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Inventor(s)	Wan; Jian et al.

Systems and methods for facilitating users to exit from a vehicle

Abstract

A vehicle including a vehicle door, a detection unit and a vehicle processor is disclosed. The detection unit may be configured to detect an object presence in proximity to the vehicle and object information associated with an object. The vehicle processor may be configured to obtain the object information from the detection unit when the detection unit detects the object presence, and determine that the object may be approaching towards the vehicle door based on the object information. The vehicle processor may further output the object information to a user device responsive to determining that the object may be approaching towards the vehicle door.

Inventors: **Wan; Jian (Novi, MI), Von hausen; Christian (Duisburg Aldenrade, DE), Prakah-Asante; Kwaku O. (Commerce Township, MI), To; Curtis Sai-Hay (Troy, MI)**

Applicant: **Ford Global Technologies, LLC** (Dearborn, MI)

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Primary Examiner: La; Anh V

Attorney, Agent or Firm: Eversheds Sutherland (US) LLP

Background/Summary

FIELD

(1) The present disclosure relates to systems and methods for facilitating users to exit from a vehicle.

BACKGROUND

(2) Vehicles typically include rear-view mirrors that facilitate drivers to see if other vehicles, motorists, objects, people, etc. may be in proximity to vehicle rear side. Such mirrors facilitate the drivers to conveniently drive the vehicles and/or exit from the vehicles. For example, a driver may look at a rear-view mirror before exiting the vehicle to ensure that no one is approaching the vehicle from the vehicle rear side.

(3) While the rear-view mirror may assist the driver to conveniently exit from the vehicle, other passengers or occupants in the vehicle may not have a clear view of the vehicle rear side while exiting the vehicle. For example, an occupant sitting in a sitting area behind a driver sitting area may not have access to the rear-view mirror, and hence may not know if someone may be approaching a vehicle door from where the occupant may exit. Furthermore, there may be instances where the driver may miss or forget to look at the rear-view mirror while exiting the vehicle. Such instances may cause inconvenience to the driver and/or the vehicle occupants, especially when another vehicle or motorist may be approaching towards the vehicle door from where the driver/occupants may be exiting.
(4) Therefore, a system is required that may facilitate vehicle users to conveniently exit from a vehicle.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) The detailed description is set forth with reference to the accompanying drawings. The use of the same reference numerals may indicate similar or identical items. Various embodiments may utilize elements and/or components other than those illustrated in the drawings, and some elements and/or components may not be present in various embodiments. Elements and/or components in the figures are not necessarily drawn to scale. Throughout this disclosure, depending on the context, singular and plural terminology may be used interchangeably.
(2) FIG. **1** depicts an example environment in which techniques and structures for providing the systems and methods disclosed herein may be implemented.
(3) FIG. **2** depicts a block diagram of an example system to facilitate vehicle users to exit from a vehicle in accordance with the present disclosure.
(4) FIG. **3** depicts a first example display from Augmented Reality (AR) eyeglasses in accordance with the present disclosure.
(5) FIG. **4** depicts a second example display from Augmented Reality (AR) eyeglasses in accordance with the present disclosure.
(6) FIG. **5** depicts a flow diagram of an example method to facilitate vehicle users to exit from a vehicle in accordance with the present disclosure.
DETAILED DESCRIPTION
Overview
(7) The present disclosure describes a vehicle and a user device configured to facilitate vehicle occupants to conveniently exit from the vehicle. The user device may be, for example, Augmented Reality (AR) eyeglasses (or AR glasses) that the vehicle occupants may wear. The vehicle may be configured to detect an object presence in proximity to the vehicle when the object may be approaching towards the vehicle or a vehicle door. For example, the vehicle may be configured to detect that a motorist may be approaching towards a passenger door from a vehicle rear side. Responsive to detecting the motorist presence in proximity to the vehicle, the vehicle may determine object/motorist information. The motorist information may include, for example, a real-time motorist location relative to the vehicle, speed and direction of motorist movement, and/or a motorist image. Responsive to determining the motorist information, the vehicle may transmit the motorist information to the AR glasses (e.g., the AR glasses worn by a passenger sitting adjacent to the passenger door).
(8) The AR glasses may obtain the motorist information and determine a location of a vehicle door towards which the motorist may be approaching, based on the motorist information. For example, the AR glasses may determine a passenger door location in the vehicle towards which the motorist may be approaching based on the motorist information. In some aspects, the AR glasses may

