SYSTEMS AND METHODS FOR PREVENTING DOOR DINGS

Abstract

A first vehicle including a detection unit, a transceiver and a processor is disclosed. The detection unit may be configured to detect a distance between the first vehicle and a second vehicle located adjacent to the first vehicle. The transceiver may be configured to receive a second vehicle door dimension. The processor may be configured to compare the distance with the second vehicle door dimension, and determine that the second vehicle door dimension may be greater than the distance. Responsive to determining that the second vehicle door dimension may be greater than the distance, the processor may control an operation of a first vehicle component.

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Background/Summary

[0001] The present disclosure relates to systems and methods for preventing door dings in parked vehicles using vehicle running boards.

BACKGROUND

[0002] There are known instances of parked vehicles getting door dents or dings when doors of adjacent vehicles contact the parked vehicle's body. Door dings are particularly challenging to repair when an operator of an adjacent vehicle opens the vehicle door by force, thereby causing considerable dent to the parked vehicle's body. Such instances may cause inconvenience to the operator or users associated with the parked vehicle. Currently, there are limited means to prevent door dings from occurring, when the vehicle may be located in a parking lot with multiple vehicles parked adjacent to each other.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] 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.

[0004] FIG. **1** depicts an example environment in which techniques and structures for providing the systems and methods disclosed herein may be implemented.

[0005] FIG. **2** depicts a block diagram of an example system for preventing door dings in accordance with the present disclosure.

[0006] FIG. **3** depicts an example snapshot of a vehicle right running board in an extended position in accordance with the present disclosure.

[0007] FIG. **4** depicts an example snapshot of a vehicle left running board in an extended position in accordance with the present disclosure.

[0008] FIG. **5** depicts an example snapshot of two vehicles of different heights in accordance with the present disclosure.

[0009] FIG. **6** depicts a flow diagram of an example method for preventing door dings in accordance with the present disclosure.

DETAILED DESCRIPTION

Overview

[0010] The present disclosure describes a vehicle (e.g., a first vehicle) configured to prevent door dings/dents by shielding the vehicle's doors/body by using vehicle's running boards. The running boards may be configured to move between a retracted position and an extended position. The running boards may shield the vehicle's doors/body from opening doors of other vehicles (e.g., a second vehicle) parked adjacent to the first vehicle, when the running boards may be disposed in the extended position. In some aspects, when a door associated with the second vehicle may be opening, the opening door may contact the first vehicle's running board instead of contacting the first vehicle's doors/body, thereby preventing the first vehicle from getting dents.

[0011] In some aspects, the first vehicle may be configured to determine a distance between the adjacent sides of the first vehicle and the second vehicle, when the second vehicle may be parked adjacent to the first vehicle. The first vehicle may determine the distance by using inputs obtained from one or more sensors installed in the first vehicle. The first vehicle may further obtain dimensions/length of the door associated with the second vehicle (or "second vehicle door") from the second vehicle. In some embodiments, the door dimensions of the second vehicle may further

be determined by a process that includes, but is not limited to, use of an image captured by camera or other imaging system. Responsive to determining the distance and obtaining the second vehicle door length, the first vehicle may compare the distance with the second vehicle door length.

[0012] The first vehicle may cause the running board on the first vehicle side facing the second vehicle to move to the extended position, when the second vehicle door length may be greater than the distance between the adjacent sides of the first and second vehicles. Stated another way, the first vehicle may cause the running board to move to the extended position when a probability of the second vehicle door contacting the first vehicle body/doors may be high (e.g., during the second vehicle door opening operation). In this manner, the first vehicle prevents its body from getting dents from the opening second vehicle door.

[0013] On the other hand, the first vehicle may keep the running board in the retracted position when the second vehicle door length may be less than the distance between the adjacent sides of the first and second vehicles.

[0014] The first vehicle may be further configured to adjust the first vehicle height relative to the second vehicle height, so that both the first and second vehicles may be at equivalent heights when the first and second vehicles may be parked adjacent to each other. If the first vehicle is not configured to adjust the first vehicle height to be equivalent to the second vehicle height, the first vehicle may transmit a height adjustment notification to the second vehicle, causing the second vehicle to adjust the second vehicle height to be equivalent to the first vehicle height.

