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(54) **Title:** A METHOD, PERFORMED BY A CONTROL DEVICE, FOR CONTROLLING A VEHICLE POSITION IN RELATION TO A PLATFORM, A CONTROL DEVICE AND A VEHICLE COMPRISING SUCH A CONTROL DEVICE

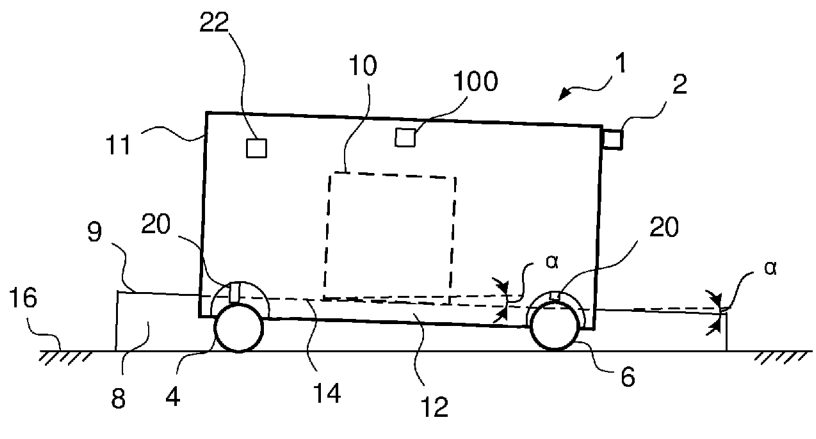

Fig. 1b

(57) **Abstract:** The invention relates to a method, performed by a control device (100), for controlling a vehicle (1) position in relation to a platform (8), the vehicle (1) comprising: at least one sensor device (2); at least two front wheels (4); at least two rear wheels (6); and the control device (100). The method comprising: determining (s101) a platform height above a road surface (16) at the platform (8); determining (s102) an inclination of the platform (8); controlling (s103) the vehicle (1), so that a floor surface (14) of the vehicle (1) has a level corresponding to the platform height; and controlling (s104) the vehicle (1), so that the floor surface (14) of the vehicle (1) has an inclination corresponding to the inclination of the platform (8). The invention also relates to a computer program (P), a computer-readable medium, a control device (100) and a vehicle (1) comprising such a control device (100).

WO 2020/117111 A1

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A method, performed by a control device, for controlling a vehicle position in relation to a platform, a control device and a vehicle comprising such a control device

TECHNICAL FIELD

The invention relates to a method, performed by a control device, for controlling a vehicle position in relation to a platform according to the appended claims. The invention further relates to a computer program, a computer-readable medium, a control device and a vehicle according to the appended claims.

BACKGROUND

Different types of vehicles are operated for loading and unloading goods, cargo and passengers on platforms, such as loading docks. When the vehicle is stopped or parked adjacent to the platform whereby goods, cargo and passengers are transferred from the platform or vehicle through a door opening of the vehicle. For convenience of loading and unloading the vehicle, it is desirable that a floor of the vehicle be aligned as closely as possible with the elevation of the platform surface.

Vehicles of today are typically manufactured for a specific purpose, e.g. a bus is manufactured for transporting people and a truck is manufactured for transporting goods. Such vehicles are typically manufactured and completely assembled in a factory or they may be partly assembled in a factory and completed at a body manufacturer. Once the vehicle is assembled, the vehicle can be used for the specific purpose. Thus, a bus may be used as a bus and a truck for transporting goods will be used as a truck for transporting goods. Different vehicles are thus needed for different purposes, which may require a large fleet of vehicles and which is very costly. It may therefore be desired to be able to customize a vehicle depending on different missions.

There are, for example, known solutions where a truck can be rebuilt by changing a concrete mixer to a loading platform. This increases the flexibility and two different functions can be achieved by means of one single vehicle. Also, document US-2016/0129958 A discloses a modular electric vehicle using interchangeable vehicle assembly modules. The user can thereby disassemble and reassemble the vehicle for use in different applications. Disassembling and reassembling such a vehicle would, however, be a very cumbersome and time consuming work. Furthermore, when a failure occurs in one of the known vehicle modules it may be difficult to replace the failing module, which may result in that the vehicle may be unusable for a considerable period of time. It may also be cumbersome to transport the replacing module to the site of the vehicle with the failing module.

SUMMARY

Despite known solutions in the art, it is desired to facilitate and minimize the time for loading and unloading of a vehicle. It is also desired to increase security and minimize damages at loading and unloading of a vehicle.

An object of the invention is to facilitate and minimize the time for loading and unloading of a vehicle.

A further object of the invention is to increase security and minimize damages at loading and unloading of a vehicle.

The herein mentioned objects are achieved with a method, performed by a control device, for controlling a vehicle position in relation to a platform according to the appended claims. The herein mentioned objects are also achieved with a computer program, a computer-readable medium, a control device and a vehicle, according to the appended claims.

According to an aspect of the invention a method, performed by a control device, for controlling a vehicle position in relation to a platform, the vehicle comprising: at least one sensor device; at least two front wheels; at least two rear wheels; and the control device, the method comprising: determining a platform height above a road surface at the platform; determining an inclination of the platform; controlling the vehicle, so that a floor surface of the vehicle has a level corresponding to the platform height; and controlling the vehicle, so that the floor surface of the vehicle has an inclination corresponding to the inclination of the platform.

According to a further aspect of the invention a control device for controlling a vehicle position in relation to a platform, the vehicle comprising: at least one sensor device; at least two front wheels; at least two rear wheels; and the control device, the control device being configured to: determine a platform height above a road surface at the platform; determine an inclination of the platform; control the vehicle, so that a floor surface of the vehicle has a level corresponding to the platform height; and control the vehicle, so that the floor surface of the vehicle has an inclination corresponding to the inclination of the platform.

By such a method and control device, loading and unloading of the vehicle is facilitated. The time is minimized, the security is increased and damages minimized when loading and unloading of the vehicle.

By determining the platform height above a road surface and determining any inclination of the platform, the vehicle may be controlled, so that the floor surface of the vehicle has a level corresponding to the platform height, and also so the floor surface of the vehicle has an inclination corresponding to the inclination of the platform.

Loading and unloading goods, cargo and passengers on the platform are facilitated when the floor surface of the vehicle has a level and an inclination corresponding to the platform height, and to any inclination of the platform. The time will be minimized when loading and unloading goods, cargo and passengers on the platform, since the goods and cargo may easily be moved between the surfaces of the vehicle floor and the platform, without any lift. The security is increased and damages minimized on the goods, cargo and passengers, since there is no step between the surfaces of the vehicle floor and the platform.

According to yet another aspect of the invention a vehicle assembled from a set of modules is provided. The vehicle comprises at least one drive module and at least one functional module, wherein the at least one drive module comprises the a least two front wheels or the at least two rear wheels, and is configured to be autonomously operated and drive the assembled vehicle. The vehicle further comprises a control device as disclosed herein.

By such a vehicle, loading and unloading of the vehicle is facilitated. The time is minimized, the security is increased and damages minimized when loading and unloading of the vehicle.

Vehicles of today are typically manufactured for a specific purpose, e.g. a bus is manufactured for transporting people and a truck is manufactured for transporting goods. Such vehicles are typically manufactured and completely assembled in a factory or they are partly assembled in a factory and completed at a body manufacturer. Once the vehicle is assembled, the vehicle will only be used for the specific purpose. Thus, a bus will only be used as a bus and a truck for transporting goods will be used as a truck for transporting goods. Different vehicles are thus needed for different purposes, which may require a large fleet of vehicles and which may be very costly. Assembling a vehicle from a set of modules according to the invention makes it possible to dynamically assemble a modularised vehicle depending on a current mission or function to be performed. This way, from the same set of modules, for example a truck, a garbage truck, a bus or a snowplough can be assembled. Not only will this result in an increased flexibility, but the cost for a vehicle owner will decrease significantly compared to having a plurality of different vehicles for different applications. The vehicle is autonomously operated by means of the at least one drive module. Also, by using at least one autonomously operated drive module, the drive module may autonomously/automatically perform physical and electrical connection/disconnection with a second module. This way, no manual work is required and the assembly of the vehicle is less cumbersome and much more time efficient.

Since the vehicle is configured to be autonomously operated and drive the assembled vehicle, the platform height above a road surface and any inclination of the platform are autonomously determined by the control device of the vehicle. In addition, the vehicle is autonomously controlled, so that the floor surface of the vehicle has a level corresponding to the platform height, and also so the floor surface of the vehicle has an inclination corresponding to the inclination of the platform.

Additional objectives, advantages and novel features of the invention will be apparent to one skilled in the art from the following details, and through exercising the invention. While the invention is described below, it should be apparent that the invention may not be limited to the specifically described details. One skilled in the art, having access to the teachings herein, will recognize additional applications, modifications and incorporations in other areas, which are within the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Below is a description of, as examples, preferred embodiments with reference to the enclosed drawings, in which:

Figures 1a and 1b schematically illustrate side views of a vehicle provided with a control device according to an embodiment;

Figures 2a and 2b schematically illustrate side views of a vehicle provided with a control device according to an embodiment;

Figure 2c schematically illustrate a view of from behind of a vehicle provided with a control device according to an embodiment;

Figures 3a and 3b schematically illustrate side views of a modularised vehicle provided with a control device according to an embodiment;

Figure 4 schematically illustrates a drive module provided with a control device according to an embodiment;

Figure 5a illustrates a flow chart for a method, performed by a control device, for controlling the height of a modularised vehicle according to an embodiment;

Figure 5b illustrates a flow chart for a method, performed by a control device, for controlling the height of a modularised vehicle according to an embodiment; and

Figure 6 schematically illustrates a control device or computer according to an embodiment.

DETAILED DESCRIPTION

The method, performed by the control device, for controlling a vehicle position in relation to a platform will facilitate loading and unloading the vehicle and minimizing the time for loading and unloading. In addition, security will increase and damages minimized when loading and unloading the vehicle.

Modularised vehicles are typically assembled at the customer's premises and the customer may thus buy a set of modules from a manufacturer. The assembled vehicle may comprise at least two modules including at least one drive module and at least one functional module. Such a modularised vehicle is applicable on all sorts of road vehicles and may thus relate to heavy vehicles, such as buses, trucks etc., which may be used on public roads.

According to an aspect, the present disclosure relates to a method, performed by a control device, for controlling a vehicle position in relation to a platform, the vehicle comprising: at least one sensor device; at least two front wheels; at least two rear wheels; and the control device, the method comprising: determining a platform height above a road surface at the platform; determining an inclination of the platform; controlling the vehicle, so that a floor surface of the vehicle has a level corresponding to the platform height; and controlling the vehicle, so that the floor surface of the vehicle has an inclination corresponding to the inclination of the platform.

By such a method, loading and unloading of the vehicle is facilitated. The time is minimized, the security is increased and damages minimized when loading and unloading of the vehicle.

By determining the platform height above a road surface and determining any inclination of the platform, the vehicle is controlled, so that the floor surface of the vehicle has a level corresponding to the platform height, and also so the floor surface of the vehicle has an inclination corresponding to the inclination of the platform.

Based on the determined platform height above a road surface and the determined inclination of the platform, the vehicle level and inclination is controlled when the vehicle is moving towards the platform or when the vehicle has stopped adjacent to the platform. The vehicle level is controlled so that a specific component of the vehicle is changing height. The level of the platform surface above the road surface may be the same level as the platform height above the road surface. The level of the floor surface above the road surface may be the same level as a floor surface height above the road surface.