determine the passenger door location in an AR or virtual space associated with the AR glasses in a vehicle interior portion.
(9) Responsive to determining the passenger door location, the AR glasses may output the passenger door location so that the passenger may know that the motorist may be approaching towards the passenger door. In this case, the passenger may not open the passenger door till the motorist crosses the passenger door. In this manner, the AR glasses may assist the passenger in conveniently exiting the vehicle, even when the passenger may not see the motorist in passenger's direct line of sight.
(10) In some aspects, the AR glasses may output the passenger door location by overlaying a passenger door digital image on a display screen associated with the AR glasses. The AR glasses may further cause the passenger door digital image to illuminate in a predetermined pattern based on motorist speed and location in proximity to the passenger door, to accordingly alert the passenger. In further aspects, the AR glasses may output the motorist image on the display screen. In additional aspects, the AR glasses may output the passenger door location via an audible signal output from an AR glasses speaker. The AR glasses may further output a haptic feedback to alert the passenger.
(11) The present disclosure discloses a vehicle and a user device that may facilitate vehicle occupants to conveniently exit from the vehicle. The vehicle may transmit the motorist information to the AR glasses even when the vehicle ignition may be switched OFF, thereby enabling the AR glasses to alert the vehicle occupants even when the vehicle's power may be OFF. Further, the vehicle and the user device may enable even those occupants who may be sitting in sitting areas located in a middle row or a back row of the vehicle interior portion to be aware of an approaching object/motorist, thereby enabling their convenient exit from the vehicle.
(12) These and other advantages of the present disclosure are provided in detail herein.
ILLUSTRATIVE EMBODIMENTS
(13) The disclosure will be described more fully hereinafter with reference to the accompanying drawings, in which example embodiments of the disclosure are shown, and not intended to be limiting.
(14) FIG. **1** depicts an example environment **100** in which techniques and structures for providing the systems and methods disclosed herein may be implemented. The environment **100** may include a vehicle **102** that may be parked (or in a stationary state) on a parking spot **104** on a road. The vehicle **102** may take the form of any passenger or commercial vehicle such as, for example, a car, a work vehicle, a crossover vehicle, a truck, a van, a minivan, a taxi, a bus, etc. The vehicle **102** may be a manually driven vehicle, and/or may be configured to operate in a partially or fully autonomous mode.
(15) In some aspects, one or more occupants may be sitting in the vehicle **102** (e.g., in a vehicle interior portion). For example, as shown in FIG. **1**, a driver **106** may be sitting in a driver sitting area and a passenger **108** may be sitting in a sitting area behind the driver sitting area inside the vehicle **102**. Example sitting arrangement of the driver **106** and the passenger **108** shown in FIG. **1** should not be construed as limiting. The passenger **108** may be sitting anywhere in the vehicle **102** relative to the driver **106** without departing from the present disclosure scope.
(16) The driver **106** and the passenger **108** may be associated with respective user devices, which may be, for example, mobile phones, tablets, wearable devices such as smartwatches or Augmented Reality (AR) eyeglasses (AR glasses), or any other device with communication capabilities. In the exemplary aspect depicted in FIG. **1**, the driver **106** may be wearing driver AR glasses **110** and the passenger **108** may be wearing passenger AR glasses **112**. The driver and passenger AR glasses **110**, **112** may be configured to communicatively couple with the vehicle **102** (e.g., when the driver **106** and the passenger **108** may be sitting inside the vehicle **102**) and may output one or more notifications based on signals/information/data received from the vehicle **102**. The driver and passenger AR glasses **110**, **112** may output the notifications as AR images overlaid or “augmented”

on real-life view of vehicle's surrounding that the driver **106**/passenger **108** may be viewing via respective driver and passenger AR glasses **110**, **112**, or output the notifications as audible and/or haptic signals. A person ordinarily skilled in the art may appreciate that in the driver and passenger AR glasses **110**, **112**, the glasses themselves act as display screens on which the AR images may be displayed or overlaid as notifications for the wearer (e.g., the driver **106**/passenger **108**).

(17) The environment **100** may further include a motorist who may be driving a motorbike (collectively referred to as a motorist **114** in the present disclosure) in proximity to the vehicle **102** and approaching towards one or more vehicle doors, e.g., a driver door **116** and/or a passenger door **118**. The motorist **114** is illustrated as an example in FIG. **1** and should not be construed as limiting. The motorist **114** may be replaced by any other object or another vehicle that may be located in proximity to the vehicle **102** and approaching towards the driver door **116** and/or the passenger door **118**.