[0015] When the second vehicle door may be opening, the first vehicle may increase the first vehicle height to be greater than the second vehicle height, thereby enabling the running board associated with the first vehicle to efficiently shield the first vehicle body from the opening second vehicle door. In a similar manner, when the first vehicle door may be opening, the second vehicle may increase the second vehicle height, so that a running board associated with the second vehicle may efficiently shield the second vehicle body from the opening first vehicle door.

[0016] The present disclosure discloses a vehicle that uses the vehicle's running boards to shield its body from getting dents due to the opening doors of adjacent vehicles. The vehicle does not use external devices or structures, and instead uses in-built vehicle components to shield its body from dents. Further, the vehicle moves the running boards to the extended position (fully or partially) only when the adjacent vehicle is parked close to the vehicle and not otherwise, thereby ensuring that the running boards are not unnecessarily obstructing passage between parked vehicles.

[0017] These and other advantages of the present disclosure are provided in detail herein.

Illustrative Embodiments

[0018] 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.

[0019] 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** (or a "first vehicle") that may be located in a parking lot or a geographical area where a plurality of vehicles may be parked/located in proximity to each other. In the exemplary aspect depicted in FIG. **1**, the vehicle **102** is parked between a vehicle **104** (or a "second vehicle") and a vehicle **106** (or a third vehicle). The vehicle **104** may be located/parked adjacent to the vehicle **102** and at a right side of the vehicle **102**, and the vehicle **106** may be located/parked adjacent to the vehicle **102** and at a left side of the vehicle **102**.

[0020] Each vehicle **102**, **104**, **106** 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. Further, each vehicle **102**, **104**, **106** may be a manually driven vehicle, and/or may be configured to operate in a fully autonomous (e.g., driverless) mode or a partially autonomous mode, and may include any powertrain such as, for example, a gasoline engine, one or more electrically-actuated motor(s), a hybrid system, etc.

[0021] In some aspects, the vehicle **102** (and one or both of the vehicles **104**, **106**) may include right and left running boards **108***a*, **108***b* (collectively referred to as running boards **108**) that may be disposed on right and left body sides of the vehicle **102**, in proximity to a vehicle bottom portion/bed. A person ordinarily skilled in the art may appreciate that the running boards **108** are typically positioned/disposed on both the left and right sides of the vehicle **102** to provide assistance for the ingress and egress to/from a vehicle interior portion through a corresponding vehicle door (e.g., front and rear vehicle doors). Each running board **108** may include a generally planar upper surface configured to receive a vehicle operator or passenger's foot when the vehicle operator and/or the passenger may be entering the vehicle interior portion or exiting the vehicle **102**, thereby enabling the vehicle operator/passenger to conveniently enter/exit into/from the vehicle **102**.

[0022] In accordance with the present disclosure, each running board **108** may be configured to move between a retracted position and an extended position. In the extended position, the running board **108** may extend away from the vehicle body such that the planar upper surface of the running board **108** may be perpendicular to the vehicle height, thereby enabling the vehicle operator and/or the passenger to conveniently place the foot on the planar upper surface (to enter or exit into/from the vehicle **102**). On the other hand, in the retracted position, the running board **108** may not extend away from the vehicle body and may instead be tucked in or under the vehicle bottom portion/bed.

[0023] In some aspects, the vehicle **102** may be configured to use the running boards **108** to prevent door dings/dents on the vehicle doors/body associated with the vehicle **102** (or "vehicle **102** body"). Specifically, the vehicle **102** may move the running boards **108** to a fully extended position or a partially extended position when the vehicle **102** may be parked between one or more adjacent vehicles (e.g., the vehicles **104**, **106**) to prevent doors associated with the adjacent vehicles from contacting the vehicle **102** body when the adjacent vehicle's doors may be opening. In this case, the adjacent vehicle's doors may contact the running boards **108** in the fully or partially extended position and not contact the vehicle **102** body, thereby preventing door dings on the vehicle **102**.

[0024] In an exemplary aspect, the vehicle **102** may include a detection unit (or a vehicle sensory system, shown as vehicle sensory system **232** in FIG. **2**) that may be configured to determine a first distance "dR" between the vehicle **102** and the vehicle **104**. Specifically, the detection unit may determine the first distance "dR" between a vehicle **102** right side and a vehicle **104** left side. The vehicle **102** may further obtain a dimension or length "R" of a left vehicle door(s) **110** associated with the vehicle **104** from a server (shown as server **204** in FIG. **2**) or directly from the vehicle **104**. In some embodiments, the door dimension or length "R" of the second vehicle may further be determined by a process that includes, but is not limited to, use of an image captured by camera or other imaging system associated with the vehicle **102**. In some aspects, the length "R" may be the vehicle door length from the vehicle body when the left vehicle door **110** may be in a fully open state.

