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Methods and systems for parking trailers towed by vehicle utilizing vehicle sensors and based on a profile and required clearances for the trailer

Abstract

Methods and systems are provided that include sensors and a processor of a vehicle that is configured to tow a trailer. The sensors are configured to obtain sensor data pertaining to surroundings of the trailer. The processor is coupled to the sensors, and is configured to at least facilitate retrieving information as to a profile of the trailer, the profile including required clearances for the trailer based on extensions of the trailer that are configured to be retracted while the trailer is moving and fully extended when the trailer is parked and the extensions are utilized; determining whether any obstacles are in a path of the trailer when the extensions are fully extended, based on the sensor data and the profile; and taking an action, in accordance with instructions provided by the processor, when obstacles are in the path of the trailer.

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Background/Summary

TECHNICAL FIELD
(1) The technical field generally relates to vehicles and, more specifically, to systems and methods for parking trailers towed by vehicles.
BACKGROUND
(2) Certain vehicles today have systems that control towing of a trailer, including parking of the trailer. However, existing techniques may not always provide optimal parking for the trailer.
(3) Accordingly, it is desirable to provide improved methods and systems for controlling parking of a trailer that is being towed by the vehicle. Furthermore, other desirable features and characteristics of the present invention will become apparent from the subsequent detailed description of the invention and the appended claims, taken in conjunction with the accompanying drawings and this background of the invention.
SUMMARY

(4) In an exemplary embodiment, a method is provided that includes obtaining, via one or more sensors of a vehicle that is towing a trailer, sensor data pertaining to surroundings of the trailer; retrieving information as to a profile of the trailer, the profile including required clearances for the trailer based on one or more extensions of the trailer that are configured to be retracted while the trailer is moving and fully extended when the trailer is parked and the one or more extensions are utilized; determining, via a processor, whether any obstacles are in a path of the trailer when the one or more extensions are fully extended, based on the sensor data and the profile; and taking an action, in accordance with instructions provided by the processor, when it is determined that one or more obstacles are in the path of the trailer.

(5) Also in an exemplary embodiment, the step of taking the action includes providing a warning for a user on a display system of the vehicle in accordance with the instructions provided by the processor when it is determined that one or more obstacles are in the path of the trailer.

(6) Also in an exemplary embodiment, the step of taking the action includes performing an automatic control action pertaining to movement of the vehicle in accordance with the instructions provided by the processor when it is determined that one or more obstacles are in the path of the trailer.

(7) Also in an exemplary embodiment, the determining as to whether any obstacles are in the path of the trailer is performed before the one or more extensions are fully extended.

(8) Also in an exemplary embodiment, the determining as to whether any obstacles are in the path of the trailer is performed while the trailer is being parked in a parking spot as it is towed by the vehicle.

(9) Also in an exemplary embodiment, the method further includes generating, via the processor, the profile for the trailer based on information as to the one or more extensions of the trailer and respective clearances required for the one or more extensions when fully extended; and storing, into a non-transitory computer readable storage medium of the vehicle, the profile for the trailer prior to towing the trailer by the vehicle.

(10) Also in an exemplary embodiment, the method further includes transmitting the profile to a remote server for storage at the remote server and for subsequent use by other users of other trailers.

(11) Also in an exemplary embodiment, the method further includes obtaining, via a transceiver, the profile from a remote server pertaining to one or more other trailers with similar characteristics as the trailer; and storing, into a non-transitory computer readable storage medium of the vehicle, the profile prior to towing the trailer by the vehicle.

(12) Also in an exemplary embodiment, the method further includes determining, via the processor, whether any ground surface issues are present in proximity to the vehicle for when the one or more extensions are fully extended, based on the sensor data and the profile; and taking the action, in accordance with the instructions provided by the processor, when it is determined that one or more ground surface issues proximate the trailer.

(13) Also in an exemplary embodiment, the method further includes determining, via the processor, whether any conditions are present in proximity to the trailer for when the one or more extensions are fully extended, based on the sensor data and the profile; obtaining weather conditions in proximity to the trailer that may affect the conditions; and taking the action, in accordance with the instructions provided by the processor, when it is determined that the conditions are likely to pose a problem given the weather conditions.

(14) Also in an exemplary embodiment, the method further comprises determining, via the processor using the sensor data, respective distances of one or more hook-ups to the trailer; and taking the action, in accordance with the instructions provided by the processor, when it is determined that one or more of the respective distances exceed a predetermined threshold.

(15) In another exemplary embodiment, a system is provided that includes one or more sensors of a vehicle that is configured to tow a trailer, the one or more sensors configured to obtain sensor data

pertaining to surroundings of the trailer; and a processor that is coupled to the one or more sensors and that is configured to at least facilitate retrieving information as to a profile of the trailer, the profile including required clearances for the trailer based on one or more extensions of the trailer that are configured to be retracted while the trailer is moving and fully extended when the trailer is parked and the one or more extensions are utilized; determining whether any obstacles are in a path of the trailer when the one or more extensions are fully extended, based on the sensor data and the profile; and taking an action, in accordance with instructions provided by the processor, when it is determined that one or more obstacles are in the path of the trailer.

(16) Also in an exemplary embodiment, the processor is further configured to at least facilitate providing a warning for a user on a display system of the vehicle in accordance with the instructions provided by the processor when it is determined that one or more obstacles are in the path of the trailer.

(17) Also in an exemplary embodiment, the processor is further configured to at least facilitate performing an automatic control action pertaining to movement of the vehicle in accordance with the instructions provided by the processor when it is determined that one or more obstacles are in the path of the trailer.

(18) Also in an exemplary embodiment, the processor is further configured to at least facilitate determining whether any obstacles are in the path of the trailer before the one or more extensions are extended and the trailer is being parked in a parking spot as it is towed by the vehicle.

(19) Also in an exemplary embodiment, the processor is further configured to at least facilitate generating the profile for the trailer based on information as to the one or more extensions of the trailer and respective clearances required for the one or more extensions when fully extended; and storing, into a non-transitory computer readable storage medium of the vehicle, the profile for the trailer prior to towing the trailer by the vehicle.

(20) Also in an exemplary embodiment, the processor is further configured to at least facilitate transmitting the profile to a remote server for storage at the remote server and for subsequent use by other users of other trailers.