(18) In the exemplary aspect depicted in FIG. **1**, the motorist **114** may be approaching the driver door **116** and/or the passenger door **118** from a vehicle rear side, and hence the driver **106** and/or the passenger **108** may not be aware of motorist's approach towards respective doors. To make the driver **106** and/or the passenger **108** aware of motorist's approach towards the driver door **116** and/or the passenger door **118**, the vehicle **102** may be configured to determine and transmit motorist information (or object information) to the driver and passenger AR glasses **110**, **112**. The driver and passenger AR glasses **110**, **112** may be configured to determine a vehicle door (e.g., the driver door **116** and/or the passenger door **118**) towards which the motorist **114** may be approaching based on the motorist information, and output a notification on the driver and/or passenger AR glasses **110**, **112** including the location of the determined vehicle door. The notification may further include information associated with the motorist **114**, e.g., a motorist type (e.g., whether a car, a bus, a motorbike, etc. may be approaching the vehicle door), motorist's approach speed and/or direction towards the vehicle door, and/or the like. The notification may be output in the form of an AR image overlaid on the display screen of the driver and/or passenger AR glasses **110**, **112**, and/or an audible signal or a haptic feedback. The driver **106** and/or the passenger **108** may view/hear the notification, and may accordingly open the vehicle door when the motorist **114** may have crossed the vehicle door to conveniently exit from the vehicle **102**. In this manner, the vehicle **102** and the driver and/or passenger AR glasses **110**, **112** assist the driver **106** and/or the passenger **108** to be aware of the approaching motorist **114**, even if the driver **106** and/or the passenger **108** are not able to directly view the motorist **114** in their respective lines of sight.

(19) The motorist information described above may include a motorist image, a motorist speed towards the vehicle **102**, a motorist movement direction towards the vehicle **102**, a motorist real-time location in proximity to the vehicle **102**, and/or the like. In some aspects, the vehicle **102** may determine the motorist information based on inputs obtained from a vehicle detection unit (shown as detection unit **210** in FIG. **2**), which may include one or more Radio Detection and Ranging (Radar) sensors, Light Detection and Ranging (lidar) sensors, vehicle cameras, and/or the like. In some aspects, the detection unit may be configured to detect the motorized information described above even when a vehicle ignition associated with the vehicle **102** may be switched OFF or in an “OFF state”. Further, the vehicle **102** may be configured to transmit the motorized information to the driver and/or passenger AR glasses **110**, **112** even when the vehicle ignition may be switched OFF. In this manner, the driver and/or passenger AR glasses **110**, **112** may receive the motorized information and accordingly output the notification for the driver **106** and/or the passenger **108** irrespective of the vehicle operational state.

(20) The details of the vehicle **102**, the driver and/or passenger AR glasses **110**, **112**, and the process of outputting the notification are described below in conjunction with FIG. **2**.

(21) The vehicle **102**, the driver and passenger AR glasses **110**, **112**, the driver **106** and the passenger **108** implement and/or perform operations, as described here in the present disclosure, in accordance with the owner manual and safety guidelines. In addition, any action taken by the driver

106 or the passenger **108** should comply with all the rules specific to the location and operation of the vehicle **102** (e.g., Federal, state, country, city, etc.). The notifications or recommendations, as provided by the vehicle **102**, and the driver and/or passenger AR glasses **110**. **112**, should be treated as suggestions and only followed according to any rules specific to the location and operation of the vehicle **102**.

(22) FIG. **2** depicts a block diagram of an example system **200** to facilitate vehicle users (the driver **106** and/or the passenger **108**) to exit from the vehicle **102** in accordance with the present disclosure. While describing FIG. **2**, references will be made to FIGS. **3** and **4**. FIG. **2** is described by taking the passenger **108** as an example or from the context of the passenger **108**; however, the same system **200** and the description described below are applicable to the driver **106**.

(23) The system **200** may include the vehicle **102**, a user device **202**, and one or more servers **204** (or server **204**) communicatively coupled with each other via one or more networks **206** (or network **206**). The user device **202** may a mobile phone, a tablet, a wearable device such as a smartwatch or Augmented Reality (AR) eyeglasses (AR glasses), or any other device with communication capabilities associated with the passenger **108**. For the sake of the description of FIG. **2**, the user device **202** is assumed to be the passenger AR glasses **112** associated with the passenger **108**.