[0025] Responsive to obtaining the length "R" and determining the first distance "dR", the vehicle **102** may compare "R" with "dR". The vehicle **102** may cause the right running board **108***a* to move to the fully or partially extended position when "R" may be greater than "dR". Stated another way, when the distance between the vehicles **102** and **104** may be less than the left vehicle door **110** length, the vehicle **102** may cause the right running board **108***a* to move to the fully or partially extended position. In the fully or partially extended position, the right running board **108***a* may shield the right vehicle doors/body and/or a right side rearview mirror **112** associated with the vehicle **102** from getting in contact with the left vehicle door **110**, when the left vehicle door **110** may be opening. In this case, the left vehicle door **110** may contact the right running board **108***a* (instead of contact to the vehicle **102** right vehicle doors/body and/or the right side rearview mirror **112**), thereby potentially preventing the vehicle **102** from getting any dent. Stated another way, the

right running board **108***a* may act as a physical barrier for potential door dings on the vehicle **102** caused due to the left vehicle door **110**.

[0026] On the other hand, when the vehicle **102** determines that "R" may be less than "dR" based on the comparison described above, the vehicle **102** may not cause the right running board **108***a* to move to the fully or partially extended position, and may instead keep the right running board **108***a* in the retracted position. A person ordinarily skilled in the art may appreciate that in this case, the left vehicle door **110** may not contact the vehicle **102** right vehicle doors/body and/or the right side rearview mirror **112** even when the left vehicle door **110** may be fully opened. Therefore, in this case, the vehicle **102** may keep the right running board **108***a* in the retracted position, to ensure that the right running board **108***a* does not unnecessarily obstruct passage between the vehicles **102** and **104**.

[0027] In a similar manner, the detection unit may determine a second distance "dL" between the vehicles **102** and **106** (specifically between a vehicle **102** left side and a vehicle **106** right side), and the vehicle **102** may obtain a dimension or length "L" of a right vehicle door(s) **114** associated with the vehicle **106** from the server or directly from the vehicle **106**. The vehicle **102** may then compare "L" with "dL", and may move the left running board **108***b* to the fully or partially extended position to shield the vehicle **102** left vehicle doors/body and/or a left side rearview mirror **116** when "L" may be greater than "dL", in the similar manner as described above. On the other hand, when "L" may be less than "dL", the vehicle **102** may not cause the left running board **108***b* to move to the fully or partially extended position.

[0028] A person ordinarily skilled in the art may appreciate from the description above that the vehicle **102** may independently move the right and left running boards **108***a*, **108***b* based on "R", "dR", "L" and "dL". Stated another way, the vehicle **102** may have both the running boards **108***a*, **108***b* extended at the same time, or may have only one running board extended at a particular time, based on "R", "dR", "L" and "dL".

[0029] In some aspects, the vehicles **104** and **106** may have running boards similar to the running boards **108**, and the vehicles **104** and **106** may control movement of their respective running boards in a similar manner as described above. In further aspects, each vehicle **102**, **104**, **106** may be configured to adjust its vehicle height, so that its running boards in partially/fully extended positions may effectively shield the vehicle's body/doors from getting dents. The process of adjusting the vehicle height, and further vehicle details are described below in conjunction with FIGS. **2-5**.

[0030] The vehicles **102**, **104**, **106** 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 vehicle operator based on recommendations or notifications provided by the vehicles **102**, **104**, **106** should comply with all the rules specific to the location and operation of the vehicles **102**, **104**, **106** (e.g., Federal, state, country, city, etc.). The recommendations or notifications, as provided by the vehicles **102**, **104**, **106** should be treated as suggestions and only followed according to any rules specific to the location and operation of the vehicles **102**, **104**, **106**.

[0031] FIG. **2** depicts a block diagram of an example system **200** for preventing door dings in accordance with the present disclosure. While describing FIG. **2**, references will be made to FIGS. **3**, **4** and **5**.

[0032] The system **200** may include the vehicle **102** (or the first vehicle), the vehicle **104** (or the second vehicle), the vehicle **106** (or the third vehicle), 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 be associated with the vehicle operator/user of the vehicle **102**, and may be, for example, a mobile phone, a laptop, a computer, a tablet, a smartwatch, a wearable device, or any other device with communication capabilities.