(21) Also in an exemplary embodiment, the processor is further configured to at least facilitate obtaining, via a transceiver, the profile from a remote server pertaining to one or more other trailers with similar characteristics as the trailer; and storing, into a non-transitory computer readable storage medium of the vehicle, the profile prior to towing the trailer by the vehicle.

(22) Also in an exemplary embodiment, the processor is further configured to at least facilitate determining whether any ground surface issues are present in proximity to the vehicle for when the one or more extensions are fully extended, based on the sensor data and the profile; and taking the action, in accordance with the instructions provided by the processor, when it is determined that one or more ground surface issues proximate the trailer.

(23) In accordance with another exemplary embodiment, a vehicle is provided that includes a body, a propulsion system, one or more sensors, and a processor. The propulsion system is configured to generate movement of the body. The hitch is configured for coupling to a trailer for towing the trailer. The one or more sensors are configured to obtain sensor data pertaining to surroundings of the trailer. The processor is coupled to the one or more sensors, and is configured to at least facilitate retrieving information as to a profile of the trailer, the profile including required clearances for the trailer based on one or more extensions of the trailer that are configured to be retracted while the trailer is moving and fully extended when the trailer is parked and the one or more extensions are utilized; determining whether any obstacles are in a path of the trailer when the one or more extensions are fully extended, based on the sensor data and the profile; and taking an action, in accordance with instructions provided by the processor, when it is determined that one or more obstacles are in the path of the trailer.

Description

DESCRIPTION OF THE DRAWINGS

(1) The present disclosure will hereinafter be described in conjunction with the following drawing figures, wherein like numerals denote like elements, and wherein:

(2) FIG. **1** is a functional diagram of a vehicle that is configured to tow and control parking for a trailer, and with the vehicle depicted along with the trailer and a remote server that communicates with the vehicle, in accordance with exemplary embodiments;

(3) FIG. **2** is a flowchart of a process for controlling parking related functionality for a trailer that is being towed by a vehicle, and that can be implemented in connection with the vehicle, the trailer, and the remote server of FIG. **1**, in accordance with exemplary embodiments; and

(4) FIG. **3** is a flowchart of a sub-process corresponding to a step of the process of FIG. **2**, namely the step of customizing a trailer profile, in accordance with exemplary embodiments;

(5) FIG. **4** is a flowchart of a sub-process corresponding to another step of the process of FIG. **2**, namely the step of implementing the profile during a parking maneuver for the trailer, in accordance with exemplary embodiments;

(6) FIG. **5** is a flowchart of a sub-process corresponding to an additional step of the process of FIG. **2**, namely the step of implementing the profile following a parking maneuver for the trailer, in accordance with exemplary embodiments; and

(7) FIGS. **6**A, **6**B, and FIG. **7** provide exemplary implementations of the process of FIG. **2**, including the sub-process of FIG. **3**, in accordance with exemplary embodiments.

DETAILED DESCRIPTION

(8) The following detailed description is merely exemplary in nature and is not intended to limit the disclosure or the application and uses thereof. Furthermore, there is no intention to be bound by any theory presented in the preceding background or the following detailed description.

(9) FIG. **1** is a functional diagram of a vehicle **100** alongside a trailer **101**. In various embodiments, the vehicle **100** is configured to tow the trailer **101**. In addition, in various embodiments, and as described in greater detail further below, the vehicle **100** includes a control system **120** that is configured to control and optimize parking related maneuvers for the trailer **101**, and specifically that takes into account extensions **103** of the trailer **101** that are not visible while the trailer **101** is being parked and/or is otherwise moving, in accordance with the steps of the process **200** of FIG. **2** and the sub-processes and implementations of FIGS. **3-7** and as described in greater detail further below in connection therewith.

(10) As depicted in FIG. **1**, in exemplary embodiments the trailer **101** includes a body **102** as well as a plurality of extensions **103**. In various embodiments, the extensions **103** are in a retracted stated, and not visible, when not in use (e.g., when the trailer **101** is being parked and/or moving). Specifically, in various embodiments, the extensions **103** are configured to be retracted while the trailer **101** is moving and extended when the trailer **101** is parked and the extensions **103** are utilized Accordingly, while the trailer **101** is being parked or is otherwise moving, the entire envelope of the trailer **101** is represented by the body **102** of the trailer **101**. However, when the extensions **103** are extended, they generate respective extended regions **104** that increase the envelope of the trailer **101** and that require additional clearance from obstacles. In the exemplary depiction of FIG. **1**, the extensions **103** include a first extension **103(1)** (e.g., a slide out), a second extension **103(2)** (e.g., a kitchen), and a third extension **103(3)** (e.g., an awning), each of which generate respective extended regions **104(1)**, **104(2)**, and **104(3)** with associated required clearances when extended. It will be appreciated that in different embodiments the trailer **101** may have a different number and/or type(s) of the extensions **103**.

(11) In various embodiments, the vehicle **100** comprises an automobile. The vehicle **100** may be any one of a number of different types of automobiles, such as, for example, a sedan, a wagon, a

truck, or a sport utility vehicle (SUV), and may be two-wheel drive (2WD) (i.e., rear-wheel drive or front-wheel drive), four-wheel drive (4WD) or all-wheel drive (AWD), and/or various other types of vehicles in certain embodiments. In certain embodiments, the vehicle **100** may also comprise a motorcycle or other vehicle, such as aircraft, spacecraft, watercraft, and so on, and/or one or more other types of mobile platforms (e.g., a robot and/or other mobile platform).

(12) In certain embodiments, the vehicle **100** may comprise an autonomous or semi-autonomous vehicle, for example in which vehicle control (including acceleration, deceleration, braking, and/or steering) is automatically planned and executed by the control system **120**. In certain other embodiments, the vehicle **100** may comprise a human operated vehicle in which control is executed via a human driver.

(13) In the depicted embodiment, the vehicle **100** includes a body **110** that is arranged on a chassis. The body **110** substantially encloses other components of the vehicle **100**. As depicted in FIG. **1**, in various embodiments the vehicle **100** includes a hitch **111** that is configured to be coupled to the trailer **101** for towing the trailer **101**.

(14) In various embodiments, the vehicle **100** also includes a drive system **112**. In various embodiments, the drive system **112** includes one or more engines and/or motors that provide for movement of the vehicle **100** that are controlled via inputs by a driver (e.g., via an accelerator pedal in certain embodiments) and/or automatically via the control system **120**. In various embodiments, the drive system **112** may also include or be coupled to one or more other vehicle systems that control movement of the vehicle **100**, such as braking system and/or steering system that may similarly be controlled either via inputs by a driver (e.g., via a brake pedal or accelerator pedal, respectively, in certain embodiments) and/or automatically via the control system **120**.