(24) The server **204** may be part of a cloud-based computing infrastructure and may be associated with and/or include a Telematics Service Delivery Network (SDN) that provides digital data services to the vehicle **102** and other vehicles (not shown in FIG. **2**) that may be part of the vehicle fleet. In further aspects, the server **204** may be configured to store 3-Dimensional (3D) digital images of vehicle interior portions associated with a plurality of vehicles (including a 3D digital image of a vehicle interior portion associated with the vehicle **102**), and a plurality of digital images (or “digital twins”) associated with a plurality of vehicle components as visible from the vehicle interior portions. For example, the server **204** may store digital images of the driver door **116**, the passenger door **118**, and other vehicle doors/components as visible from the vehicle interior portion associated with the vehicle **102**. The server **204** may be configured to transmit, via the network **206**, the 3D digital image of the vehicle interior portion associated with the vehicle **102** (or vehicle interior portion 3D image) and the vehicle component digital images (e.g., vehicle door digital images) to the user device **202** at a predefined frequency or when the user device **202** transmits a request to the server **204** to obtain the 3D/digital images described above.

(25) The network **206** illustrates an example communication infrastructure in which the connected devices discussed in various embodiments of this disclosure may communicate. The network **206** may be and/or include the Internet, a private network, public network or other configuration that operates using any one or more known communication protocols such as, for example, transmission control protocol/Internet protocol (TCP/IP), Bluetooth®, BLE, Wi-Fi based on the Institute of Electrical and Electronics Engineers (IEEE) standard 802.11, ultra-wideband (UWB), and cellular technologies such as Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA), High-Speed Packet Access (HSPDA), Long-Term Evolution (LTE), Global System for Mobile Communications (GSM), and Fifth Generation (5G), to name a few examples.

(26) The vehicle **102** may include a plurality of units/modules including, but not limited to, a vehicle communication module **208**, a detection unit **210** (or a “situation sensing” unit), a vehicle control unit (VCU) **212**, a vehicle memory **214**, and a vehicle processor **216** (or a “situation determination” unit), which may be communicatively coupled with each other. The vehicle communication module **208** may be configured to communicatively pair or couple the vehicle **102** with one or more external devices or systems, e.g., the user device **202** via the network **206**. The vehicle communication module **208** may be additionally configured to receive/transmit data/information/signals from/to external systems and devices via the network **206**. For example, the vehicle communication module **208** may transmit or receive information/signals to/from the user device **202** and/or the server **204**. The vehicle communication module **208** may be further

configured to transmit/receive signals/information to/from the vehicle units described above.
(27) The detection unit **210** may include a plurality of vehicle sensors including, but not limited to, Radio Detection and Ranging (Radar) sensors, Light Detection and Ranging (lidar) sensors, vehicle interior and exterior cameras, and/or the like. The detection unit **210** may be configured to detect an object presence (i.e., presence of an object such as the motorist **114**) in proximity to the vehicle **102** and object information (or the motorist information, as described above in conjunction with FIG. **1**) associated with the detected object. The object information may include, but is not limited to, object location in proximity to the vehicle **102**, an object movement speed, an object movement direction, and an object image. For example, the detection unit **210** may be configured to detect a real-time motorist location relative to the vehicle **102** when the motorist **114** may be approaching towards the vehicle **102** (e.g., towards the passenger door **118**), the approach speed and direction associated with the motorist **114** relative to the vehicle **102**/passenger door **118**, and the motorist image as the motorist **114** approaches the vehicle **102**. As described above in conjunction with FIG. **1**, the motorist **114** may be approaching the vehicle **102** from the vehicle rear side.
(28) The VCU **212** may include a plurality of Electronic Control Units (ECUs, not shown) that may enable the VCU **212** to control vehicle operational aspects and implement one or more instruction sets received from the server **204** and/or the vehicle processor **216**. In some aspects, the VCU **212** may be configured to determine an operation or movement state associated with the vehicle **102**. For example, the VCU **212** may be configured to determine whether the vehicle **102** may be in motion, stationary, in a park drive mode and/or whether the vehicle ignition may be switched OFF.
(29) The vehicle processor **216** may utilize the vehicle memory **214** to store programs in code and/or to store data for performing operations in accordance with the present disclosure. The vehicle memory **214** may be a non-transitory computer-readable storage medium or memory storing the program codes that may enable the vehicle processor **216** to perform operations in accordance with the present disclosure. The vehicle memory **214** may include any one or a combination of volatile memory elements (e.g., dynamic random-access memory (DRAM), synchronous dynamic random-access memory (SDRAM), etc.) and may include any one or more nonvolatile memory elements (e.g., erasable programmable read-only memory (EPROM), flash memory, electronically erasable programmable read-only memory (EEPROM), programmable read-only memory (PROM), etc.).
(30) The user device **202** may include a plurality of units/modules including, but not limited to, a device communication module **218**, a device processor **220**, a device memory **222**, a display screen **224** and a speaker **226**, communicatively coupled with each other. The device communication module **218** may be configured to communicatively pair or couple the user device **202** with one or more external devices or systems, e.g., the vehicle **102** via the network **206**. In an exemplary aspect, the device communication module **218** may be configured to communicatively couple with the vehicle **102** when the user device **202** may be disposed within a predefined distance of the vehicle **102**. For example, when the user device **202** is the passenger AR glasses **112**, the device communication module **218** may communicatively couple the user device **202** with the vehicle **102** when the passenger **108** may be sitting inside the vehicle **102** wearing the passenger AR glasses **112**, or the user device **202** may be located in the vehicle interior portion.
(31) In some aspects, the vehicle communication module **208** and the device communication module **218** may enable pairing or coupling of the vehicle **102** and the user device **202** by exchanging predefined identifiers (e.g., vehicle and/or user device identifiers) and/or authentication codes that may be pre-stored in the vehicle memory **214** and the device memory **222**. The vehicle communication module **208** and the device communication module **218** pairs or couples the vehicle **102** and the user device **202** using known pairing technologies, and hence are not described here in detail.
(32) As described above in conjunction with FIG. **1**, when the user device **202** is the passenger AR glasses **112**, the display screen **224** may be the transparent glasses of the passenger AR glasses **112**