[0033] 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 vehicles **102**, **104**, **106** and other vehicles (not shown) that may be part of a vehicle fleet. In further aspects, the server **204** may be configured to store vehicle dimensions associated with a plurality of vehicles (including the vehicles **102**, **104** and **106**). The vehicle dimensions may include, for example, vehicle door lengths/dimensions, vehicle height, vehicle length, and/or the like. The server **204** may be configured to transmit the vehicle dimensions to the vehicle **102**, **104** or **106**, when the respective vehicles transmit a request to the server **204** to obtain the vehicle dimensions of a particular vehicle.

[0034] 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®, Bluetooth® low Energy (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.

[0035] The vehicle **102** may include a plurality of units including, but not limited to, an automotive computer **208**, a Vehicle Control Unit (VCU) **210**, and a dent prevention unit **212** (or unit **212**). The VCU **210** may include a plurality of Electronic Control Units (ECUs) **214** disposed in communication with the automotive computer **208**.

[0036] In some aspects, the user device **202** may be configured to connect with the automotive computer **208** and/or the unit **212** via the network **206**, which may communicate via one or more wireless connection(s), and/or may connect with the vehicle **102** directly by using near field communication (NFC) protocols, Bluetooth® protocols, Wi-Fi, Ultra-Wide Band (UWB), and other possible data connection and sharing techniques.

[0037] The automotive computer **208** and/or the unit **212** may be installed anywhere in the vehicle **102**, in accordance with the disclosure. Further, the automotive computer **208** may operate as a functional part of the unit **212**. The automotive computer **208** may be or include an electronic vehicle controller, having one or more processor(s) **216** and a memory **218**. Moreover, the unit **212** may be separate from the automotive computer **208** (as shown in FIG. **2**) or may be integrated as part of the automotive computer **208**.

[0038] The processor(s) **216** may be disposed in communication with one or more memory devices disposed in communication with the respective computing systems (e.g., the memory **218** and/or one or more external databases not shown in FIG. **2**). The processor(s) **216** may utilize the memory **218** to store programs in code and/or to store data for performing operations in accordance with the disclosure. The memory **218** may be a non-transitory computer-readable storage medium or memory storing a dent prevention program code. The memory **218** 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.).

[0039] In accordance with some aspects, the VCU **210** may share a power bus with the automotive computer **208** and may be configured and/or programmed to coordinate the data between vehicle systems, connected servers (e.g., the server **204**), the user device **202**, the vehicles **104**, **106**, and/or the like. The VCU **210** may include or communicate with any combination of the ECUs **214**, such as, for example, a Body Control Module (BCM) **220**, an Engine Control Module (ECM) **222**, a Transmission Control Module (TCM) **224**, a telematics control unit (TCU) **226**, a Driver Assistances Technologies (DAT) controller **228**, etc. The VCU **210** may further include and/or

communicate with a Vehicle Perception System (VPS) **230**, having connectivity with and/or control of one or more vehicle sensory system(s) **232** (or a detection unit). The vehicle sensory system **232** may include one or more vehicle sensors including, but not limited to, a Radio Detection and Ranging (RADAR or "radar") sensor configured for detection and localization of objects inside and outside the vehicle **102** using radio waves, sitting area buckle sensors, sonar sensors, ultrasonic sensors, sitting area sensors, a Light Detecting and Ranging ("lidar") sensor, door sensors, proximity sensors, temperature sensors, wheel sensors, one or more ambient weather or temperature sensors, vehicle interior and exterior cameras, steering wheel sensors, etc. In some aspects, the vehicle sensory system **232** may be configured to determine the first distance "dR" between the vehicles **102** and **104**, and the second distance "dL" between the vehicles **102** and **106**, as described above in conjunction with FIG. **1**.

[0040] In some aspects, the VCU **210** may control vehicle operational aspects and implement one or more instruction sets received from the server **204**, the user device **202**, the vehicles **104**, **106**, from one or more instruction sets stored in the memory **218**, including instructions operational as part of the unit **212**.