The definition that a floor surface of the vehicle has a level corresponding to the platform height comprises that the level and height correspond exactly to each other or that there is some difference between the level and height. The difference between the level and height may be very small, and will not affect boarding and exit the vehicle or loading and unloading of the vehicle.

The vehicle can be configured with a passenger compartment for accommodating passengers and may thus function as a bus. According to another example, the vehicle can be configured with a load compartment for accommodating load, goods and cargo, and may thus function as a truck.

The determined platform height above the road surface at the platform is compared to the actual vehicle floor surface level in relation to the road surface. The vehicle floor surface level present when the vehicle approaching the platform is a vehicle floor surface level used when driving the vehicle during normal driving conditions. However, the vehicle floor surface level used when driving the vehicle during normal driving conditions may vary depending on the weight of the passengers and/or the loaded goods within the vehicle. The vehicle floor surface level present when the vehicle approaching the platform is detected by any means of a height sensor device. The height sensor device may also be used during controlling the vehicle floor surface level before arriving at platform, so that a floor surface of the vehicle has a level corresponding to the height of the platform surface. Determining the platform height above a road surface at the platform, is based on detected height information from any means of a height or position sensor device. Such sensor device may be a laser sensor, ultra sound sensor, a radar, a lidar or the like. Such sensor devices may also be combined on the vehicle in order to increase the accuracy of the determining of the platform height. Determining the inclination of the platform is based on detected inclination information from any means of an inclination sensor device. Such sensor device may be a laser sensor, ultra sound sensor, a radar, a lidar or the like. Such sensor devices may also be combined on the vehicle in order to increase the accuracy of the determining of the inclination of the platform. The sensor devices also detects an outer edge of the platform and transmit signals to the control unit for controlling the vehicle to be positioned with an outer edge of the floor surface of the vehicle parallel to the outer edge of the platform.

The control device comprised in the vehicle is configured to receive commands and instructions from a control centre or an off-board system and to execute the commands/instructions for controlling the vehicle level and inclination in relation to the road surface based on data from the sensor device. The vehicle may be autonomously operated in order to determining the platform height above a road surface at the platform; determining the inclination of the platform; controlling the vehicle, so that a floor surface of the vehicle has a level corresponding to the platform height; and controlling the vehicle, so that the floor surface of the vehicle has an inclination corresponding to the inclination of the platform.

Controlling the vehicle level in relation to the road surface according to the method is performed, by the control device comprised in the vehicle, without instructions from the control centre.

According to an aspect, controlling the vehicle, so that the floor surface of the vehicle has an inclination corresponding to the inclination of the platform, comprises controlling the inclination of the vehicle in a longitudinal direction of the vehicle and in a lateral direction of the vehicle.

Determining an inclination of the platform surface may result in that the platform surface has an inclination in relation to a horizontal plane. The platform surface may have an inclination in any direction of a horizontal plane. Controlling the inclination of the vehicle in a longitudinal direction of the vehicle and in a lateral direction of the vehicle may result in that the floor surface of the vehicle may achieve a corresponding inclination to the inclination of the platform. The vehicle may comprise a sensor device, such as a levelling sensor, which is connected to the control device. The sensor device may detect the inclination of the vehicle.

According to an aspect, controlling the vehicle, comprises controlling an individually controllable wheel suspension of at least one wheel.

The wheel suspension of the vehicle is arranged between each wheel and a body of the vehicle. The wheel suspension may comprise springs and dampers for improving the driving characteristics of the vehicle. The wheel suspension of the vehicle may comprise adjusting means for controlling the vehicle level when arriving at the platform. The control device receives information about the platform and the road surface at the platform. Thereafter the control device is configured to control the adjusting means of each wheel suspension individually to adjust the vehicle in relation to the platform. The road surface at the platform may have a curvature and have cavities, which the individually controllable wheel suspension of at least one wheel may compensate for. The suspension system may also be controlled so that an outer edge of the platform is parallel to an outer edge of the floor surface of the vehicle.

According to an aspect, controlling the vehicle, comprises controlling an individually controllable wheel suspension of at least one wheel, so that the floor surface of the vehicle coincide with a platform surface in a common plane.

The control device receives information about the platform height and the inclination of the platform surface above the road surface at the platform from the one or more sensor device(s). Thereafter the control device controls the adjusting means of each wheel suspension individually to adjust the vehicle level and inclination corresponding to the platform height and the inclination of the platform surface. The vehicle may have at least four wheels, each provided with an individually controlled wheel suspension. Controlling the inclination of the vehicle in a longitudinal direction of the vehicle and in a lateral direction of the vehicle is possible when arranging the wheels in the area of, for example, each corner of the vehicle. Individually adjusting the distance between each wheel and the body of the vehicle, and thus the distance between the road surface and the floor surface of the vehicle, results in an adjustment of the level and inclination of the floor surface of the vehicle to correspond to the platform height and the inclination of the platform surface. The adjustment of the level and inclination of the floor surface of the vehicle to correspond to the platform height and the inclination of the platform surface results in that the floor surface of the vehicle will coincide with a platform surface in a common plane.

According to an aspect, determining a platform height comprises determining the platform height by means of the least one sensor device.

At least one sensor device is arranged on the vehicle for determining the platform height. Such sensor device may be a laser sensor, ultra sound sensor, a radar, a lidar or the like. Such sensor devices may also be combined on the vehicle in order to increase the accuracy of the determining of the height of the platform. The sensor device is connected to the control device, and provides the control device with information about the platform height. When the vehicle approaches the platform, the sensor device detects the platform height. Signals from the sensor device is transmitted to the control device. Based on the information from the sensor device, the control unit controls the vehicle, so that the floor surface of the vehicle has a level corresponding to the platform height. A plurality of sensor devices for determining the platform height are arranged on the vehicle. One sensor device is arranged in front of the vehicle. Another sensor device is arranged at the rear of the vehicle and two other sensor devices are arranged on each side of the vehicle.

Signals from the sensor comprising the information about the platform height above the road surface at the target destination is received by the control device in the vehicle. The control device is configured to control the vehicle height when approaching the platform, so that the floor surface of the vehicle has a level corresponding to the height of the platform surface. The control device is configured to verify that the level of the floor surface of the vehicle corresponds to the height of the platform surface when the vehicle is close to or adjacent to the platform. Controlling of the floor surface level by means of the control device may set a number of software marks (flags) of the control device. If the control device determines that the floor surface level is higher than the platform height, a first flag is set by the control device in a software of the control device. If the control device determines that the floor surface level is lower than the platform height, a second flag is set by the control device in the software of the control device. If the control device determines that the floor surface level already correspond to the platform height a third flag is set by the control device in the software of the control device. Depending on the flag set, the control device controls the vehicle to a floor surface level that correspond to the platform height at the target destination, so that a floor surface of the vehicle has a level corresponding to the height of the platform surface. The definition of the expression that the floor surface of the vehicle corresponds to the height of the platform surface is that there is a small margin of error between the level of the floor surface and the height of the platform surface.

According to an aspect, controlling the vehicle, so that the floor surface of the vehicle has an inclination corresponding to the inclination of the platform, comprises determining the inclination of the floor surface by means of a level sensor and determining the inclination of the platform by means of the at least one sensor device.

The vehicle may comprise a sensor device, such as a level sensor, which is connected to the control device. The sensor device may detect the inclination of the vehicle and transmit the information to the control device. At least one sensor device is arranged on the vehicle for determining the inclination of the platform. Such sensor device may be a laser sensor, ultra sound sensor, a radar, a lidar or the like. Such sensor devices may also be combined on the vehicle in order to increase the accuracy of the determining of the inclination of the platform. The sensor device is connected to the control device, and provides the control device with information about the inclination of the platform. Determining an inclination of the platform surface may result in that the platform surface has an inclination in relation to a horizontal plane. The platform surface may have an inclination in any direction of a horizontal plane. When the vehicle approaches the platform, the sensor device detects the inclination of the platform. Signals from the sensor device is transmitted to the control device. A plurality of sensor devices for determining the inclination of the platform are arranged on the vehicle. One sensor device is arranged in front of the vehicle. Another sensor device is arranged at the rear of the vehicle and two other sensor devices are arranged on each side of the vehicle. Based on the information from the sensor device, the control unit is configured to control the vehicle, so that the floor surface of the vehicle has an inclination corresponding to the inclination of the platform.

According to an aspect, the method comprises the further step of determining the distance between the vehicle and the platform by means of the at least one sensor device.

When the vehicle approaches the platform, the at least one sensor device detects the platform. The at least one sensor device transfers the detected signals of the platform to the control device. Based on these signals, the control device determines the distance between the vehicle and the platform. Based on the determined distance between the vehicle and the platform, the control device controls the vehicle to move to a position adjacent to the platform.

According to an aspect, the method comprises the further step of determining the shape of the road surface by means of the at least one sensor device.

The road surface at the platform may have a curvature, cavities and elevations, which may influence on the position of the vehicle in relation to the platform. At least one sensor device is arranged on the vehicle for determining the shape of the road surface. The sensor device may detect the curvature and any cavities in the road surface at the platform. The sensor device may also detect any elevation or bump in the road surface at the platform. Such sensor device may be a laser sensor, ultra sound sensor, a radar, a lidar or the like. Such sensor devices may also be combined on the vehicle in order to increase the accuracy of the determining of the shape of the road surface. The sensor device is connected to the control device, and provides the control device with information about the shape of the road surface. When the vehicle approaches the platform, the sensor device detects the shape of the road surface at the platform. Signals from the sensor device is transmitted to the control device. Based on the information from the sensor device, the control unit may controlling the vehicle, so that the floor surface of the vehicle has a level and inclination corresponding to the platform height and inclination. A plurality of sensor devices for determining the shape of the road surface may be arranged on the vehicle. One sensor device is arranged in front of the vehicle. Another sensor device is arranged at the rear of the vehicle and two other sensor devices are arranged on each side of the vehicle. A further sensor device for determining the shape of the road surface is arranged on the underside of the vehicle.

According to an aspect, the method comprises the further step of determining any obstacles above or beside the road surface in front of the platform by means of the at least one sensor device.

When approaching the platform, the vehicle may interfere with obstacles above or beside the road surface in front of the platform. Such obstacles may be a ceiling above and in front of the platform. Such obstacles may also be another vehicle parked at the platform. At least one sensor device is arranged on the vehicle for determining any obstacles above or beside the road surface in front of the platform. The sensor device may detect the any obstacles above or beside the road surface in front of the platform. Such sensor device may be a laser sensor, ultra sound sensor, a radar, a lidar or the like. Such sensor devices may also be combined on the vehicle in order to increase the accuracy of the determining of any obstacles above or beside the road surface in front of the platform. The sensor device is connected to the control device, and provides the control device with information about any obstacles above or beside the road surface in front of the platform. When the vehicle approaches the platform, the sensor device detects any obstacles above or beside the road surface in front of the platform. Signals from the sensor device is transmitted to the control device. Based on the information from the sensor device, the control device is configured to control the vehicle, so that the vehicle avoids the detected obstacles. A plurality of sensor devices for determining any obstacles above or beside the road surface in front of the platform may be arranged on the vehicle. One sensor device is arranged in front of the vehicle. Another sensor device is arranged at the rear of the vehicle and two other sensor devices are arranged on each side of the vehicle.