through which the passenger **108** may view real-life objects (e.g., vehicle components or real-life objects located in proximity to the vehicle **102**) or on which one or more AR images (or notifications) may be displayed for the passenger **108**. The speaker **226** may be configured to audibly output messages or notifications (e.g., notifications received from the vehicle **102**, the server **204** and/or the device processor **220**).

(33) The device processor **220** may utilize the device memory **222** to store programs in code and/or to store data for performing operations in accordance with the present disclosure. The device memory **222** may be a non-transitory computer-readable storage medium or memory storing the program codes that may enable the device processor **220** to perform operation in accordance with the present disclosure. The device memory **222** may include any one or a combination of volatile memory elements (e.g., dynamic random-access memory (DRAM), synchronous dynamic random-access memory (SDRAM), etc.) and may include any one or more nonvolatile memory elements (e.g., erasable programmable read-only memory (EPROM), flash memory, electronically erasable programmable read-only memory (EEPROM), programmable read-only memory (PROM), etc.).

(34) In some aspects, the device memory **222** may include a plurality of modules and databases including, but not limited to, a display module **228**, a location determination module **230**, a space alignment module **232** and a 3D image database **234**. The 3D image database **234** may be configured to store the vehicle interior portion 3D image(s) associated with the vehicle **102** and the vehicle component digital images (or the vehicle door digital images) that the user device **202** may receive, via the device communication module **218**, from the server **204**, as described above.

(35) The display module **228**, the location determination module **230** and the space alignment module **232**, as described herein, may be stored in the form of computer-executable instructions, and the device processor **220** may be configured and/or programmed to execute the stored computer-executable instructions for performing operations in accordance with the present disclosure.

(36) In operation, when the passenger **108** enters the vehicle **102** or may be sitting inside the vehicle **102** wearing the user device **202**/passenger AR glasses **112**, the device communication module **218** and the vehicle communication module **208** may pair with each other to enable pairing/coupling of the user device **202** and the vehicle **102**. Responsive to the user device **202** and the vehicle **102** coupling with each other, the device processor **220** may execute instructions stored in the space alignment module **232** to “align” a user device coordinate system (i.e., a coordinate system in an AR space associated with the passenger AR glasses **112**) with a vehicle interior portion coordinate system. In this case, responsive to the user device **202** and the vehicle **102** coupling with each other, the device processor **220** may first obtain the vehicle interior portion 3D image(s) associated with the vehicle **102** from the 3D image database **234** and align the respective coordinate systems of the user device **202** and the vehicle interior portion based on the vehicle interior portion 3D image(s).

(37) In some aspects, the device processor **220** may align the coordinate systems described above by using an image marker having a fixed relationship with the vehicle interior portion. For example, the device processor **220** may transmit a visual and/or audible request, e.g., via the speaker **226**, to the passenger **108** to look at a fixed point (e.g., a vehicle steering wheel, a vehicle infotainment system, etc.) in the vehicle interior portion. When the passenger **108** looks at the fixed point through the user device **202**, the device processor **220** may determine a user device line of sight and may correlate the user device line of sight with the vehicle interior portion 3D image(s) obtained from the 3D image database **234** to align the coordinate systems associated with the user device **202** and the vehicle **102**. For example, by using the user device line of sight, the device processor **220** may determine where in the user device line of sight are different vehicle components (e.g., the vehicle steering wheel, the vehicle infotainment system, the passenger door **118**, and/or the like) located. Based on such determination and the vehicle interior portion 3D image(s), the device processor **220** may align coordinate systems associated with the user device

202 and the vehicle interior portion. In some aspects, the device processor **220** may align the coordinate systems to determine a user device location within the vehicle interior portion where the user device **202** may be located (and hence where the passenger **108** may be sitting). For example, based on the alignment described above, the device processor **220** may determine that the user device **202** (and hence the passenger **108**) may be located in the sitting area behind the driving sitting area, as shown in FIG. **1** (or adjacent to the passenger door **118**).