(15) In various embodiments, as depicted in FIG. **1**, the control system **120** is coupled to the drive system **112**, and controls operation thereof. In addition, in various embodiments, the control system **120** provides information and/or control over towing of the trailer **101** and parking thereof, including taking into account the extensions **103** of the trailer **101** that are retracted and are not visible during parking and other movement of the trailer **101**, for example as described in greater detail further below.

(16) Also as depicted in FIG. **1**, in various embodiments, the control system **120** includes a sensor array **130**, a display system **132**, a transceiver **134**, and a controller **136**.

(17) In various embodiments, the sensor array **130** includes various sensors that collect sensor data as to the vehicle **100** and the trailer **101**, and the surroundings in proximity to the trailer **101** (e.g., in regions in which the trailer **101** may be parked and/or moved). In various embodiments, the sensor array **130** includes one or more cameras **138**, Lidar sensors **140**, sonar sensors **142**, and ultrasonic sensors **144** that are configured to detect objects in proximity to the trailer **101**, for example as the trailer **101** is being parked. Also in various embodiments, the sensor array **130** also includes one or more input sensors **146** that are configured to receive user inputs, for example for customizing the profile for the trailer **101** via the display system **132** of the vehicle **100**. In certain embodiments, the sensor array **130** may also include one or more other sensors.

(18) In various embodiments, the display system **132** provides interfacing between the control system **120** and one or more drivers or other users of the vehicle **100**. In various embodiments, the display system **132** provides information for the driver or other user to help customize the profile for the trailer **101** and receives inputs from the user pertaining thereto. Also in various embodiments, the display system **132** provides information for the user as to detected obstacles in proximity to the trailer **101** to assist in parking or other movement of the trailer **101**. In various embodiments, the display system **132** provides this functionality in accordance with instructions provided by the controller **136**.

(19) In various embodiments, the transceiver **134** is utilized to transmit messages to a driver or other user of the vehicle **100**. In certain embodiments, the transceiver **134** is used to receive and transmit messages with the remote server **170** as to profiles for the trailer **101** and/or for other

trailers (e.g., similar trailers). Also in certain embodiments, the transceiver **134** may be utilized to transmit messages to and/or receive messages from the driver or other user, for example as to the profile and/or obstacles detected in proximity to the trailer **101**.

(20) In various embodiments, the controller **136** is coupled to the sensor array **130**, the display system **132**, and the transceiver **134**, as well as to the drive system **112** (and/or related systems such as a braking system and/or steering system in certain embodiments). In various embodiments, the controller **136** controls the functionality of the control system **120**, as well as of the drive system **112** and related systems.

(21) In various embodiments, the controller (or computer system) **230** provides information and/or control over towing of the trailer **101**, including parking the trailer **101** while considering the extensions **103** and the resulting changes in the envelope of the trailer **101** and required clearances when the extensions **103** are extended. In various embodiments, the controller **136** performs these steps in accordance with the steps of the process **200** of FIG. **2** and the sub-processes and implementations of FIGS. **3-7** and described further below in connection therewith.

(22) In various embodiments, the controller **136** (and, in certain embodiments, the control system **120** itself) is disposed within the body **110** of the vehicle **100**. In certain embodiments, the controller **136** and/or control system **120** and/or one or more components thereof may be disposed outside the body **110**, for example on a remote server, in the cloud, or other device where image processing is performed remotely.

(23) It will be appreciated that the controller **136** may otherwise differ from the embodiment depicted in FIG. **1**. For example, the controller **136** may be coupled to or may otherwise utilize one or more remote computer systems and/or other control systems, for example as part of one or more of the above-identified vehicle **100** devices and systems.

(24) As depicted in FIG. **1**, in various embodiments, the controller **136** comprises a computer system, and includes a processor **148**, a memory **150**, an interface **152**, a storage device **154**, and a computer bus **156**. The processor **148** performs the computation and control functions of the controller **136**, and may comprise any type of processor or multiple processors, single integrated circuits such as a microprocessor, or any suitable number of integrated circuit devices and/or circuit boards working in cooperation to accomplish the functions of a processing unit. During operation, the processor **148** executes one or more programs **160** contained within the memory **150** and, as such, controls the general operation of the controller **136** in executing the processes described herein, such as the process **200** of FIG. **2** and the sub-processes and implementations of FIGS. **3-7** and as described in connection therewith.

(25) The memory **150** can be any type of suitable memory. For example, the memory **150** may include various types of dynamic random access memory (DRAM) such as SDRAM, the various types of static RAM (SRAM), and the various types of non-volatile memory (PROM, EPROM, and flash). In certain examples, the memory **150** is located on and/or co-located on the same computer chip as the processor **148**. In the depicted embodiment, the memory **150** stores the above-referenced program **160** along with one or more profiles **162** (e.g., of the trailer **101** that is towed by the vehicle **100**).

(26) The bus **156** serves to transmit programs, data, status and other information or signals between the various components of the computer system of the controller **136**. The interface **152** allows communication to the computer system of the controller **136**, for example from a system driver and/or another computer system, and can be implemented using any suitable method and apparatus. In one embodiment, the interface **152** obtains the various data from the sensor array **130** and/or the stored profiles **162** from the memory **150**. The interface **152** may also include one or more network interfaces to communicate with technicians, and/or one or more storage interfaces to connect to storage apparatuses, such as the storage device **154**.

(27) The storage device **154** can be any suitable type of storage apparatus, including various different types of direct access storage and/or other memory devices. In one exemplary

embodiment, the storage device **154** comprises a program product from which memory **150** can receive a program **160** that executes one or more embodiments of the process **200** of FIG. **2** and the sub-processes and implementations of FIGS. **3-7** and as described in connection therewith. In another exemplary embodiment, the program product may be directly stored in and/or otherwise accessed by the memory **150** and/or a secondary storage device (e.g., disk **164**), such as that referenced below.

(28) The bus **156** can be any suitable physical or logical means of connecting computer systems and components. This includes, but is not limited to, direct hard-wired connections, fiber optics, infrared and wireless bus technologies. During operation, the program **160** is stored in the memory **150** and executed by the processor **148**.