According to an aspect, the method comprises the further step of receiving information about the platform height and the inclination of the platform from another vehicle.

Other vehicles may have visited the site of the platform and thus registered and stored information about the platform height above the road surface and the inclination of the platform. The information about the platform height above the road surface and the inclination of the platform are received from such other vehicle before the vehicle is arriving at the target destination. The information may be received close to the moment when the vehicle is arriving at the target destination. As soon as there is a change in platform height above the road surface or the inclination of the platform is changed, the vehicle may receive updated information about the platform height and the inclination of the platform. A change in platform height above the road surface and a change of the inclination of the platform may take place due to reconstruction of the road and/or the platform.

The vehicle height and inclination is controlled before arriving at the target destination. The vehicle height and inclination are controlled so that a specific component of the vehicle is changing height. The vehicle height and inclination may be controlled before arriving at the target destination, so that the floor surface of the vehicle may have a level above the road surface and an inclination corresponding to the level of the platform surface above the road surface and the inclination of the platform at the target destination. The level of the platform surface above the road surface may be the same level as the platform height above the road surface. The level of the floor surface above the road surface may be the same level as a floor surface height above the road surface.

Alternatively, or in addition, the information about the platform height and the inclination of the platform is received from an external control centre. The control device comprised in the vehicle is configured to receive information, commands and instructions from the control centre or an off-board system and to execute the commands/instructions for controlling the vehicle height and inclination corresponding to the platform height and platform inclination at the target destination.

In addition, a door actuator is controlled for opening at least one door of the vehicle. The door is opened after verifying that the floor surface of the vehicle has a level and inclination that correspond to the height and inclination of the platform surface. The door actuator is controlled by the control device in the vehicle. If the doors of the vehicle are opened when there is a difference between the floor surface level and the platform surface height, the doors may be obstructed by the platform, which may lead to a technical malfunction of the doors and/or the door actuators. Opening of the doors after verifying that the floor surface of the vehicle has a level corresponding to the height of the platform surface may result in a secure and convenient boarding and exit of passengers to and from the vehicle. Also, load and goods may safely be loaded and unloaded to and from the vehicle if the doors are opened after verifying that the floor surface of the vehicle has a level and inclination corresponding to the height and inclination of the platform surface.

The present disclosure also relates to a computer program comprising instructions which, when the program is executed by a computer, causes the computer to carry out the method disclosed above. The invention further relates to a computer-readable medium comprising instructions, which when executed by a computer causes the computer to carry out the method disclosed above.

Furthermore, the present disclosure relates to a control device for controlling a vehicle position in relation to a platform, the vehicle comprising: at least one sensor device; at least two front wheels; at least two rear wheels; and the control device, the control device being configured to: determine a platform height above a road surface at the platform; determine an inclination of the platform; control the vehicle, so that a floor surface of the vehicle has a level corresponding to the platform height; and control the vehicle, so that the floor surface of the vehicle has an inclination corresponding to the inclination of the platform.

By such control device, loading and unloading of the vehicle is facilitated. The time is minimized, the security is increased and damages minimized when loading and unloading of the vehicle.

The control device is configured to determine the platform height above a road surface and determining any inclination of the platform. Based on this determination, the control device is configured to control the vehicle, so that the floor surface of the vehicle may have a level corresponding to the platform height, and also so the floor surface of the vehicle has an inclination corresponding to the inclination of the platform.

Based on the determined platform height above a road surface and the determined inclination of the platform, the control device is configured to control the vehicle, so the level of the floor surface of the vehicle and inclination of the floor surface of the vehicle is controlled when the vehicle is moving towards the platform or when the vehicle has stopped adjacent to the platform. The control device is configured to control the level of the floor surface of the vehicle and inclination of the floor surface the vehicle, so that a specific component of the vehicle is changing height. The level of the platform surface above the road surface may be the same level as the platform height above the road surface. The level of the floor surface above the road surface may be the same level as a floor surface height above the road surface.

The vehicle may be configured with a passenger compartment for accommodating passengers and may thus function as a bus. According to another example, the vehicle may be configured with a load compartment for accommodating load, goods and cargo, and may thus function as a truck.

The control device comprised in the vehicle is configured to receive commands and instructions from a control centre or an off-board system and to execute the commands/instructions for controlling the vehicle level and inclination in relation to the road surface based on data from the sensor device. The vehicle may be autonomously operated by the control device in order to determine the platform height above a road surface at the platform; determine the inclination of the platform; control the vehicle, so that a floor surface of the vehicle has a level corresponding to the platform height; and control the vehicle, so that the floor surface of the vehicle has an inclination corresponding to the inclination of the platform.

The control device comprised in the vehicle is configured to control the floor surface level in relation to the height of the platform surface, without instructions from the control centre.

According to an aspect, the control device, configured to control the vehicle, so that the floor surface of the vehicle has an inclination corresponding to the inclination of the platform, comprising controlling the inclination of the vehicle in a longitudinal direction of the vehicle and in a lateral direction of the vehicle.

The control device is configured to determine any inclination of the platform surface. This may result in the determination that the platform surface has an inclination in relation to a horizontal plane. The platform surface may have an inclination in any direction of a horizontal plane. The control device is configured to control the inclination of the vehicle in a longitudinal direction of the vehicle and in a lateral direction of the vehicle so that the floor surface of the vehicle achieves a corresponding inclination to the inclination of the platform. The vehicle may comprise a sensor device, such as a levelling member, which is connected to the control device. The level sensor may detect the inclination of the vehicle and transmit signals about the detection to the control unit.

According to an aspect, the control device, configured to control the vehicle, comprising controlling an individually controllable wheel suspension of at least one wheel.

The control device receives transmitted information from a sensor device about the platform and the road surface at the platform. Thereafter the control device controls adjusting means of each wheel suspension individually to adjust the vehicle in relation to the platform. The road surface at the platform may have curvatures, cavities and elevations, which the individually controllable wheel suspension of at least one wheel may compensate for.

According to an aspect, the control device, configured to control the vehicle, comprising controlling an individually controllable wheel suspension of at least one wheel, so that the floor surface of the vehicle coincide with a platform surface in a common plane.

The control device receives information about the platform height and the inclination of the platform surface above the road surface at the platform from the sensor device. Thereafter the control device controls the adjusting means of each wheel suspension individually to adjust the vehicle level and inclination corresponding to the platform height and the inclination of the platform surface. The vehicle may have at least four wheels, each provided with an individually controlled wheel suspension. Controlling the inclination of the vehicle in a longitudinal direction of the vehicle and in a lateral direction of the vehicle is possible when arranging the wheels in the area of, for example, each corner of the vehicle. Individually adjusting the distance between each wheel and the body of the vehicle, and thus the distance between the road surface and the floor surface of the vehicle, results in an adjustment of the level and inclination of the floor surface of the vehicle to correspond to the platform height and the inclination of the platform surface. The adjustment of the level and inclination of the floor surface of the vehicle to correspond to the platform height and the inclination of the platform surface results in that the floor surface of the vehicle will coincide with a platform surface in a common plane.

According to an aspect, the control device, configured to determine a platform height, comprising determining the platform height by means of the least one sensor device.

At least one sensor device is arranged on the vehicle for determining the platform height. Such sensor device may be a laser sensor, ultra sound sensor, a radar, a lidar or the like. Such sensor devices may also be combined on the vehicle in order to increase the accuracy of the determining of the height of the platform. The sensor device is connected to the control device, and provides the control device with information about the platform height. When the vehicle approaches the platform, the sensor device detects the platform height. Signals from the sensor device is transmitted to the control device. Based on the information from the sensor device, the control device may control the vehicle, so that the floor surface of the vehicle has a level corresponding to the platform height. A plurality of sensor devices for determining the platform height is arranged on the vehicle. One sensor device is arranged in front of the vehicle. Another sensor device is arranged at the rear of the vehicle and two other sensor devices are arranged on each side of the vehicle.

The signal comprising the information about the platform height above the road surface at the target destination is received by the control device in the vehicle. The control device is configured to control the vehicle height when approaching the platform, so that the floor surface of the vehicle has a level corresponding to the height of the platform surface. The control device is configured to verify that the level of the floor surface of the vehicle corresponds to the height of the platform surface when the vehicle is close to or adjacent to the platform. The definition of the expression that the floor surface of the vehicle corresponds to the height of the platform surface is that there is a small margin of error between the level of the floor surface and the height of the platform surface.

According to an aspect, the control device, configured to control the vehicle, so that the floor surface of the vehicle has an inclination corresponding to the inclination of the platform, comprising determine the inclination of the floor surface by means of a level sensor and determine the inclination of the platform by means of the at least one sensor device.

The vehicle may comprise a sensor device, such as a level sensor, which is connected to the control device. The sensor device may detect the inclination of the vehicle and transmit the information to the control device. At least one sensor device is arranged on the vehicle for determining the inclination of the platform. Such sensor device may be a laser sensor, ultra sound sensor, a radar, a lidar or the like. Such sensor devices may also be combined on the vehicle in order to increase the accuracy of the determining of the inclination of the platform. The sensor device is connected to the control device, and provides the control device with information about the inclination of the platform. Determining an inclination of the platform surface may result in that the platform surface has an inclination in relation to a horizontal plane. The platform surface may have an inclination in any direction of a horizontal plane. When the vehicle approaches the platform, the sensor device detects the inclination of the platform. Signals from the sensor device is transmitted to the control device. A plurality of sensor devices for determining the inclination of the platform are arranged on the vehicle. One sensor device is arranged in front of the vehicle. Another sensor device is arranged at the rear of the vehicle and two other sensor devices are arranged on each side of the vehicle. Based on the information from the sensor device, the control unit is configured to control the vehicle, so that the floor surface of the vehicle has an inclination that correspond to the inclination of the platform.

According to an aspect, the control device further is configured to determine the distance between the vehicle and the platform by means of the at least one sensor device.

When the vehicle approaches the platform, the at least one sensor device detects the platform. The at least one sensor device transfers the detected signals of the platform to the control device. Based on these signals, the control device is configured to determine the distance between the vehicle and the platform. Based on the determined distance between the vehicle and the platform, the control device is configured to control the vehicle to move to a position adjacent to the platform.

According to an aspect, the control device further is configured to determine the shape of the road surface by means of the at least one sensor device.

The road surface at the platform may have a curvature, cavities and elevations, which may influence on the position of the vehicle in relation to the platform. At least one sensor device is arranged on the vehicle for determining the shape of the road surface. The sensor device may detect the curvature and any cavities in the road surface at the platform. The sensor device may also detect any elevation or bump in the road surface at the platform. Such sensor device may be a laser sensor, ultra sound sensor, a radar, a lidar or the like. Such sensor devices may also be combined on the vehicle in order to increase the accuracy of the determining of the shape of the road surface. The sensor device is connected to the control device, and provides the control device with information about the shape of the road surface. When the vehicle approaches the platform, the sensor device detects the shape of the road surface at the platform. Signals from the sensor device is transmitted to the control device. Based on the information from the sensor device, the control device is configured to control the vehicle, so that the floor surface of the vehicle has a level and inclination corresponding to the platform height and inclination. A plurality of sensor devices for determining the shape of the road surface is arranged on the vehicle. One sensor device is arranged in front of the vehicle. Another sensor device is arranged at the rear of the vehicle and two other sensor devices are arranged on each side of the vehicle. A further sensor device for determining the shape of the road surface is arranged on the underside of the vehicle.