(38) In other aspects, the device processor **220** may align the coordinate systems described above by using known algorithms or methods such as simultaneous localization and mapping (SLAM) method/algorithm (that may be pre-stored in the space alignment module **232**). By using the SLAM method, the device processor **220** may match the user device coordinate system with the vehicle interior portion's geometry, as described above.

(39) In further aspects, responsive to the user device **202** and the vehicle **102** pairing/coupling with each other, the vehicle processor **216** may obtain the object information (or the motorist information, as described above) from the detection unit **210**. In some aspects, the vehicle processor **216** may obtain the object information from the detection unit **210** when the detection unit **210** detects the object presence (or the motorist presence) in proximity to the vehicle **102**. In further aspects, the vehicle processor **216** may obtain the object information from the detection unit **210** when the vehicle **102** may be stationary or parked, and/or when the vehicle ignition may be switched OFF or in the OFF state. The vehicle processor **216** may determine vehicle's operational or movement state (i.e., whether the vehicle **102** may be in motion or stationary, in a park drive mode and/or whether the vehicle ignition may be switched OFF) based on inputs obtained from the VCU **212**.

(40) Responsive to obtaining the object information, the vehicle processor **216** may determine that the object/motorist **114** may be approaching towards a vehicle door (e.g., the passenger door **118**) based on the object information. For example, the vehicle processor **216** may determine that the motorist **114** may be approaching towards the passenger door **118** from the vehicle rear side based on the motorist location in proximity to the vehicle **102**, and/or motorist's speed and direction of movement relative to the vehicle **102**. Responsive to determining that the object may be approaching towards the passenger door **118**, the vehicle processor **216** may output/transmit, via the vehicle communication module **208**, the object information to the user device **202** (specifically to the device communication module **218**) via the network **206**.

(41) The device communication module **218** may receive the object information from the vehicle communication module **208** and may transmit the received object information to the device processor **220**. The device processor **220** may obtain the object information from the device communication module **218** and may execute the instructions stored in the location determination module **230** to determine a vehicle door location associated with the vehicle door (towards which the object may be approaching) in the vehicle interior portion based on the obtained object information. For example, based on the motorist image and/or direction and speed of motorist movement, the device processor **220** may determine that the motorist **114** may be approaching towards the passenger door **118**. Responsive to determining that the motorist **114** may be approaching the passenger door **118**, the device processor **220** may determine a “passenger door location” in the AR space associated with the user device **202**/passenger AR glasses **112** based on the vehicle interior portion 3D image and the user device location in the vehicle interior portion (that the device processor **220** determines while aligning the coordinate systems associated with the user device **202** and the vehicle interior portion, as described above).

(42) Responsive to determining the passenger door location, the device processor **220** may output the passenger door location to indicate to the passenger **108** that the object/motorist **114** may be approaching the passenger door **118** (and hence the passenger **108** should not open the passenger door **118** to exit the vehicle **102**). In some aspects, the device processor **220** may output the passenger door location via an audible signal output from the speaker **226**. For example, the device

processor **220** may output an audible signal stating, "A motorist is approaching from behind. Do not open your door", from the speaker **226** to enable the passenger **108** to hear the signal and not open the passenger door **118** till the object/motorist **114** crosses the passenger door **118**. In this manner, the device processor **220** may enable the passenger **108** to know about the motorist approach towards the passenger door **118**, even when the motorist **114** may not be in line of sight of the passenger **108**.

(43) In further aspects, the device processor **220** may execute the instructions stored in the display module **228** and output the passenger door location on the display screen **224**. In an exemplary aspect, the device processor **220** may output the passenger door location on the display screen **224** by overlaying the passenger door digital image (that the device processor **220** may obtain from the 3D image database **234**) on the display screen **224** based on the user device location in the vehicle interior portion and the passenger door location. For example, when the user device location may be the sitting area behind the driver sitting area and the object/motorist **114** may be approaching towards the passenger door **118**, the device processor **220** may determine that the passenger door **118** may be located towards a left side corner of the display screen **224** when the passenger **108** may be viewing through the user device **202**/passenger AR glasses **112**, and may accordingly overlay a passenger door digital image **302** towards the left side corner of the display screen **224**, as shown in FIG. **3**. Since the coordinate systems associated with the user device **202** and the vehicle interior portion are aligned, the passenger door digital image **302** may be overlaid at an "actual" position where the physical passenger door **118** may be located in the vehicle interior portion. In an exemplary aspect, the passenger door digital image **302** may have same shape and size as the physical passenger door **118**.