(29) It will be appreciated that while this exemplary embodiment is described in the context of a fully functioning computer system, those skilled in the art will recognize that the mechanisms of the present disclosure are capable of being distributed as a program product with one or more types of non-transitory computer-readable signal bearing media used to store the program and the instructions thereof and carry out the distribution thereof, such as a non-transitory computer readable medium bearing the program and containing computer instructions stored therein for causing a computer processor (such as the processor **148**) to perform and execute the program. Such a program product may take a variety of forms, and the present disclosure applies equally regardless of the particular type of computer-readable signal bearing media used to carry out the distribution. Examples of signal bearing media include: recordable media such as floppy disks, hard drives, memory cards and optical disks, and transmission media such as digital and analog communication links. It will be appreciated that cloud-based storage and/or other techniques may also be utilized in certain embodiments. It will similarly be appreciated that the computer system of the controller **136** may also otherwise differ from the embodiment depicted in FIG. **1**, for example in that the computer system of the controller **136** may be coupled to or may otherwise utilize one or more remote computer systems and/or other control systems.

(30) With continued reference to FIG. **1**, in various embodiments the remote server **170** communicates with the control system **120** via one or more wireless communication networks **180**. As noted above, in various embodiments, the control system **120** and the remote server **170** share information regarding the profile **162** of the trailer **101** for the vehicle **100** of FIG. **1**, as well as additional profiles **178** (discussed below) for different trailers and vehicles.

(31) As depicted in FIG. **1**, in various embodiments, the remote server **170** includes a transceiver **172**, a processor **174**, and a memory **176**. In various embodiments, the transceiver **172** is utilized to communicate with the transceiver **134** of the control system **120**, including for the sharing of profiles **162**, **178** with one another in accordance with instructions provided by the processor **174**. Also as depicted in FIG. **1**, in various embodiments, the memory **176** of the remote server **170** stores the various profiles **178** of different trailers and vehicles, for example for use in sharing with the trailer **101** and the vehicle **100** of FIG. **1** as well as with various other trailers and vehicles.

(32) With reference to FIG. **2**, a flowchart is provided of a process **200** for controlling parking related functionality for a trailer that is being towed by a vehicle, in accordance with exemplary embodiments. In various embodiments, the process **200** can be implemented in connection with the vehicle **100**, the trailer **101**, and the remote server **170** of FIG. **1**

(33) In various embodiments, the process **200** begins at step **202**, for example when the profile for the trailer is being generated. In various embodiments, this may occur when the trailer **101** is towed by the vehicle **100** for the first time in accordance with the process **200**. In other embodiments, this may also occur at one or more subsequent times in which the trailer **101** is to be towed by the vehicle **100**.

(34) In various embodiments, the trailer profile is generated at step **204**. In various embodiments, the trailer profile is generated in advance of towing and parking of the trailer **101**, so that the control system **120** is ready to assist with parking and/or other movement of the trailer **101** when

the time arrives. In various embodiments, the trailer profile includes not only the dimensions associated with the body of the trailer (e.g., length and width thereof), but also including all extensions **103** thereof and required clearances when fully extended and utilized. Specifically, in various embodiments, the trailer profile utilizes the extensions **103** of the trailer **101** from FIG. **1**, along with respective extended regions **104** thereof that will be part of the trailer **101** envelope when parking (e.g., to avoid contact of objects with the extensions **103**, and so on). A more detailed explanation of the generating of the profile of step **204** will be provided further below in connection with FIG. **3**.

(35) In various embodiments, the trailer profile is implemented during parking maneuvers at step **206**. In various embodiments, the trailer profile of step **204** is utilized while the trailer **101** is being parked, such that no objects or impediments will interfere with the trailer **101** as it is parked, after considering the extensions **103** and their respective extended regions **104** and required clearances after the trailer **101** is parked. A more detailed explanation of the utilizing of the trailer profile during parking maneuvers of step **206** will be provided further below in connection with FIG. **4** (along with implementations pertaining thereto in FIGS. **6**A, **6**B, and **7**).

(36) In various embodiments, the trailer profile is also implemented subsequent to parking maneuvers at step **208**. In various embodiments, during step **208**, the trailer profile of step **204** is utilized after the trailer **101** is being parked and/or as the trailer **101** is exiting the parking spot, for example such that nothing pertaining to the trailer **101** and/or the vehicle **100** is let behind. A more detailed explanation of the utilizing of the trailer profile after the parking maneuvers of step **208** will be provided further below in connection with FIG. **5**.

(37) In various embodiments, the process may then terminate at step **210**.

(38) As alluded to above, FIG. **3** is a flowchart of a sub-process corresponding to step **204** of the process **200** of FIG. **2**, namely the step of customizing a trailer profile, in accordance with exemplary embodiments. In various embodiments, the sub-process of step **204** begins when trailering profile enhancements are initiated at step **302**. For example, in certain embodiments, a driver or other user of the vehicle **100** may begin preparation or enhancement of a profile pertaining to the trailer **101**, such as the first time the trailer **101** is hitched to the vehicle **100** in certain embodiments.

(39) In various embodiments, trailer profile setup is initiated (step **304**). In various embodiments, the initiation of the trailer profile setup is initiated via the display system **132** of FIG. **1**, in accordance with instructions provided by the processor **148** of FIG. **1**, and its interaction with the user. In various embodiments, the setup of the trailer profile may be initiated in one of three manners, as set forth in steps **306**, **308**, and **312** below, respectively.

(40) In a first implementation illustrated in step **306**, a common profile may be utilized for the trailer profile in certain embodiments. Specifically, in certain embodiments, during step **306**, the processor **148** may find an existing profile for a similar type of trailer as the trailer **101** that is now hitched to the vehicle **100**. For example, in certain embodiments, such an existing profile may already exist for one or more other different owners of one or more other different trailers that have been previously towed by one or more other different vehicles, with the other different trailers having similar dimensions (including of other similar extensions thereof that retract and extend in a similar manner) as the trailer **101** at issue for the present user and the present vehicle **100**. In certain embodiments, the common profile may be previously stored in a computer memory, such as in the stored profiles **178** of the memory **176** of the remote server **170** of FIG. **1**. Also in certain embodiments, the common profile is transmitted from the remote server **170** to the vehicle **100** of the present user, and is then downloaded and stored in the memory **150** of the vehicle **100** as the current profile **162** therefor with the current trailer **101**. In various embodiments, the trailer clearances are saved to the current profile **162** in the memory **150** (step **318**).