According to an aspect, the control device further is configured to determine any obstacles above or beside the road surface in front of the platform by means of the at least one sensor device.

When approaching the platform, the vehicle may interfere with obstacles above or beside the road surface in front of the platform. Such obstacles may be a ceiling above and in front of the platform. Such obstacles may also be another vehicle parked at the platform. At least one sensor device is arranged on the vehicle for determining any obstacles above or beside the road surface in front of the platform. The sensor device may detect the any obstacles above or beside the road surface in front of the platform. Such sensor device may be a laser sensor, ultra sound sensor, a radar, a lidar or the like. Such sensor devices may also be combined on the vehicle in order to increase the accuracy of the determining of any obstacles above or beside the road surface in front of the platform. The sensor device is connected to the control device, and provides the control device with information about any obstacles above or beside the road surface in front of the platform. When the vehicle approaches the platform, the sensor device detects any obstacles above or beside the road surface in front of the platform. Signals from the sensor device is transmitted to the control device. Based on the information from the sensor device, the control device is configured to control the vehicle, so that the vehicle avoids the detected obstacles. A plurality of sensor devices for determining any obstacles above or beside the road surface in front of the platform are arranged on the vehicle. One sensor device is arranged in front of the vehicle. Another sensor device is arranged at the rear of the vehicle and two other sensor devices are arranged on each side of the vehicle.

According to an aspect, the control device further is configured to receive information about the platform height and the inclination of the platform from another vehicle.

The information about the platform height above the road surface and the inclination of the platform may be received from another vehicle before the vehicle is arriving at the target destination. The information may be received close to the moment when the vehicle is arriving at the target destination. As soon as there is a change in platform height above the road surface or the inclination of the platform is changed, the vehicle may receive updated information about the platform height and the inclination of the platform. A change in platform height above the road surface and a change of the inclination of the platform may take place due to reconstruction of the road and/or the platform.

The control device is configured to control the vehicle height and inclination before arriving at the target destination. The vehicle height and inclination are controlled so that a specific component of the vehicle is changing height. The control device may be configured to control the vehicle height and inclination before arriving at the target destination, so that the floor surface of the vehicle may have a level above the road surface and an inclination corresponding to the level of the platform surface above the road surface and the inclination of the platform at the target destination. The level of the platform surface above the road surface is the same level as the platform height above the road surface. The level of the floor surface above the road surface is the same level as a floor surface height above the road surface.

Alternatively, or in addition, the information about the platform height and the inclination of the platform from may be received by the control device in the vehicle from an external control centre. The control device comprised in the vehicle is configured to receive information, commands and instructions from the control centre or an off-board system and to execute the commands/instructions for controlling the vehicle height and inclination corresponding to the platform height and platform inclination at the target destination.

In addition, the control device is configured to control a door actuator for opening at least one door of the vehicle. The door is opened after verifying that the floor surface of the vehicle has a level and inclination that correspond to the height and inclination of the platform surface. If the doors of the vehicle are opened when there is a difference between the floor surface level and the platform surface height, the doors may be obstructed by the platform, which may lead to a technical malfunction of the doors and/or the door actuators. Opening of the doors after verifying that the floor surface of the vehicle has a level corresponding to the height of the platform surface may result in a secure and convenient boarding and exit of passengers to and from the vehicle. Also, load and goods may safely be loaded and unloaded to and from the vehicle if the doors are opened after verifying that the floor surface of the vehicle has a level and inclination corresponding to the height and inclination of the platform surface.

Furthermore, the present disclosure relates to a vehicle, comprising at least one sensor device, at least two front wheels; and at least two rear wheels, wherein the vehicle comprising the herein mentioned control device.

The vehicle is applicable on all sorts of road vehicles and may thus relate to heavy vehicles, such as buses, trucks etc., which may be used on public roads. The vehicle may also be a boat or ship, and also an aircraft. The control unit, comprised in the vehicle, is configured to perform the herein mentioned method steps and activities. The control unit may be configured to autonomously operate the vehicle.

According to an aspect, the vehicle is a modular vehicle comprising at least one drive module and at least one functional module, wherein the at least one drive module comprises the at least two front wheels or the at least two rear wheels, and is configured to be autonomously operated and drive the assembled vehicle.

The modularised vehicle is applicable on all sorts of road vehicles and may thus relate to heavy vehicles, such as buses, trucks etc., which may be used on public roads. The control unit, comprised in the modularised vehicle, is configured to perform the herein mentioned method steps and activities. The control unit may be configured to autonomously operate the modularised vehicle.

Loading and unloading such a modularised vehicle is facilitated. The time is minimized, the security is increased and damages minimized when loading and unloading such a modularised vehicle.

At least one drive module is used together with different functional modules. The functional modules are designed for specific purposes. Therefore, by combining a drive module with a suitable functional module, it is possible to customize a vehicle depending on different missions. A functional module is prepared to perform a specific function and the autonomously operated drive module may connect with the functional module to achieve an assembled vehicle customized for a certain mission. For example, the at least one functional module is configured with a passenger compartment for accommodating passengers and may thus function as a bus when being assembled with the at least one drive module. According to another example, the at least one functional module is configured with a load compartment for accommodating load and goods and may thus function as a truck when being assembled with the at least one drive module.

The at least one drive module and thus the assembled vehicle may be configured to be autonomously operated. The control device comprised in the functional module is configured to receive commands and instructions from a control centre or an off-board system and to execute the commands/instructions for driving the vehicle and also for controlling the vehicle height in relation to the road surface. This way, the assembled vehicle can drive itself based on the received commands and instructions. The control device comprised in any one of the modules may control the assembled vehicle to be autonomously driven or operated also based on data from the at least one sensor device, taking situations that may happen during transportation into account. The autonomously operation of the modularised vehicle may thus comprise determining a platform height above a road surface at the platform; determining an inclination of the platform; controlling the modularised vehicle, so that a floor surface of the vehicle has a level corresponding to the platform height; and controlling the modularised vehicle, so that the floor surface of the modularised vehicle has an inclination corresponding to the inclination of the platform. controlling the modularised vehicle, so that a floor surface of the vehicle has a level corresponding to the platform height; and controlling the modularised vehicle, so that the floor surface of the modularised vehicle has an inclination corresponding to the inclination of the platform may be performed, by the control device comprised in any one of the modules, without instructions from the control centre.

The functional module is adapted to be releasably connected to the drive module for forming the assembled vehicle. The drive module comprises a pair of wheels and is configured to be autonomously operated and drive the assembled vehicle when the drive module and a functional module are connected. The functional module comprising at least one connecting means adapted for physically connecting the functional module to the drive module. The functional module may also comprise wheels.

The connecting means may comprise a physical interface for the purpose of physically connecting and disconnecting the modules. The drive module and the functional module each suitably comprises at least one physical interface for the purpose of physically connecting and disconnecting the modules. The physical interface on the drive module is connected to the control device, which is configured to control the physical interface on the drive module to physically connect and disconnect the modules. The functional module is provided with an indentation. The indentation is adapted for the drive module. Due to the indentation the length of the assembled vehicle will coincide with the length of the functional module. However, the functional module may be configured without an indentation and the drive module may be connected directly to the front side or the rear side of the functional module.

The driving module may comprise a suspension system, which is arranged between each of the wheels and a body of the driving module. The suspension system may comprise springs and dampers for improving the driving characteristics of the driving module and also of the assembled vehicle. The suspension system of the driving module may comprise adjusting means for controlling the vehicle level when approaching the platform. The control device is connected to the adjusting means of the suspension system. The control device may receive information about the platform height above the road surface at a target destination. The control device is configured to control the adjusting means of the suspension system based on the information about the platform height above the road surface at a target destination in order to adjust the vehicle level before arriving at the target destination. The control device is configured to control the adjusting means of each wheel suspension individually to adjust the vehicle in relation to the platform.

The present disclosure will now be further illustrated with reference to the appended figures.

Fig. 1a schematically illustrates a side view of a vehicle 1 provided with a control device 100 according to an embodiment. The vehicle 1 comprises at least one sensor device 2, at least two front wheels 4 and at least two rear wheels 6. The vehicle 1 is in fig. 1a positioned beside of or in front of a platform 8. A door opening 10 is arranged in a body 11 of the vehicle 1. Goods, cargo and passengers are transferred from the platform 8 or vehicle 1 through the door opening 10 of the vehicle 1. The vehicle 1 comprises a floor 12 with a floor surface 14. The control device 100 is configured for controlling the vehicle position in relation to the platform 8. The control device 100 is configured to determine a platform height above a road surface 16 at the platform 8 and also determine an inclination of the platform 8. The control device 100 receives information from a sensor device 2 about the vehicle position in relation to the platform 8. Based in the signals from the sensor device 2 the control device 100 is configured to determine a platform height above a road surface 16 at the platform 8 and also determine an inclination of the platform 8. The vehicle 1 comprises the sensor device 2. However, the control device 100 may alternatively receive said information from a sensor device arranged on another vehicle. The sensor device 2may be configured to detect objects in the surroundings of the vehicle 1. The sensor device 2 is connected to the control device 100 and transfer signals to the control device 100 about the position of objects in the surrounding. The sensor device 2 may detect the shape of the platform 8, such as the height, inclination and any curvature of the platform 8. The sensor device 2 may also detect the distance between the vehicle 1 and the platform 8. The control device 100, with input from the sensor device 2 is configured to determine the platform height and the inclination of the platform 8. The sensor device 2 may detect the shape of the road surface 16 in front of the platform 8. Together with the control device 100, the sensor device 2 is configured to determine the shape of the road surface 16. The sensor device 2 may detect any obstacles 18 above or beside the road surface 16 in front of the platform 8. Together with the control device 100, the sensor device 2 is configured to determine if there are any obstacles 18 above or beside the road surface 16 in front of the platform 8. In fig. 1 the platform 8 has an inclination α in relation to the road surface 16 at the platform 8.

The floor surface 14 of the vehicle 1 has a different level and a different inclination in relation to the height and inclination α of the platform 8.

Fig. 1b schematically illustrate a side view of the vehicle 1 provided with a control device 100 according to an embodiment. In fig. 1b the vehicle 1 has been controlled, so that the floor surface 14 of the vehicle 1 has a level corresponding to the platform height. In addition, the vehicle 1 has been controlled, so that the floor surface 14 of the vehicle 1 has an inclination α in the longitudinal direction of the vehicle 1, corresponding to the inclination α of the platform 8. The inclination α of the vehicle 1 is controlled in a longitudinal direction of the vehicle 1 and in a lateral direction of the vehicle 1. The control device 100 is configured to control an individually controllable wheel suspension 20 of the wheels of the vehicle 1. Each wheel of the vehicle 1 is provided with such an individually controllable wheel suspension 20.

The vehicle 1 comprises a level sensor 22, which detects the inclination of the floor surface 14 in the vehicle 1. The level sensor 22 is connected to the control device 100. The control device 100, with input from the level sensor 22 is configured to determine the inclination of the floor surface 14 in the vehicle 1. When having information about the inclination of the platform 8 and the inclination of the floor surface 14, the vehicle 1 is controlled by the control device 100, so the floor surface 14 of the vehicle 1 will have an inclination corresponding to the inclination of the platform 8.