(44) In some aspects, the device processor **220** may additionally cause the passenger door digital image **302** to illuminate in a predefined pattern based on the object information. For example, if the object may be travelling at a high speed towards the passenger door **118** or may be very near to (or within a predefined threshold distance from) the passenger door **118**, the device processor **220** may cause the passenger door digital image **302** to illuminate and flash at a predefined frequency to inform/alert the passenger **108** about the approaching object. As another example, based on the distance from the passenger door **118** and/or the approach speed, the device processor **220** may cause the passenger door digital image **302** to illuminate in red, yellow or green colors (or any other predetermined colors). In further aspects, the device processor **220** may overlay an indicator **304** on the display screen **224** indicating object/motorist's direction of movement to the passenger **108**, as shown in FIG. **3**.

(45) FIG. **3** depicts just one example aspect or way of outputting the passenger door location on the display screen **224**. In other aspects, the device processor **220** may overlay another type of indicator (e.g., an arrow **402**, as shown in FIG. **4**) on the display screen **224** to indicate the passenger door location to the passenger **108**. In further aspects, the device processor **220** may overlay an object/motorist image **404** (that may be part of the object information obtained from the vehicle **102**) on the display screen **224**, as shown in FIG. **4**. In yet another aspect, the device processor **220** may overlay a graphical representation of the motorist **114** on the display screen **224**. In this case as well, the arrow **402**, the object image **404** and/or the graphical representation may illuminate in a predefined pattern and/or color based on the object information. In some aspects, the device processor **220** may further increase or decrease the size of the arrow **402**/object image **404** based on the object's distance from the passenger door **118** and/or the object's approach speed. The device processor **220** may further output haptic feedback or vibration based on the object's distance from the passenger door **118** and/or the object's approach speed.

(46) Since the coordinate systems associated with the user device **202** and the vehicle interior portion are aligned, only "relevant" occupants in the vehicle interior portion may receive or view the passenger door location. For example, an occupant sitting adjacent to the passenger **108** and exiting the vehicle **102** from a vehicle door opposite to the passenger door **118** may not view the

passenger door location on respective user device, as the object/motorist **114** may be approaching towards the passenger door **118** and not the opposite vehicle door. On the other hand, if the motorist **114** may be approaching the driver door **116**, the driver AR glasses **110** may output the driver door location, so that the driver **106** may know about the approach of the motorist **114** towards the driver door **116**.

(47) FIG. **5** depicts a flow diagram of an example method **500** to facilitate vehicle users to exit from the vehicle **102** in accordance with the present disclosure. FIG. **5** may be described with continued reference to prior figures. The following process is exemplary and not confined to the steps described hereafter. Moreover, alternative embodiments may include more or less steps than are shown or described herein and may include these steps in a different order than the order described in the following example embodiments.

(48) The method **500** starts at step **502**. At step **504**, the method **500** may include obtaining, by the vehicle processor **216**, the object information from the detection unit **210** when the detection unit **210** detects the object presence in proximity to the vehicle **102**. At step **506**, the method **500** may include determining, by the vehicle processor **216**, that the object/motorist **114** may be approaching towards the passenger door **118** based on the object information. At step **508**, the method **500** may include outputting, by the vehicle processor **216**, the object information to the user device **202** responsive to determining that the object/motorist **114** may be approaching towards the passenger door **118**.

(49) As described above, responsive to obtaining the object information from the vehicle **102**/vehicle processor **216**, the user device **202** may determine and output the passenger door location for the passenger **108**. The passenger **108** may view/hear the notification including the passenger door location and may accordingly decide not to open the passenger door **118** till the motorist **114** crosses the passenger door **118**.

(50) The method **500** ends at step **510**.

(51) In the above disclosure, reference has been made to the accompanying drawings, which form a part hereof, which illustrate specific implementations in which the present disclosure may be practiced. It is understood that other implementations may be utilized, and structural changes may be made without departing from the scope of the present disclosure. References in the specification to “one embodiment,” “an embodiment,” “an example embodiment,” etc., indicate that the embodiment described may include a particular feature, structure, or characteristic, but every embodiment may not necessarily include the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. Further, when a feature, structure, or characteristic is described in connection with an embodiment, one skilled in the art will recognize such feature, structure, or characteristic in connection with other embodiments whether or not explicitly described.