(41) In a second implementation illustrated in step **308**, manual setup of the current profile may be required. Specifically, in certain embodiments, and further with reference to step **310**, in various

embodiments the user is prompted via a message of the display system **132** to manually enter space claims around a visual representation of the trailer **101** on a display screen of the display system **132**. For example, in certain embodiments, the user manually enters the dimensions for the trailer **101**, including the extensions **103** and the respective extended regions **104** of FIG. **1** (and associated required clearances) when the extensions **103** are fully extended. In various embodiments, the user inputs are received via the input sensors **146** associated with the display system **132**. In various embodiments, the processor **148** constructs the current profile based on the manual inputs, and then stores the current profile in the memory **150** of the vehicle **100** as the current profile **162** therefor for use with the current trailer **101**. In various embodiments, the trailer clearances are saved to the current profile **162** in the memory **150** (step **318**).

(42) In a third implementation illustrated in step **312**, automated setup of the current profile may be utilized. Specifically, in certain embodiments, and further with reference to step **314**, in various embodiments the user is prompted via a message of the display system **132** goes through a step by step process to extend or "pop out" all extensions **103** of the trailer **101**. In various embodiments, the display system **132** provides the user with prompts for the user to implement the extending of each of the extensions **103** in a step by step manner, and the processor **148** then utilizes sensor data to ascertain and learn the updated dimensions of the trailer **101** when the extensions **103** are extended. In various embodiments, the processor **148** utilizes this data to "learn" the additional zones (e.g., the extended regions **104** of FIG. **1**) of the trailer **101** with respect to the extensions **103** of the trailer **101**, and automatically builds the current profile for the trailer **101** accordingly. In various embodiments, the processor **148** then stores the current profile in the memory **150** of the vehicle **100** as the current profile **162** therefor for use with the current trailer **101**. In various embodiments, the trailer clearances are saved to the current profile **162** in the memory **150** (step **318**).

(43) FIG. **4** is a flowchart of a sub-process corresponding to step **206** of the process **200** of FIG. **2**, namely the step of implementing the profile during a parking maneuver for the trailer, in accordance with exemplary embodiments. The sub-process of step **206** is described below in connection with FIG. **4** as well as FIG. **6**A, FIG. B, and FIG. **7**, which depict exemplary implementations thereof.

(44) As depicted in FIG. **4**, in various embodiments, the sub-process of step **206** begins at step **402** when a parking maneuver is initiated for the trailer (e.g., when the trailer **101** is being parked while hitched to the vehicle **100**). In various embodiments, the parking maneuver is initiated at some future time after the above-described profile of step **204** has already been initiated or enhanced.

(45) In various embodiments, trailer clearances are obtained from the trailer profile (step **404**). In various embodiments, the processor **148** of FIG. **1** obtains clearances for the trailer **101** from the current profile **162** stored in the memory **150** of FIG. **1**, including the dimensions and associated clearances of the trailer **101** when each of the extensions **103** thereof are in their fully extended positions.

(46) Also in various embodiments, vehicle sensing is enabled for trailering (step **406**). In various embodiments, the processor **148** of FIG. **1** provides instructions for the sensor array **130** of FIG. **1** to be enabled or woken up in order to obtain sensor data while the trailer **101** is being parked, including obstacles that may be in the path of the trailer **101** and any other conditions that may be present on the ground nearby (e.g., potholes, bumps, and the like).

(47) In various embodiments, clearances are checked (step **408**). Specifically, in various embodiments, clearances of any detected surrounding objects are checked, and compared to clearances required based on the current profile for the trailer **101**. In various embodiments, this is performed by the processor **148** utilizing the sensor data in comparison with the current profile **162** for the trailer **101**. In addition, in various embodiments, the area surrounding the trailer **101** and the parking spot is also examined for a spatial awareness as to hook-ups (e.g., electricity, water, sewage, and the like) that the trailer **101** may utilize while in the parking spot. For example, in

various embodiments, in addition to determining potential obstructions, the process also determines the distances to the hook-ups (from the trailer **101**) and helps to make sure that such distances to the hook-ups do not exceed a maximum distance from a relevant point on the trailer (which would also be included in the trailer **101** profile in various embodiments).

(48) In various embodiments, a determination is made as to whether any obstructions are in the path of the trailer (step **410**). Specifically, in various embodiments, the processor **148** determines whether any detected objects are in the path of the trailer **101** as the trailer **101** is being moved to the parking spot and parked, and also as to whether any detected objects would be in the path of, or would be likely to contact, the trailer **101** as the extensions **103** thereof are fully extended. Also in various embodiments, a determination is made as to relevant hook-ups nearby, and as to whether the distances to the hook-ups exceed a maximum distance.

(49) In various embodiments, if it is determined in step **410** that one or more are obstructions are in the path of the trailer, or that a maximum distance to a hook-up is exceeded, then a notification is provided for the user (step **412**). In certain embodiments, a warning as to the obstruction is provided for a driver or other user of the vehicle **100** on a screen of the display system **132** of FIG. **1**, in accordance with instructions provided by the processor **148**. In certain embodiments, an image of the obstruction (and/or hook-up) may also be displayed on the display screen of the display system **132**. In certain other embodiments, the warning may be provided to a smart phone or other personal device of the user, for example via a message transmitted thereto via the transceiver **134** of FIG. **1** in accordance with instructions provided by the processor **148**. In addition, in certain embodiments, the processor **148** may also provide instructions for automated control of movement of the vehicle **100** and the trailer **101** (e.g., by automatically moving, braking, and/or steering of the vehicle **100**) in order to avoid the obstacles.

(50) In various embodiments, the process **300** continues to check for obstructions and any hook-ups (step **414**). Specifically, in various embodiments, additional sensor data continues to be collected via the sensor array **130** and analyzed via the processor **148** with respect to the same obstruction and other possible obstructions and/or issues with nearby hook-ups (such as exceeding the maximum distance to the hook-ups). In various embodiments, the process **300** returns to step **410**, and steps **410-414** continue in this manner until a determination is made in a subsequent iteration of step **410** that no obstructions are present in the path of the trailer **101** (and, in various embodiments, that there are no issues with nearby hook-ups).

(51) In various embodiments, once a determination is made that there are not obstructions detected in the path of the trailer (and, in various embodiments, no issues with nearby hook-ups), a determination is made as to whether there are any ground surface conditions or other conditions present that may affect the trailer (step **416**). In various embodiments, this determination is made by the processor **148** based on the sensor data as to the ground in proximity to the trailer **101**. For example, in certain embodiments, the determination is made as to whether any significant bumps, dips, trenches, puddles, branches, or other conditions are present that would affect the usability of the trailer **101** as it is parked.