The control device 100 is configured to control an individually controllable wheel suspension 20 of at least one wheel. The position of the body 11 of the vehicle 1 is adjusted in relation to the wheels by means of the wheel suspension 20 of each wheel. By adjusting the position of the body 11 of the vehicle 1, also the position of the floor surface 14 of the vehicle 1 may be adjusted. The control device 100 is configured to control the individually controllable wheel suspension 20 of wheels, so that the floor surface 14 of the vehicle 1 coincide with a platform surface 9 in a common plane. The control device 100 further is configured to receive information about the platform height and the inclination of the platform 8 from another vehicle 21. The information about the platform height and the inclination of the platform 8 may be received wireless directly from the other vehicle or via a control centre 24. The control device 100 further is configured to receive information about the platform height and the inclination of the platform 8 from a control centre 24.

Figures 2a and 2b schematically illustrate side views of a vehicle 1 provided with a control device 100 according to an embodiment. In fig. 2a the vehicle 1 approaches the platform 8. The vehicle 1 may be a bus, a truck or any other type of heavy vehicle. The height and inclination of the platform 8 is determined by means of the sensor device 2. In addition, the shape of the road surface 16 is determined by means of the at least one sensor device 2. The platform 8 in fig. 2a has an inclination β in relation to a horizontal plane.

In fig. 2b the vehicle 1 has reached the platform 8 and has parked adjacent to the platform 8. Based on the information from the sensor device 2, the control unit has controlled the vehicle 1, so that a floor surface 14 of the vehicle 1 has a level corresponding to the platform height; and so that the floor surface 14 of the vehicle 1 has an inclination β corresponding to the inclination β of the platform 8. At this position, a door 26 of the door opening 10 is opened. However, it is possible that the floor surface 14 of the vehicle 1 has an inclination which is smaller than the inclination β of the platform 8 in order to facilitate a manoeuvring of a pallet loader within the vehicle 1.

Fig. 2c schematically illustrate a view of from behind of the vehicle 1 provided with a control device 100 according to an embodiment. The platform 8 in fig. 2c has, in addition to the inclination β in fig. 2a and 2b an inclination α in relation to a horizontal plane. The vehicle 1 has been controlled so that the floor surface 14 of the vehicle 1 has an inclination α, in the lateral direction, in addition to the inclination β in the longitudinal direction of the vehicle 1

Fig. 3a schematically illustrates a side view of a modular vehicle 1, comprising two drive modules 30 and a functional module 40 provided with a control device 100 according to an embodiment.

The vehicle 1 may be a modular vehicle 1 comprising at least one drive module 30 and at least one functional module. The modular vehicle 1 may comprise only one drive module 30. Depending on the direction of travel, the drive module 30 comprises two front wheels 4 or two rear wheels 6. However, the modular vehicle 1 may comprise two drive modules 30, of which one of the drive modules 30 comprises the two front wheels 4 and the other drive module 30 comprises the two rear wheels 6. The modular vehicle 1 is configured to be autonomously operated and drive the assembled vehicle 1.

The drive modules 30 are adapted to be releasably connected to the functional module 40 for forming the assembled vehicle 1. In fig. 3a the drive modules 30 and the functional module 40 are disconnected from each other. Each drive module 30 comprises a pair of wheels 48 and is configured to be autonomously operated and drive the assembled vehicle 1 when the drive modules 30 and a functional module 40 are connected. The pair of wheels 48 of the drive module 30 correspond to the at least two front wheels 4 or the at least two rear wheels 6 of the vehicle 1. The functional module 40 comprising at least one connecting means 42 adapted for physically connecting the functional module 40 to the drive module 30. The control device 100 is comprised in any of the modules 30, 40. Thus, the control device 100 may be comprised in each of the drive modules 30. The control device 100 may alternatively be comprised in the functional module 40.

The connecting means 42 may comprise a physical interface 42 for the purpose of physically connecting and disconnecting the modules 30, 40. The drive module 30 and the functional module 40 each suitably comprises at least one physical interface 42 for the purpose of physically connecting and disconnecting the modules 30, 40. The physical interface 42 on the drive module 40 is connected to the control device 100, which is configured to control the physical interface 42 on the drive module 30 to physically connect and disconnect the modules 30, 40. The functional module 40 in fig. 1 is provided with an indentation 46, which is adapted for each drive module 30. Due to the indentation 46 the length of the assembled vehicle 1 will coincide with the length of the functional module 40. However, the functional module 40 may be configured without an indentation 46 and the drive modules 30 may be connected directly to the front side or the rear side of the functional module 40. The functional module is provided with at least one door opening 10.

The functional module 40 is provided with a floor 12. The floor 12 is provided with a floor surface 14. At least one sensor device 2 is arranged on the functional module 40. The sensor device 2 may provide the control device 100 with information of the level of the floor surface 14 of the functional module 40. The sensor device 2 may also provide the control device 100 with information of the height and inclination of the platform surface 9 (fig. 1a). The sensor device 2 may also be arranged on the drive modules 30.

Fig. 3b schematically illustrates a side view of the two drive modules 30 and the functional module 40 provided with a control device 100 according to an embodiment. In fig. 1b the drive modules 30 and the functional module 40 are connected to each other. The connected drive modules 30 and functional module 40 together form the assembled vehicle 1. The drive modules 30 and the functional module 40 are connected by means of the connecting means 42.

Fig. 4 schematically a drive module 30 provided with a control device 100 according to an embodiment. The drive module 30 may comprise a pair of wheels 48. A steering unit 39 is connected to the wheels 48. The steering unit 39 may make the drive module 30 steerable. The pair of wheels 48 may be so arranged at the drive module 30 that a centre axis 43 of each wheel 48 coincides with each other. Each wheel 48 has a centre axis 43 and is arranged at the drive module 30 so that each wheel 48 may rotate about its centre axis 43. When the centre axis 43 of each wheel 48 coincides with each other the drive module 30 has good manoeuvring abilities.

The drive module 30 is provided with a suspension system 52 for the wheels 48. The height of a body 54 of the drive module 30 is adjusted in relation to the wheels 48 by means of the suspension system 52. The control device 100 is configured to control the vehicle level by means of the suspension system 52. The suspension system 52 of the driving module 30 is arranged between the wheels 48 and a body 54 of the driving module 30. The suspension system 52 may comprise springs 54 and dampers 56 for improving the driving characteristics of the driving module 30 and also of the assembled vehicle 1. The suspension system 52 of the driving module may comprise adjusting means for controlling the vehicle level. The control device 100 is connected to the adjusting means of the suspension system 52.

The drive module 30 may comprise at least two connecting means 42. The connecting means 42 si configured as interfaces for transferring electric energy and/or transmitting electric signals, and for physically connection.

The drive module 30 may comprise at least one propulsion unit 50 connected to the pair of wheels 48. The propulsion unit 50 may be an electric machine connected to the wheels 48. Two electric machines are arranged as propulsion units 50 in the drive module 30. One electric machine 50 is connected to one wheel 48 and the other electric machine 50 is connected to the other wheel 48. The electric machines 50 are arranged in the rim 44 of the wheels 48. The wheels 48 may thereby be driven independently of each other. The electric machines 50 may also work as generators and generate electric energy when braking the wheels 48. Instead of electric machines 50 as a propulsion unit 50, the at least one propulsion unit 50 may be an internal combustion engine, such as an otto engine or a diesel engine connected to the wheels 48.

The drive module 30 may comprise at least one energy storage unit 52 for providing the propulsion unit 50 with energy.

As mentioned above the drive module 30 may comprise the control device 100. The control device 100 is configured to operate the drive module 30 as an independently driven unit. The control device 100 may be configured to transmit and receive information and control signals to and from an external control centre 24. The control device 100 may be configured to transmit and receive information and control signals to and from another vehicle 21.

Fig. 5a illustrates a flow chart for a method, performed by a control device 100, for controlling a vehicle position in relation to a platform 8. The method thus relates to the controlling of the vehicle position in relation to a platform 8 of the vehicle 1 and the modularised vehicle 1 disclosed in figures 1a - 4. The vehicle 1 comprising: at least one sensor device 2; at least two front wheels 4; at least two rear wheels 6; and the control device 100. The method comprising: determining s101 a platform height above a road surface 16 at the platform 8; determining s102 an inclination of the platform 8; controlling s103 the vehicle 1, so that a floor surface 14 of the vehicle 1 has a level corresponding to the platform height; and controlling s104 the vehicle 1, so that the floor surface 14 of the vehicle 1 has an inclination corresponding to the inclination of the platform 8.

According to an aspect, controlling s104 the vehicle 1, so that the floor surface 14 of the vehicle 1 has an inclination corresponding to the inclination of the platform 8, comprises controlling the inclination of the vehicle 1 in a longitudinal direction of the vehicle 1 and in a lateral direction of the vehicle 1. According to an aspect, controlling s103, s104 the vehicle 1, comprises controlling an individually controllable wheel suspension 20 of at least one wheel 4, 6. According to an aspect, controlling s103, s104 the vehicle 1, comprises controlling an individually controllable wheel suspension 20 of at least one wheel 4, 6, so that the floor surface 14 of the vehicle 1 coincide with a platform surface 9 in a common plane. According to an aspect, determining s101 a platform height comprises determining the platform height by means of the least one sensor device 2. According to an aspect, controlling s104 the vehicle 1, so that the floor surface 14 of the vehicle 1 has an inclination corresponding to the inclination of the platform 8, comprises determining the inclination of the floor surface 14 by means of a level sensor 22 and determining the inclination of the platform 8 by means of the at least one sensor device 2. According to an aspect, the method comprises the further step of determining s105 the distance between the vehicle 1 and the platform 8 by means of the at least one sensor device 2. According to an aspect, the method comprises the further step of determining s106 the shape of the road surface 16 by means of the at least one sensor device 2. According to an aspect, the method comprises the further step of determining s107 any obstacles 18 above or beside the road surface 16 in front of the platform 8 by means of the at least one sensor device 2. According to an aspect, the method comprises the further step of receiving s108 information about the platform height and the inclination of the platform 8 from another vehicle 21.

Fig. 5b illustrates a flow chart for a method, performed by a control device 100, for controlling a vehicle position in relation to a platform 8. The method thus relates to the controlling of the vehicle position in relation to a platform 8 of the vehicle 1 and the modularised vehicle 1 disclosed in figures 1a - 4. The method comprising: determining s101 a platform height above a road surface 16 at the platform 8; determining s102 an inclination of the platform 8; controlling the vehicle 1, so that a floor surface 14 of the vehicle 1 has a level corresponding to the platform height; controlling s103 the vehicle 1, so that the floor surface 14 of the vehicle 1 has an inclination corresponding to the inclination of the platform 8; controlling s104 the inclination of the vehicle 1 in a longitudinal direction of the vehicle 1 and in a lateral direction of the vehicle 1; controlling an individually controllable wheel suspension 20 of at least one wheel 4, 6; controlling an individually controllable wheel suspension 20 of at least one wheel 4, 6, so that the floor surface 14 of the vehicle 1 coincide with a platform surface 9 in a common plane; determining the platform height by means of the least one sensor device 2; determining the inclination of the floor surface 14 by means of a level sensor 22 and determining the inclination of the platform 8 by means of the at least one sensor device 2; determining s105 the distance between the vehicle 1 and the platform 8 by means of the at least one sensor device 2; determining s106 the shape of the road surface 16 by means of the at least one sensor device 2; determining s107 any obstacles 18 above or beside the road surface 16 in front of the platform 8 by means of the at least one sensor device 2; and receiving s108 information about the platform height and the inclination of the platform 8 from another vehicle 21.

