether it is determined that there is or is not a contradiction between the map data and the environmental data at the decision time or at the decision position.

20. The vehicle system according to claim **19**, wherein the vehicle guidance system is configured to:

operate the driving function in the automated mode at the first signaling unit if it is determined that there is no contradiction between the map data and the environmental data at the decision time; and/or

operate the driving function in the manual mode at the first signaling unit if it is determined that there is a contradiction between the map data and the environmental data at the decision time.

21. The vehicle system according to claim **20**, wherein the vehicle guidance system is configured to:

determine a map-based number of different signal groups of the first signaling unit as a property of the first signaling unit on the basis of the map data;

determine a sensor-based number of different signal groups of the first signaling unit as a property of the first signaling unit on the basis of the environmental data; and

determine that there is a contradiction between the map data and the environmental data if the map-based number of signal groups differs from the sensor-based number of signal groups.

22. The vehicle system according to claim **21**, wherein

the contradiction is that the sensor-based number of signal groups is greater than the map-based number of signal groups.

23. The vehicle system according to claim **19**, wherein the vehicle guidance system is configured to:

already determine before the decision time or the decision position that there is a contradiction between the map data and the environmental data with regard to a property of the first signaling unit; and

in response, make a decision relating to whether the driving function is operated in the automatic mode or in the manual mode at the first signaling unit dependent on a renewed check for the presence of a contradiction at the decision time or at the decision position.

24. The vehicle system according to claim **19**, wherein the vehicle guidance system is configured to:

determine an intervention time or an intervention position before reaching the first signaling unit, at which the first signaling unit should or must be taken into consideration at the latest during the automated longitudinal guidance of the vehicle; and/or

determine a reaction period or a reaction distance which is granted to the user in order to react to an offer relating to the consideration of the first signaling unit; and

determine the decision time and/or the decision position on the basis of:

(i) the intervention time or the intervention position; and/or

(ii) the reaction period or the reaction distance.

25. The vehicle system according to claim **15**, wherein the vehicle guidance system is configured to:

determine a degree of complexity for a complexity of a junction, arranged at the first signaling unit, of a road used by the vehicle with one or more other traffic routes on the basis of the data relating to the first signaling unit; and

operate the driving function in the automatic mode or in the manual mode at the first signaling unit on the basis of the determined degree of complexity.

26. The vehicle system according to claim **15**, wherein the vehicle guidance system is configured to:

determine a number of different signal groups for different directions of travel of the vehicle on the basis of the data relating to the first signaling unit; and

operate the driving function in the automatic mode or in the manual mode at the first signaling unit on the basis of the determined number of different signal groups.

27. The vehicle system according to claim **26**, wherein the vehicle guidance system is configured to:

operate the driving function in the manual mode at the first signaling unit if the determined number of different signal groups is greater than one; and

operate the driving function in the automatic mode at the first signaling unit if the determined number of signal groups is equal to one.

28. The vehicle system according to claim **15**, wherein the vehicle guidance system is configured to:

determine a user setting effected by the user of the vehicle with respect to whether the driving function is intended to be operated in the automatic mode or in the manual mode;

operate the driving function in the manual mode at the first signaling unit on the basis of the data relating to the first signaling unit whenever the user setting indicates that the driving function is intended to be operated in the automatic mode; and/or

if the user setting indicates that the driving function is intended to be operated in the manual mode, operate the driving function in the manual mode at the first signaling unit whenever operation of the driving function in the automatic mode would be possible on the basis of the data relating to the first signaling unit.

29. The vehicle system according to claim **15**, wherein the vehicle guidance system, in the manual mode, is configured to:

output an offer relating to the consideration of the first signaling unit to the user of the vehicle, via a user interface of the vehicle; and

take the first signaling unit into consideration during the automated longitudinal guidance of the vehicle at the first signaling unit if the offer is accepted by the user; and/or

not take the first signaling unit into consideration during the automated longitudinal guidance of the vehicle at the first signaling unit if the offer is not accepted by the user.

30. The vehicle system according to claim **15**, wherein the vehicle guidance system is configured, if the first signaling unit is taken into consideration during the automated longitudinal guidance of the vehicle, to:

determine whether or not the vehicle must stop at the first signaling unit on the basis of the data relating to the first signaling unit; and

cause the vehicle to be stopped in an automated manner at the first signaling unit if it is determined that the vehicle must stop at the first signaling unit; and/or

cause the vehicle to be longitudinally guided in an automated manner past the first signaling unit, if it is determined that the vehicle need not stop at the first signaling unit.

31. The vehicle system according to claim **29**, wherein

the stop at the first signaling unit is at a stop line of the first signaling unit, and

the data is on the basis of a color of a light signal from the first signaling unit that is indicated by the data.

32. A method for providing a driving function for automated longitudinal guidance of a vehicle, the method comprising:

determining data relating to a first signaling unit that is located ahead in the direction of travel of the vehicle; and

operating the driving function in an automatic mode or in a manual mode at the first signaling unit on the basis of the data relating to the first signaling unit, wherein

the first signaling unit is taken into consideration automatically in the automatic mode and only after confirmation by a user of the vehicle in the manual mode during the automatic longitudinal guidance of the vehicle.

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