(52) In various embodiments, if it is determined that one or more such ground surface conditions or other conditions are present, then weather information is ascertained (step **418**). For example, in certain embodiments, weather forecasts may be obtained (e.g., via the transceiver **134** of FIG. **1**) for a geographic region in which the trailer **101** is being parked, that may affect the trailer **101** particularly given the ground surface conditions or other conditions. For example, in various embodiments, if rain or other inclement weather is likely for the geographic region, then this may adversely affect the ground surface conditions for the trailer **101** (e.g., a dip or trench in the ground surface may soon be filled with water, and so on). By way of additional example, if one or more other conditions are presents (such as branches or other obstacles that may be in proximity to the trailer **101**), then when a storm approaches the branches may droop down and make contact with the trailer **101**, and so on.

(53) In various embodiments, a notification is provided for the user (step **420**). In certain embodiments, a warning as to the ground surface conditions, along with any weather forecast or other information that may have an effect on the ground surface conditions or other conditions, is provided for a driver or other user of the vehicle **100** on a screen of the display system **132** of FIG. **1**, in accordance with instructions provided by the processor **148**. In certain embodiments, an image of the ground surface condition or other condition may also be displayed on the display screen of the display system **132**. In certain other embodiments, the warning may be provided to a smart phone or other personal device of the user, for example via a message transmitted thereto via the transceiver **134** of FIG. **1** in accordance with instructions provided by the processor **148**. In addition, in certain embodiments, the processor **148** may also provide instructions for automated control of movement of the vehicle **100** and the trailer **101** (e.g., by automatically moving, braking, and/or steering of the vehicle **100**) in order to avoid or mitigate the ground conditions.

(54) In various embodiments, the process **300** continues to check for issues, including other ground surface conditions (step **422**). Specifically, in various embodiments, additional sensor data continues to be collected via the sensor array **130** and analyzed via the processor **148** with respect to the same ground surface conditions and other possible ground surface conditions. In various embodiments, the process **300** returns to step **416**, and steps **416**-**422** continue in this manner until a determination is made in a subsequent iteration of step **416** that no adverse ground surface conditions are surrounding the trailer **101**.

(55) In various embodiments, once a determination is made that there are not adverse ground surface conditions, the trailer is parked (step **424**). In addition, in certain embodiments, updated information as to the trailer **101** and the parking thereof (e.g., including an updated map and updated clearance data for the trailer **101**) are stored. In certain embodiments, the updated information is stored in the memory **150** of the vehicle **100** as part of an updated profile **162** for the trailer **101**. In addition, in certain embodiments, the updated information is transmitted to the remote server **170**, where the updated information as stored in an updated profile **178** that is stored in the memory **176** thereof for subsequent users of other vehicles and trailers.

(56) In various embodiments, the sub-process of step **206** then terminates (step **428**).

(57) With respect to FIGS. **6**A, and **6**B, a first implementation of the sub-process of step **206** is provided. First, as depicted in FIG. **6**A, a first illustration **600** is provided for the vehicle **100** and the trailer **101** as the trailer **101** is being parked. As shown in FIG. **6**A, in various embodiments, the sensors of the sensor array **130** of the vehicle **100** provide sensor detection in a first sensor region **602** and a second sensor region **604**.

(58) As depicted in FIG. **6**A, within the first sensor region **602** is a clearance region **606** required for extensions **103** of the trailer **101** when the extensions **103** are fully extended. Also as depicted in FIG. **6**A, in the exemplary embodiment, an obstruction **608** (i.e., a tree) is disposed within a part of the clearance region **606**.

(59) Also as depicted in FIG. **6**A, within the second sensor region **604** are multiple clearance regions **610**, **612** that are required for other extensions **103** of the trailer **101** when the extensions **103** are fully extended. Also as depicted in FIG. **6**A, in the exemplary embodiment, one or more obstructions **614** are present within a part of clearance region **612**.

(60) With reference now to FIG. **6**B, a second illustration **650** is provided, with a magnification of a region of interest associated with the obstructions **608**, **614**. As depicted in FIG. **6**B, multiple collisions **652** are depicted for the trailer **101** for when the extensions **103** are fully extended. Also as depicted in FIG. **6**B, the obstruction **608** (i.e., the tree) would be expected to contact a portion **654** of the trailer **101** when the extensions **103** are fully extended. Also as depicted in FIG. **6**B, the obstruction **614** would be expected to contact a portion **656** of the trailer **101** when the extensions **103** are fully extended.

(61) With respect to FIG. **7**, an illustration **700** is provided of a second implementation of the sub-process of step **206** is provided. Specifically, as depicted in FIG. **7**, in certain embodiments various

sensors of the sensor array **130** are located at different locations of the vehicle, including: (i) a first point "A" **720** (e.g., proximate the hitch of the vehicle **100**); (ii) a second point "B" **730** (e.g., proximate a midpoint or middle region of the vehicle **100**); and (iii) third and fourth points "C1" **740** and "C2" **750** (proximate respective side view mirrors of the vehicle **100**).

(62) Also as depicted in the illustration **700** of FIG. **7**, the extensions **103** of the trailer require clearance in a first clearance region **706**, a second clearance region **710**, and a third clearance region **712**. In an exemplary embodiment, the first clearance region **706** includes an obstruction **708** (e.g., a tree).

(63) As depicted in FIG. **7**, the sensors at point "A" **720** of the vehicle provide detection zones that include a first sensor ray **721**, a second sensor ray **722**, a third sensor ray **723**, and a fourth sensor ray **724**. In the depicted embodiment, the obstruction **708** is not detected by the first and second sensor rays **721**, **722**, but is detected via the third and fourth sensor rays **723**, **724**.

(64) Also as depicted in FIG. **7**, the sensors at point "B" **730** of the vehicle provide detection zones that include a first sensor ray **731**, a second sensor ray **732**, a third sensor ray **733**, and a fourth sensor ray **734**. In the depicted embodiment, the obstruction **708** is not detected by the first and second sensor rays **731**, **732**, but is detected via the third and fourth sensor rays **733**, **734**.