Fig. 6 is a diagram of a version of a device 500. The control device 100 of the vehicle 1 may in a version comprise the device 500. The device 500 comprises a non-volatile memory 520, a data processing unit 510 and a read/write memory 550. The non-volatile memory 520 has a first memory element 530 in which a computer programme, e.g. an operating system, is stored for controlling the function of the device 500. The device 500 further comprises a bus controller, a serial communication port, I/O means, an A/D converter, a time and date input and transfer unit, an event counter and an interruption controller (not depicted). The non-volatile memory 520 has also a second memory element 540.

There is provided a computer programme P which comprises routines for performing the safety method. The programme P may be stored in an executable form or in a compressed form in a memory 560 and/or in a read/write memory 550.

Where the data processing unit 510 is described as performing a certain function, it means that the data processing unit 510 effects a certain part of the programme stored in the memory 560 or a certain part of the programme stored in the read/write memory 550.

The data processing device 510 can communicate with a data port 599 via a data bus 515. The non-volatile memory 520 is intended for communication with the data processing unit 510 via a data bus 512. The separate memory 560 is intended to communicate with the data processing unit 510 via a data bus 511. The read/write memory 550 is adapted to communicating with the data processing unit 510 via a data bus 542.

When data are received on the data port 599, they are stored temporarily in the second memory element 540. When input data received have been temporarily stored, the data processing unit 510 is prepared to effect code execution as described above.

Parts of the methods herein described may be effected by the device 500 by means of the data processing unit 510 which runs the programme stored in the memory 560 or the read/write memory 550. When the device 500 runs the programme, methods herein described are executed.

The foregoing description of the embodiments has been furnished for illustrative and descriptive purposes. It is not intended to be exhaustive, or to limit the embodiments to the variants described. Many modifications and variations will obviously be apparent to one skilled in the art. The embodiments have been chosen and described in order to best explicate principles and practical applications, and to thereby enable one skilled in the art to understand the embodiments in terms of its various embodiments and with the various modifications that are applicable to its intended use. The components and features specified above may, within the framework of the embodiments, be combined between different embodiments specified.

Claims

1. A method, performed by a control device (100), for controlling a vehicle (1) position in relation to a platform (8), the vehicle (1) comprising:

at least one sensor device (2);

at least two front wheels (4);

at least two rear wheels (6); and

the control device (100),

the method comprising:

determining (s101) a platform height above a road surface (16) at the platform (8);

determining (s102) an inclination of the platform (8);

controlling (s103) the vehicle (1), so that a floor surface (14) of the vehicle (1) has a level corresponding to the platform height; and

controlling (s104) the vehicle (1), so that the floor surface (14) of the vehicle (1) has an inclination corresponding to the inclination of the platform (8).

2. The method according to claim 1, wherein controlling (s103) the vehicle (1), so that the floor surface (14) of the vehicle (1) has an inclination corresponding to the inclination of the platform (8), comprises controlling the inclination of the vehicle (1) in a longitudinal direction of the vehicle (1) and in a lateral direction of the vehicle (1).

3. The method according to any one of claims 1 and 2, wherein controlling (s103; s104) the vehicle (1), comprises controlling an individually controllable wheel suspension (20) of at least one wheel (4, 6).

4. The method according to claim 3, wherein controlling (s103; s104) the vehicle (1), comprises controlling an individually controllable wheel suspension (20) of at least one wheel (4, 6), so that the floor surface (14) of the vehicle (1) coincide with a platform surface (9) in a common plane.

5. The method according to any one of the preceding claims, wherein determining (s101; 102) a platform height comprises determining the platform height by means of the least one sensor device (2).

6. The method according to claim 1 or 2, wherein controlling (s103) the vehicle (1), so that the floor surface (14) of the vehicle (1) has an inclination corresponding to the inclination of the platform (8), comprises determining the inclination of the floor surface (14) by means of a level sensor (22) and determining the inclination of the platform (8) by means of the at least one sensor device (2).

7. The method according to any one of the preceding claims, wherein the method comprises the further step of:

determining (s105) the distance between the vehicle (1) and the platform (8) by means of the at least one sensor device (2).

8. The method according to any one of the preceding claims, wherein the method comprises the further step of:

determining (s106) the shape of the road surface (16) by means of the at least one sensor device (2).

9. The method according to any one of the preceding claims, wherein the method comprises the further step of:

determining (s107) any obstacles (18) above or beside the road surface (16) in front of the platform (8) by means of the at least one sensor device (2).

10. The method according to any one of the preceding claims, wherein the method comprises the further step of:

receiving (s108) information about the platform height and the inclination of the platform (8) from another vehicle (21).

11. A computer program (P) comprising instructions which, when the program is executed by a computer (100; 500), cause the computer (100; 500) to carry out the method according to any one of the preceding claims.

12. A computer-readable medium comprising instructions, which when executed by a computer (100; 500), cause the computer (100; 500) to carry out the method according to any one of claims 1-10.

13. A control device (100) for controlling a vehicle position in relation to a platform (8),

the vehicle (1) comprising:

at least one sensor device (2);

at least two front wheels (4);

at least two rear wheels (6); and

the control device (100),

the control device (100) being configured to:

determine a platform height above a road surface (16) at the platform (8);

determine an inclination of the platform (8);

control the vehicle (1), so that a floor surface (14) of the vehicle (1) has a level corresponding to the platform height; and

control the vehicle (1), so that the floor surface (14) of the vehicle (1) has an inclination corresponding to the inclination of the platform (8).

14. The control device (100) according to claim 13, wherein the control device (100) is configured to control the vehicle (1), so that the floor surface (14) of the vehicle (1) has an inclination corresponding to the inclination of the platform (8), comprising controlling the inclination of the vehicle (1) in a longitudinal direction of the vehicle (1) and in a lateral direction of the vehicle (1).

15. The control device (100) according to any one of the claims 13 and 14, wherein the control device (100) is configured to control the vehicle (1), comprising controlling an individually controllable wheel suspension (20) of at least one wheel (4, 6).

16. The control device (100) according to claim 15, wherein the control device (100) is configured to control the vehicle (1), comprising controlling an individually controllable wheel suspension (20) of at least one wheel (4, 6), so that the floor surface (14) of the vehicle (1) coincide with a platform surface (9) in a common plane.

17. The control device (100) according to any one of claims 13 - 16, wherein the control device (100) is configured to determine a platform height, comprising determining the platform height by means of the least one sensor device (2).

18. The control device (100) according to any one of claims 13 - 17, wherein the control device (100) is configured to control the vehicle (1), so that the floor surface (14) of the vehicle (1) has an inclination corresponding to the inclination of the platform (8), comprising determine the inclination of the floor surface (14) by means of a level sensor (22) and determine the inclination of the platform (8) by means of the at least one sensor device (2).

19. The control device (100) according to any one of the claims 13 - 18, wherein the control device (100) further is configured to:

determine the distance between the vehicle (1) and the platform (8) by means of the at least one sensor device (2).

20. The control device (100) according to any one of the claims 13 - 19, wherein the control device (100) further is configured to:

determine the shape of the road surface (16) by means of the at least one sensor device (2).

21. The control device (100) according to any one of the claims 13 - 20, wherein the control device (100) further is configured to:

determine any obstacles (18) above or beside the road surface (16) in front of the platform (8) by means of the at least one sensor device (2).

22. The control device (100) according to any one of claims 13 - 21, wherein the control device (100) further is configured to:

receive information about the platform height and the inclination of the platform (8) from another vehicle (21).

23. A vehicle (1), comprising:

at least one sensor device (2);

at least two front wheels (4); and

at least two rear wheels (6);

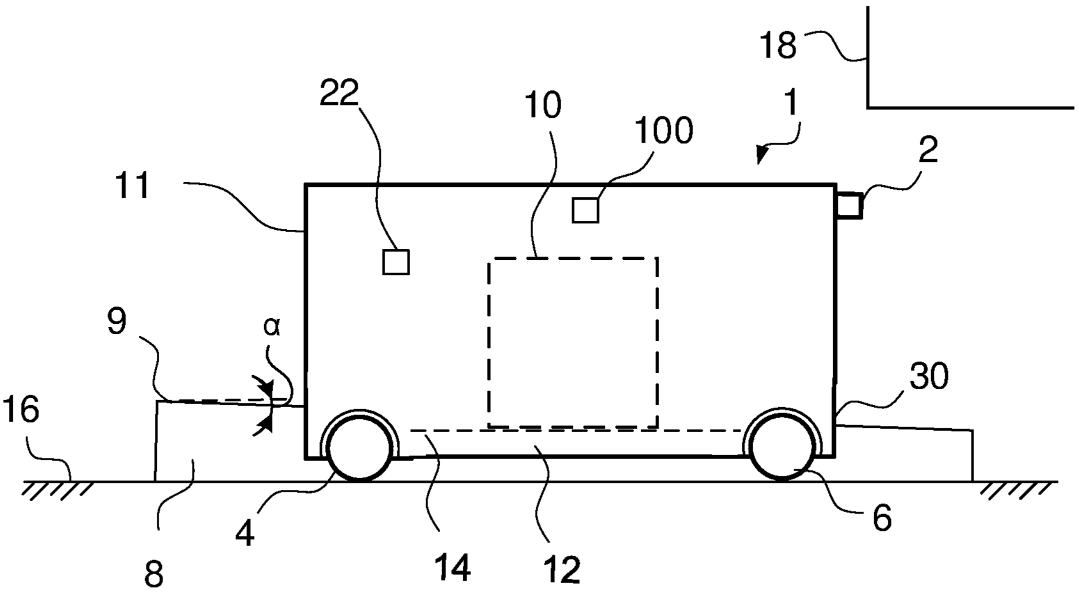
wherein the vehicle (1) comprising a control device (100) according to any one of the claims 13 – 22.

24. The vehicle (1) according to claim 23, wherein the vehicle (1) is a modular vehicle (1) comprising:

at least one drive module (30); and

at least one functional module (40),

wherein the at least one drive module (30) comprises the at least two front wheels (4) or the at least two rear wheels (6), and is configured to be autonomously operated and drive the assembled vehicle (1).