(52) Further, where appropriate, the functions described herein can be performed in one or more of hardware, software, firmware, digital components, or analog components. For example, one or more application specific integrated circuits (ASICs) can be programmed to carry out one or more of the systems and procedures described herein. Certain terms are used throughout the description and claims refer to particular system components. As one skilled in the art will appreciate, components may be referred to by different names. This document does not intend to distinguish between components that differ in name, but not function.

(53) It should also be understood that the word “example” as used herein is intended to be non-exclusionary and non-limiting in nature. More particularly, the word “example” as used herein indicates one among several examples, and it should be understood that no undue emphasis or preference is being directed to the particular example being described.

(54) A computer-readable medium (also referred to as a processor-readable medium) includes any non-transitory (e.g., tangible) medium that participates in providing data (e.g., instructions) that may be read by a computer (e.g., by a processor of a computer). Such a medium may take many

forms, including, but not limited to, non-volatile media and volatile media. Computing devices may include computer-executable instructions, where the instructions may be executable by one or more computing devices such as those listed above and stored on a computer-readable medium.
(55) With regard to the processes, systems, methods, heuristics, etc. described herein, it should be understood that, although the steps of such processes, etc. have been described as occurring according to a certain ordered sequence, such processes could be practiced with the described steps performed in an order other than the order described herein. It further should be understood that certain steps could be performed simultaneously, that other steps could be added, or that certain steps described herein could be omitted. In other words, the descriptions of processes herein are provided for the purpose of illustrating various embodiments and should in no way be construed so as to limit the claims.
(56) Accordingly, it is to be understood that the above description is intended to be illustrative and not restrictive. Many embodiments and applications other than the examples provided would be apparent upon reading the above description. The scope should be determined, not with reference to the above description, but should instead be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. It is anticipated and intended that future developments will occur in the technologies discussed herein, and that the disclosed systems and methods will be incorporated into such future embodiments. In sum, it should be understood that the application is capable of modification and variation.
(57) All terms used in the claims are intended to be given their ordinary meanings as understood by those knowledgeable in the technologies described herein unless an explicit indication to the contrary is made herein. In particular, use of the singular articles such as “a,” “the,” “said,” etc. should be read to recite one or more of the indicated elements unless a claim recites an explicit limitation to the contrary. Conditional language, such as, among others, “can,” “could,” “might,” or “may,” unless specifically stated otherwise, or otherwise understood within the context as used, is generally intended to convey that certain embodiments could include, while other embodiments may not include, certain features, elements, and/or steps. Thus, such conditional language is not generally intended to imply that features, elements, and/or steps are in any way required for one or more embodiments.

Claims

1. A user device comprising: a communication module configured to receive object information from a vehicle, wherein the communication module receives the object information indicative that an object is likely to pass the vehicle within a predetermined distance of the vehicle; and a device processor communicatively coupled with the communication module, wherein the device processor is configured to: obtain the object information from the communication module; determine a vehicle door location associated with a vehicle door in a vehicle interior portion based on the object information; and output an alert overlay of the vehicle door at the vehicle door location to indicate that the object is approaching towards the vehicle door, wherein the user device is Augmented Reality (AR) eyeglasses; a display screen, wherein the device processor presents the alert overlay of the vehicle door on the display screen; a device memory configured to store a vehicle interior portion 3-Dimensional (3D) image, wherein the communication module is further configured to communicatively couple the user device with the vehicle when the user device is located in the vehicle interior portion, wherein the device processor is further configured to: obtain the vehicle interior portion 3D image from the device memory when the user device communicatively couples with the vehicle; align a user device coordinate system with a vehicle interior portion coordinate system based on the vehicle interior portion 3D image; determine a user device location in the vehicle interior portion based on the alignment; and present the alert overlay of the vehicle door on the display screen based on the vehicle door location and the user device location.

2. The user device of claim 1, wherein the object information comprises at least one of an object location in proximity to the vehicle, an object movement speed, an object movement direction, or an object image.
3. The user device of claim 1, wherein the device processor is further configured to illuminate the alert overlay of the vehicle door in a predefined pattern based on the object information.
4. The user device of claim 1, wherein the device processor is further configured to include a digital image of the object in the alert based on the object information.
5. The user device of claim 1 further comprising a speaker, wherein the device processor outputs an audible signal output from a speaker of the user device indicative of the object.