(65) Also as depicted in FIG. **7**, the sensors at point "C1" **740** of the vehicle provide detection zones that include a first sensor ray **741**, a second sensor ray **742**, a third sensor ray **743**, and a fourth sensor ray **744**. In the depicted embodiment, the obstruction **708** is not detected by the first and second sensor rays **741**, **742**, but is detected via the third and fourth sensor rays **743**, **744**.

(66) Also as depicted in FIG. **7**, the sensors at point "C2" **750** of the vehicle provide detection zones that include a first sensor ray **751** and a second sensor ray **752**, neither of which detect the obstruction **708** (however, that would potentially detect obstructions if any were present in clearance regions **710** and/or **714** of FIG. **7**).

(67) As illustrated in FIG. **7**, in various embodiments, sensors are utilized at various locations on the vehicle **100**, with corresponding different angles associated with the corresponding detection zones and sensor rays. In various embodiments, the processor **148** aggregates the various sensor data from the various different angles for detection of the obstacles, using trigonometric principles as applied to the various different angles.

(68) FIG. **5** is a flowchart of a sub-process corresponding to step **208** of the process **200** of FIG. **2**, namely the step of implementing the profile subsequent to a parking maneuver for the trailer, in accordance with exemplary embodiments.

(69) As depicted in FIG. **5**, in various embodiments, the sub-process of step **208** begins at **502** during one or more times after the parking maneuver of step **206** has already been completed for the trailer (e.g., when the trailer **101** is still hitched to the vehicle **100** while the trailer **101** is already parked in a parking spot, and/or when the trailer **101** is exiting the parking spot while being towed by the vehicle **100**).

(70) In various embodiments, vehicle sensing is enabled for trailering (step **504**). In various embodiments, the processor **148** of FIG. **1** provides instructions for the sensor array **130** of FIG. **1** to be enabled or woken up in order to obtain sensor data after the trailer **101** has been parked and remains in the parking spot and/or when the trailer **101** is exiting the parking spot, including obstacles that may be in the path of the trailer **101** and/or that may be left behind by the trailer **101** (e.g., as to whether the trailer **101** is still hooked up to water, power, and/or other services, and/or as to whether any trailer **101** components, accessories, and/or other belongings of the user may be left behind and/or may be in the path of the trailer **101**, and the like).

(71) In various embodiments, a check is performed as to nearby obstacles using the sensor data (step **506**), and a determination is made as to whether any obstructions are in the path of the trailer and/or may be left behind (e.g. in the parking spot) (step **508**). Specifically, in various embodiments, the processor **148** makes this determination based on the sensor data as the trailer **101** remains in the parking spot and/or is exiting from the parking spot.

(72) In various embodiments, if it is determined in step **508** that one or more are obstructions are presents, then a notification is provided for the user (step **510**). In certain embodiments, a warning as to the obstruction is provided for a driver or other user of the vehicle **100** on a screen of the display system **132** of FIG. **1**, in accordance with instructions provided by the processor **148**. In certain embodiments, an image of the obstruction may also be displayed on the display screen of the display system **132**. In certain other embodiments, the warning may be provided to a smart phone or other personal device of the user, for example via a message transmitted thereto via the transceiver **134** of FIG. **1** in accordance with instructions provided by the processor **148**.

(73) In various embodiments, the process **300** continues to check for obstructions (step **512**), regardless of whether a warning was warranted. Specifically, in various embodiments, additional sensor data continues to be collected via the sensor array **130** and analyzed via the processor **148** with respect to the same obstruction and other possible obstructions.

(74) In various embodiments, a determination is made as to whether the process **300** is complete (step **514**). In certain embodiments, during step **514**, the processor **148** determines whether the post-parking maneuver is complete (e.g., when the trailer **101** has fully exited the parking spot). In various embodiments, if the process **300** is not yet deemed to be complete, then the process **300** returns to step **512**, and steps **512-514** thereafter repeat until a determination is made that the process is complete.

(75) In various embodiments, once a determination is made in an iteration of step **514** that the process **300** is complete (e.g., that the trailer **101** has fully exited the parking spot), the process terminates at step **516**.

(76) Accordingly, methods, systems, and vehicles are provided herein that provide for potentially improved information for and control of parking a trailer that is being towed by a vehicle. In various embodiments, various sensor data is utilized in detecting objects that may interfere with parking of the trailer **101**, after consideration of extensions **103** of the trailer **101** that will encompass different respective regions and require extended clearances after the extensions **103** are extended. In various embodiments, this may help to improve the experience for users of the trailer **101** and the vehicle **100**, for example by helping to prevent unwanted contact between obstacle and the trailer and/or other impediments for parking and/or movement of the trailer **101**.

(77) In addition, rather than by considering only the body of the trailer as it is being towed or parked, the consideration also of the extensions **103** of the trailer helps to prevent a situation in which the trailer **101** is parked and then the user realizes that the trailer extensions **103** cannot be fully utilized due to an obstruction or ground surface condition in the parking spot, and so on. Therefore, this provides a type of usage protection for the trailer **101**, for example by detecting collisions or obstructions ahead of time that may subsequently be present after the trailer is fully set up in the parking spot.

(78) It will be appreciated that the systems, vehicles, and methods may vary from those depicted in the Figures and described herein. For example, the vehicle **100**, the trailer **101**, the remote server **170**, and/or components thereof may different from those depicted in FIG. **1** and/or described therein. It will similarly be appreciated that the steps of the process **200** of FIG. **2**, the sub-routines of FIGS. **3-5**, and the implementations of FIGS. **6**A, **6**B, and **7** may differ from those depicted in the Figures, and/or that various steps may occur concurrently and/or in a different order than that depicted in the Figures.

(79) While at least one exemplary embodiment has been presented in the foregoing detailed description, it should be appreciated that a vast number of variations exist. It should also be appreciated that the exemplary embodiment or exemplary embodiments are only examples, and are not intended to limit the scope, applicability, or configuration of the disclosure in any way. Rather, the foregoing detailed description will provide those skilled in the art with a convenient road map for implementing the exemplary embodiment or exemplary embodiments. It should be understood that various changes can be made in the function and arrangement of elements without departing

from the scope of the disclosure as set forth in the appended claims and the legal equivalents thereof.