18
22
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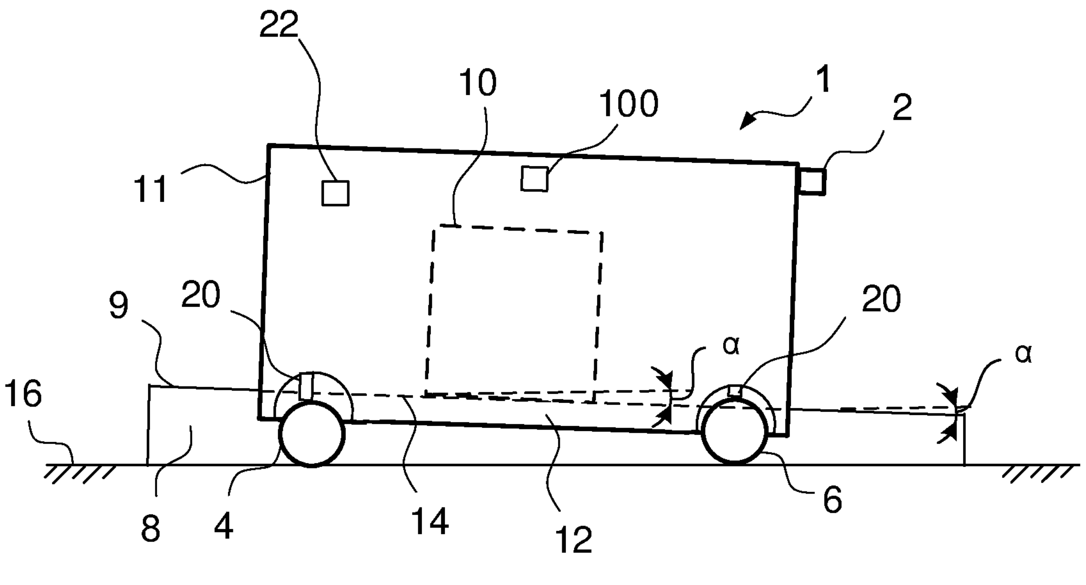
100
1
2
11
9
α
30
16
4
6
8
14
12

Fig. 1a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100
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2
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9
20
20
α
α
16
8
4
14
12
6

Fig. 1b

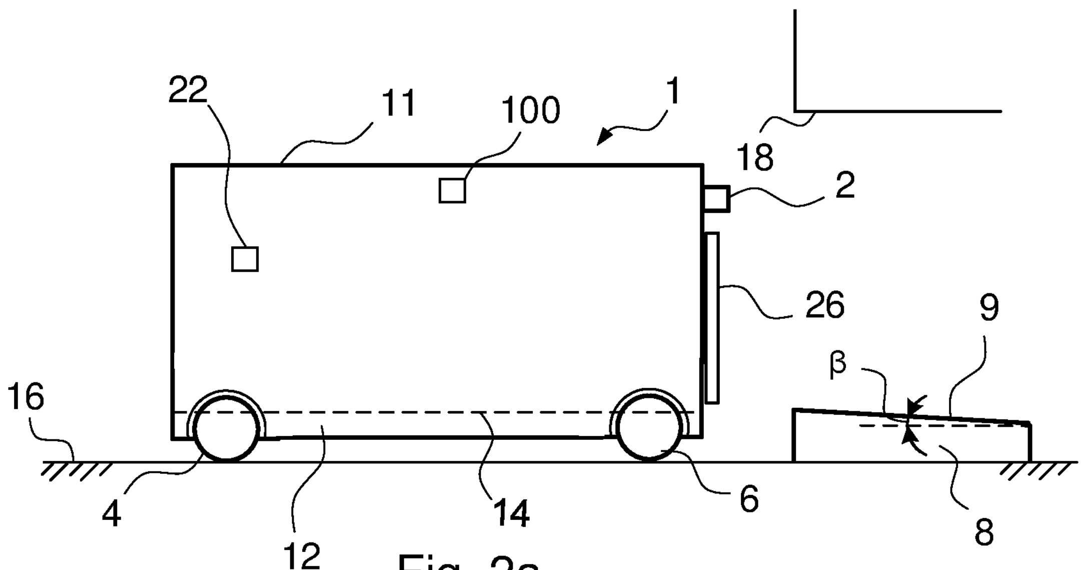


Fig. 2a

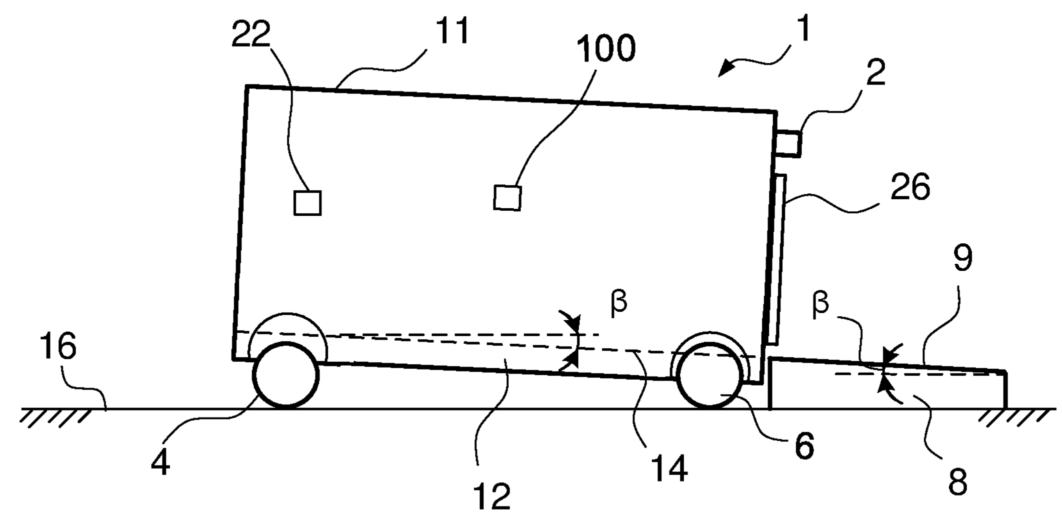


Fig. 2b

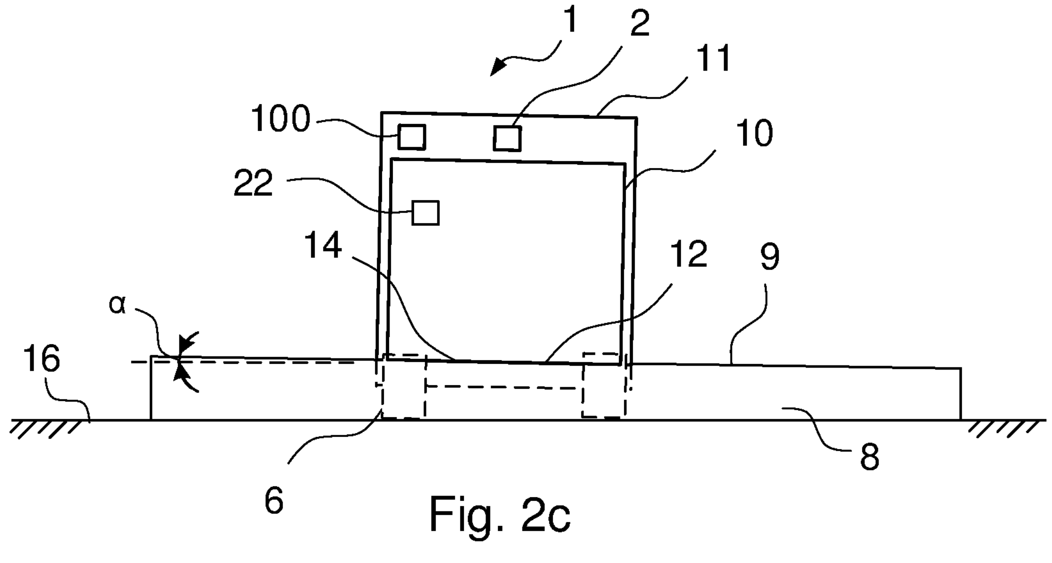


Fig. 2c

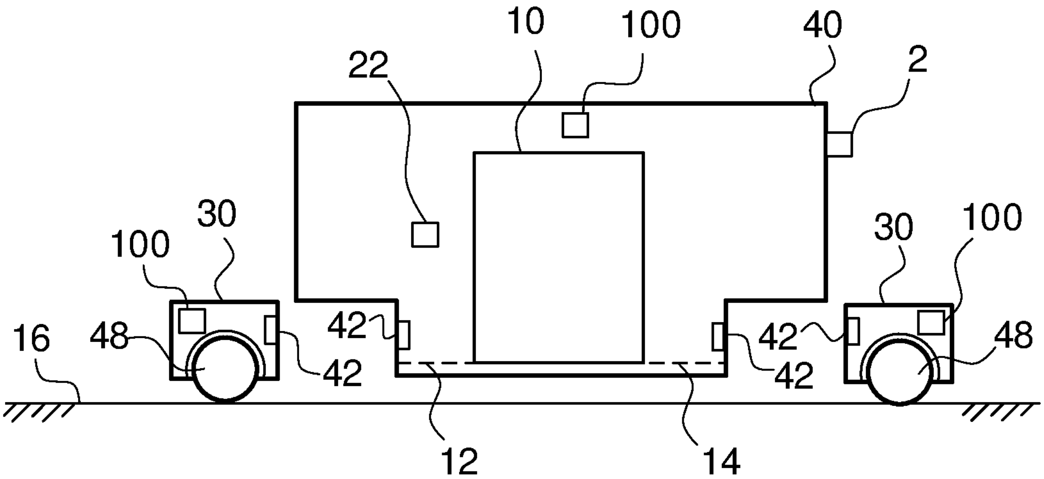
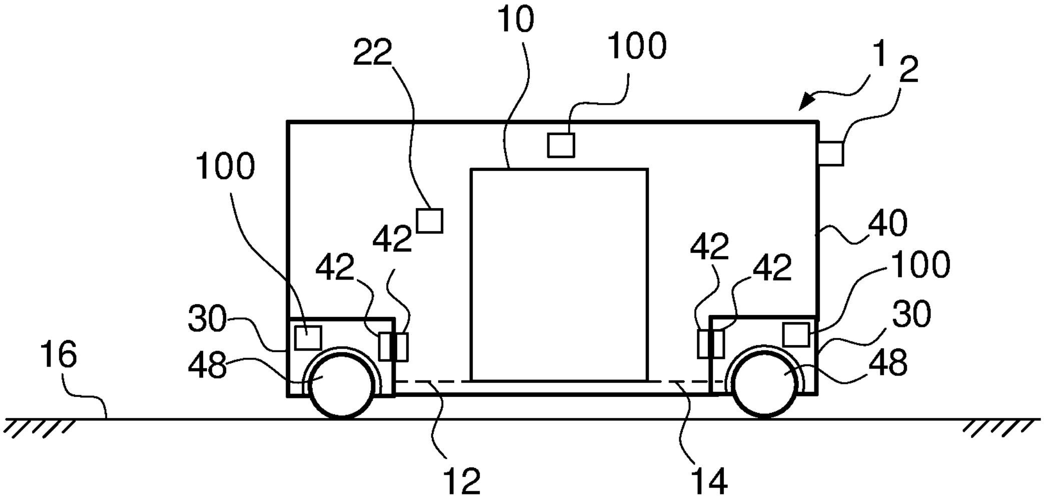

10
100
40
22
2
30
100
30
100
16
48
42
42
42
42
42
48
12
14

Fig. 3a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42
100
30
30
16
48
48
12
14

Fig. 3b

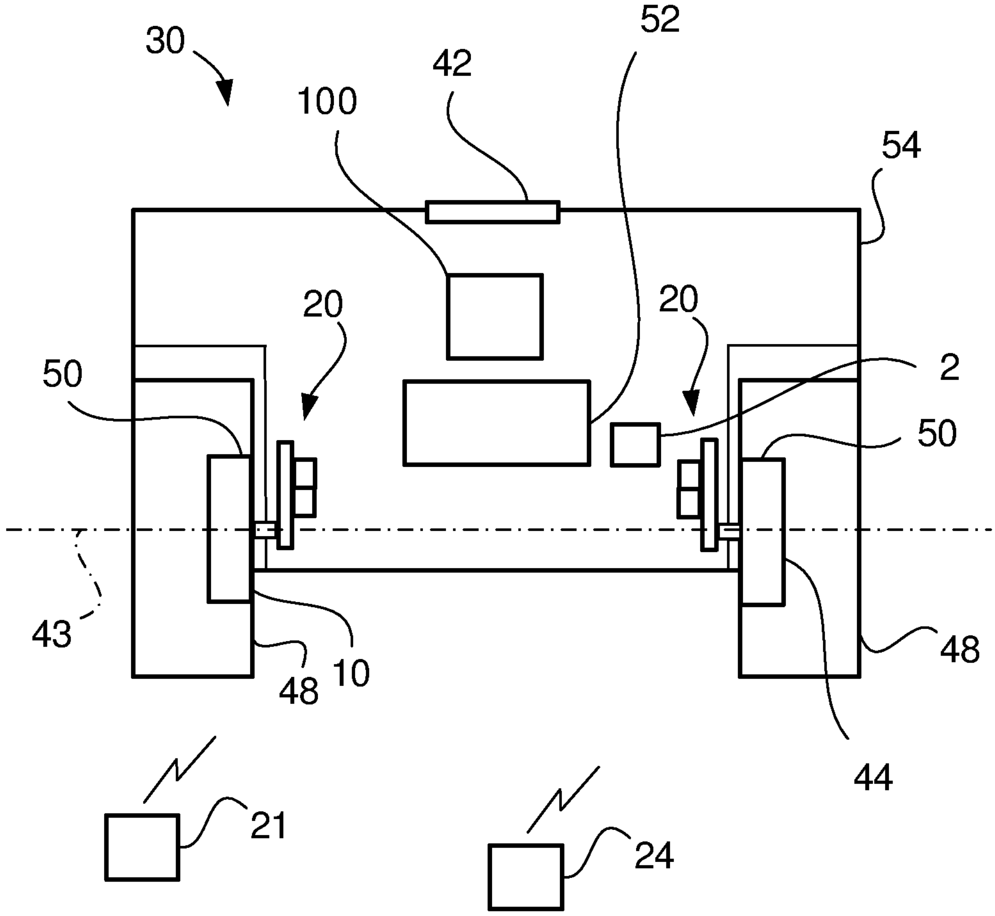

Fig. 4

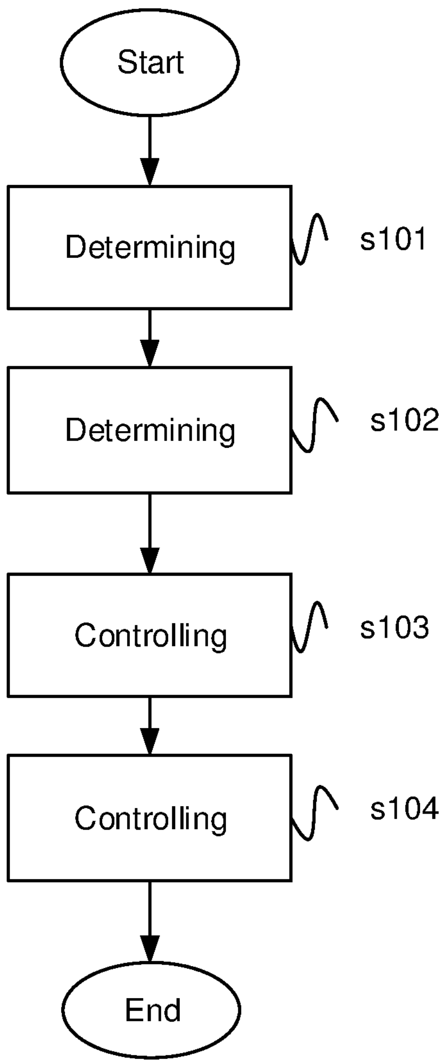
Start
Determining
s101
Determining
s102
Controlling
s103
Controlling
s104
End

Fig. 5a

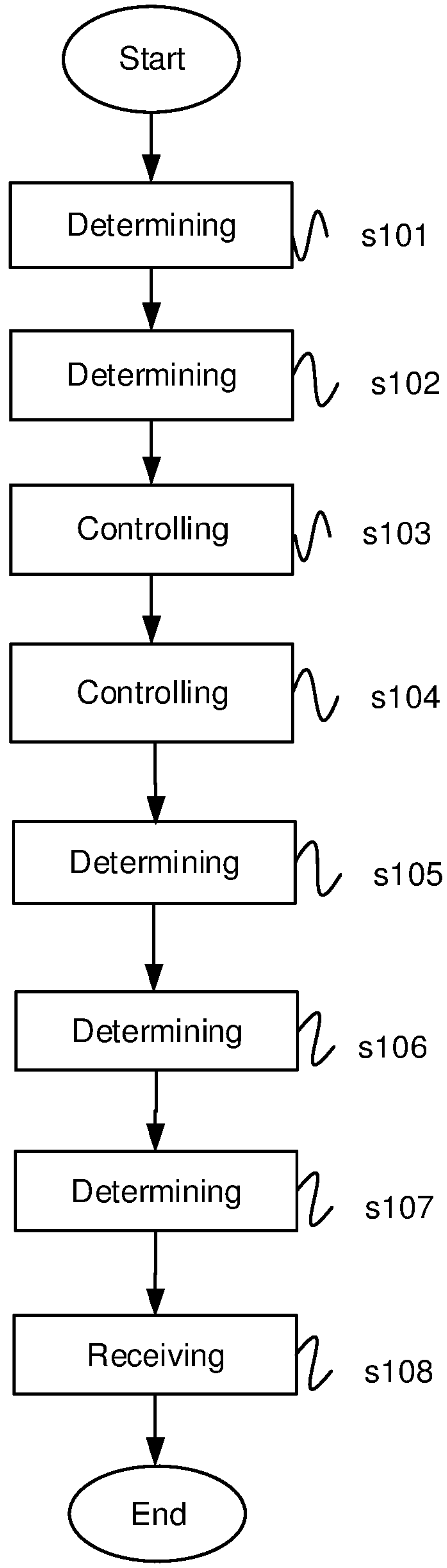
Start
Determining
s101
Determining
s102
Controlling
s103
Controlling
s104
Determining
s105
Determining
s106
Determining
s107
Receiving
s108
End

Fig. 5b

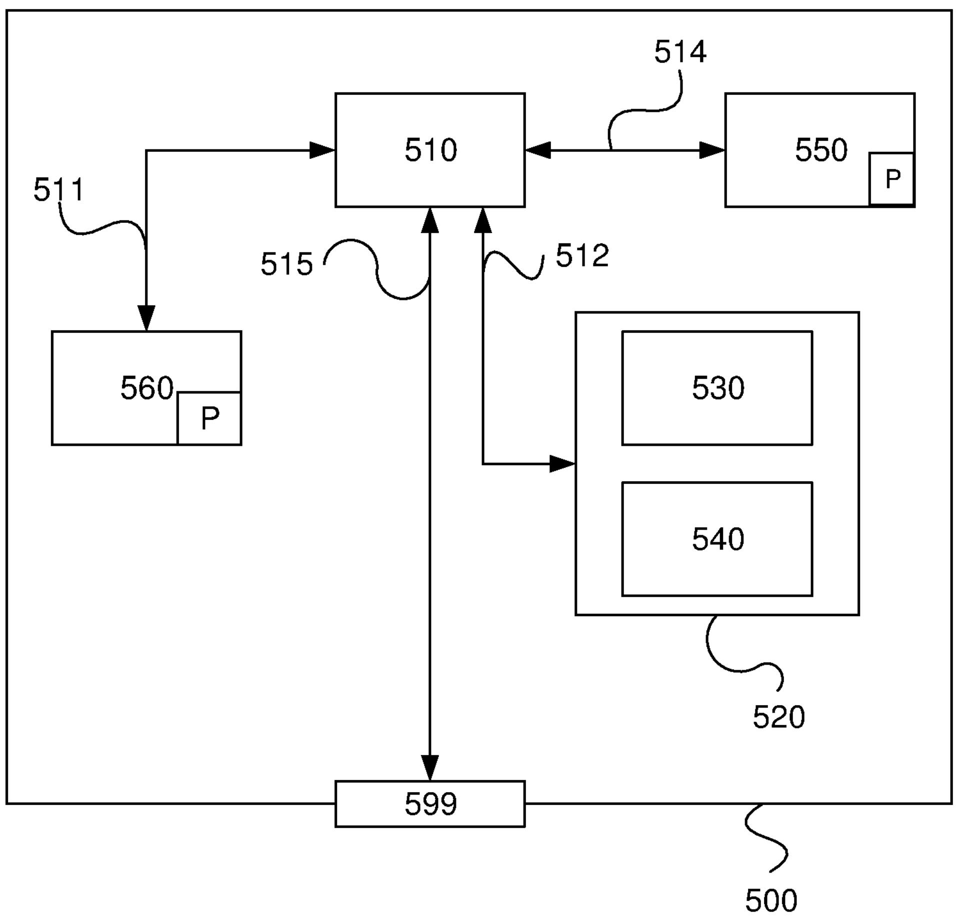

Fig. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2019/051087

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: B60G, B60P, B65G

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

SE, DK, FI, NO classes as above

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

EPO-Internal, PAJ, WPI data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 20180154727 A1 (LAVOIE ERICK MICHAEL), 7 June 2018 (2018-06-07); abstract; paragraphs [0016], [0043]-[0049]; figures 2, 3 --	1-24
A	SE 1450397 A1 (SCANIA CV AB), 4 October 2015 (2015-10-04); abstract; page 15, line 8 - page 17, line 3; figures 4a - 4c --	1-24
A	GB 2552088 A (DAIMLER AG), 10 January 2018 (2018-01-10); abstract; page 7; figure 12 --	1-24

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

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "D" document cited by the applicant in the international application
- "E" earlier application or patent but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14-11-2019	14-11-2019

Name and mailing address of the ISA/SE	Authorized officer
Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Johan Åhman Telephone No. + 46 8 782 28 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2019/051087

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1228905 A2 (HINO MOTORS LTD), 7 August 2002 (2002-08-07); abstract; paragraphs [0004]-[0008], [0014]; figures 1 - 4 --	1-24
A	EP 1787613 A2 (IVECO FRANCE SA), 23 May 2007 (2007-05-23); abstract; paragraphs [0006]-[0009]; figure 1; claim 1 --	1-24
A	SE 1351114 A1 (SCANIA CV AB), 27 March 2015 (2015-03-27); abstract; page 2, line 29 - page 3, line 15; page 27, line 15 - page 28, line 2; figures 3, 4, 7 --	1-24
A	US 20100072720 A1 (GLAVINIC ANDELKO ET AL), 25 March 2010 (2010-03-25); abstract; paragraph [0038] --	1-24
A	US 20160068357 A1 (BASTIAN II WILLIAM A), 10 March 2016 (2016-03-10); abstract; paragraph [0064]; figure 6 -- --------	1-24

Continuation of: second sheet

International Patent Classification (IPC)

B60G 17/0165 (2006.01)
B60G 17/017 (2006.01)

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				EP	2168788	A1	31/03/2010
				US	8177010	B2	15/05/2012
US	20160068357	A1	10/03/2016	US	9950881	B2	24/04/2018