Claims

1. A method comprising: obtaining, via one or more sensors of a vehicle that is towing a trailer, sensor data pertaining to surroundings of the trailer; retrieving information as to a profile of the trailer, the profile comprising required clearances for the trailer based on one or more extensions of the trailer that are configured to be retracted while the trailer is moving and fully extended when the trailer is parked and the one or more extensions are utilized; determining, via a processor, whether any obstacles are in a path of the trailer when the one or more extensions are fully extended, based on the sensor data and the profile; taking an action, in accordance with instructions provided by the processor, when it is determined that one or more obstacles are in the path of the trailer; determining, via the processor, whether any ground surface issues are present in proximity to the trailer for when the one or more extensions are fully extended, based on the sensor data and the profile; and taking the action, in accordance with the instructions provided by the processor, when it is determined that one or more ground surface issues proximate the trailer.

2. The method of claim 1, wherein the step of taking the action comprises providing a warning for a user on a display system of the vehicle in accordance with the instructions provided by the processor when it is determined that one or more obstacles are in the path of the trailer.

3. The method of claim 1, wherein the step of taking the action comprises performing an automatic control action pertaining to movement of the vehicle in accordance with the instructions provided by the processor when it is determined that one or more obstacles are in the path of the trailer.

4. The method of claim 1, wherein the determining as to whether any obstacles are in the path of the trailer is performed before the one or more extensions are fully extended.

5. The method of claim 4, wherein the determining as to whether any obstacles are in the path of the trailer is performed while the trailer is being parked in a parking spot as it is towed by the vehicle.

6. The method of claim 5, further comprising: generating, via the processor, the profile for the trailer based on information as to the one or more extensions of the trailer and respective clearances required for the one or more extensions when fully extended; and storing, into a non-transitory computer readable storage medium of the vehicle, the profile for the trailer prior to towing the trailer by the vehicle.

7. The method of claim 6, further comprising: transmitting the profile to a remote server for storage at the remote server.

8. The method of claim 5, further comprising: obtaining, via a transceiver, the profile from a remote server pertaining to one or more other trailers with similar characteristics as the trailer; and storing, into a non-transitory computer readable storage medium of the vehicle, the profile prior to towing the trailer by the vehicle.

9. The method of claim 1, further comprising: determining, via the processor, whether any conditions are present in proximity to the trailer for when the one or more extensions are fully extended, based on the sensor data and the profile; obtaining weather conditions in proximity to the trailer that may affect the conditions; and taking the action, in accordance with the instructions provided by the processor, when it is determined that the conditions are likely to pose a problem given the weather conditions.

10. The method of claim 1, further comprising: determining, via the processor using the sensor data, respective distances of one or more hook-ups to the trailer; and taking the action, in accordance with the instructions provided by the processor, when it is determined that one or more of the respective distances exceed a predetermined threshold.

11. A system comprising: one or more sensors of a vehicle that is configured to tow a trailer, the

one or more sensors configured to obtain sensor data pertaining to surroundings of the trailer; and a processor that is coupled to the one or more sensors and that is configured to at least facilitate: retrieving information as to a profile of the trailer, the profile comprising required clearances for the trailer based on one or more extensions of the trailer that are configured to be retracted while the trailer is moving and fully extended when the trailer is parked and the one or more extensions are utilized; determining whether any obstacles are in a path of the trailer when the one or more extensions are fully extended, based on the sensor data and the profile; taking an action, in accordance with instructions provided by the processor, when it is determined that one or more obstacles are in the path of the trailer; determining whether any ground surface issues are present in proximity to the vehicle for when the one or more extensions are fully extended, based on the sensor data and the profile; and taking the action, in accordance with the instructions provided by the processor, when it is determined that one or more ground surface issues proximate the trailer.

12. The system of claim 11, wherein the processor is further configured to at least facilitate providing a warning for a user on a display system of the vehicle in accordance with the instructions provided by the processor when it is determined that one or more obstacles are in the path of the trailer.

13. The system of claim 11, wherein the processor is further configured to at least facilitate performing an automatic control action pertaining to movement of the vehicle in accordance with the instructions provided by the processor when it is determined that one or more obstacles are in the path of the trailer.

14. The system of claim 11, wherein the processor is further configured to at least facilitate determining whether any obstacles are in the path of the trailer before the one or more extensions are fully extended and the trailer is being parked in a parking spot as it is towed by the vehicle.

15. The system of claim 14, wherein the processor is further configured to at least facilitate: generating the profile for the trailer based on information as to the one or more extensions of the trailer and respective clearances required for the one or more extensions when fully extended; and storing, into a non-transitory computer readable storage medium of the vehicle, the profile for the trailer prior to towing the trailer by the vehicle.

16. The system of claim 15, wherein the processor is further configured to at least facilitate transmitting the profile to a remote server for storage at the remote server.

17. The system of claim 14, wherein the processor is further configured to at least facilitate: obtaining, via a transceiver, the profile from a remote server pertaining to one or more other trailers with similar characteristics as the trailer; and storing, into a non-transitory computer readable storage medium of the vehicle, the profile prior to towing the trailer by the vehicle.

18. A vehicle comprising: a body; a propulsion system configured to generate movement of the body; a hitch for coupling to a trailer for towing the trailer; one or more sensors that are configured to obtain sensor data pertaining to surroundings of the trailer; and a processor that is coupled to the one or more sensors and that is configured to at least facilitate: retrieving information as to a profile of the trailer, the profile comprising required clearances for the trailer based on one or more extensions of the trailer that are configured to be retracted while the trailer is moving and fully extended when the trailer is parked and the one or more extensions are utilized; determining whether any obstacles are in a path of the trailer when the one or more extensions are fully extended, based on the sensor data and the profile; taking an action, in accordance with instructions provided by the processor, when it is determined that one or more obstacles are in the path of the trailer; determining whether any ground surface issues are present in proximity to the vehicle for when the one or more extensions are fully extended, based on the sensor data and the profile; and taking the action, in accordance with the instructions provided by the processor, when it is determined that one or more ground surface issues proximate the trailer.

19. The vehicle of claim 18, wherein the processor is further configured to at least facilitate: determining whether any conditions are present in proximity to the trailer for when the one or more

extensions are fully extended, based on the sensor data and the profile; obtaining weather conditions in proximity to the trailer that may affect the conditions; and taking the action, in accordance with the instructions provided by the processor, when it is determined that the conditions are likely to pose a problem given the weather conditions.

20. The vehicle of claim 18, wherein the processor is further configured to at least facilitate: determining, using the sensor data, respective distances of one or more hook-ups to the trailer; and taking the action, in accordance with the instructions provided by the processor, when it is determined that one or more of the respective distances exceed a predetermined threshold.