[0041] The TCU **226** may be configured and/or programmed to provide vehicle connectivity to wireless computing systems onboard and off board the vehicle **102**, and may include a Navigation (NAV) receiver **234** for receiving and processing a GPS signal, a BLE® Module (BLEM) **236**, a Wi-Fi transceiver, a UWB transceiver, and/or other wireless transceivers (not shown in FIG. **2**) that may be configurable for wireless communication (including cellular communication) between the vehicle **102** and other systems (e.g., a vehicle key fob (not shown in FIG. **2**), the server **204**, the user device **202**, the vehicles **104**, **106**, etc.), computers, and modules. The TCU **226** may be disposed in communication with the ECUs **214** by way of a bus. In some aspects, the TCU **226** may be configured to determine a real-time vehicle geolocation, e.g., via the NAV receiver **234**.

[0042] The ECUs **214** may control aspects of vehicle operation and communication using inputs from human drivers, inputs from the automotive computer **208**, the unit **212**, and/or via wireless signal inputs received via the wireless connection(s) from other connected devices, such as the server **204**, the vehicles **104**, **106**, the user device **202**, among others.

[0043] The BCM **220** generally includes integration of sensors, vehicle performance indicators, and variable reactors associated with vehicle systems, and may include processor-based power distribution circuitry that may control functions associated with the vehicle body such as lights, windows, security, camera(s), audio system(s), speakers, wipers, door locks and access control, various comfort controls, the right and left running boards **108***a*, **108***b*, etc. In some aspects, the BCM **220** may be configured to move the right and left running boards **108***a*, **108***b* between the retracted position and the extended position (fully or partially extended position) based on command signals received from the processor **216** and/or the unit **212**. The BCM **220** may command solenoids or stepper motors associated with the running boards **108** to move them from the retracted position to the extended position, and vice-versa. The BCM **220** may also operate as a gateway for bus and network interfaces to interact with remote ECUs (not shown in FIG. **2**).

[0044] As described above in conjunction with FIG. **1**, the right and left running boards **108***a*, **108***b* may be configured to move between a retracted position and an extended position (e.g., a fully extended or a partially extended position). In some aspects, the right running board **108***a* may extend away from a right side body of the vehicle **102**, shielding the vehicle's right side body/doors and/or the right side rearview mirror **112** from door dents/dings or preventing the left vehicle door **110** from contacting the vehicle **102** body, when the right running board **108***a* may be in the extended position (partially or fully). In this case (i.e., in the extended position), the left vehicle door **110** may contact the right running board **108***a* (instead of contacting the vehicle **102** body and/or the right side rearview mirror **112**) when the left vehicle door **110** may open, thereby preventing the vehicle **102** from getting dents. On the other hand, the right running board **108***a* may not extend away from the right side body of the vehicle **102** when the right running board **108***a*

may be in the retracted position.

[0045] In a similar manner, the left running board **108***b* may extend away from a left side body of the vehicle **102**, shielding the vehicle's left side body/doors and/or the left side rearview mirror **116** from door dents/dings or preventing the right vehicle door **114** from contacting the vehicle **102** body, when the left running board **108***b* may be in the extended position (partially or fully). In this case (i.e., in the extended position), the right vehicle door **114** may contact the left running board **108***b* (instead of contacting the vehicle **102** body and/or the left side rearview mirror **116**) when the right vehicle door **114** may open, thereby preventing the vehicle **102** from getting dents. On the other hand, the left running board **108***b* may not extend away from the left side body of the vehicle **102** when the left running board **108***b* may be in the retracted position.

[0046] The DAT controller **228** may provide Level-1 through Level-3 automated driving and driver assistance functionality that may include, for example, active parking assistance, vehicle backup assistance, and/or adaptive cruise control, among other features. The DAT controller **228** may also provide aspects of user and environmental inputs usable for user authentication.

[0047] In some aspects, the automotive computer **208** may connect with an infotainment system or a vehicle Human-Machine Interface (HMI) **238**. The HMI **238** may include a touchscreen interface portion, and may include voice recognition features, biometric identification capabilities that may identify users based on facial recognition, voice recognition, fingerprint identification, or other biological identification means. In other aspects, the HMI **238** may be further configured to receive user instructions via the touchscreen interface portion, and/or output or display notifications, recommendations, navigation maps, etc. on the touchscreen interface portion.

[0048] The computing system architecture of the automotive computer **208**, the VCU **210**, and/or the unit **212** may omit certain computing modules. It should be readily understood that the computing environment depicted in FIG. **2** is an example of a possible implementation according to the present disclosure, and thus, it should not be considered as limiting or exclusive.

[0049] In accordance with some aspects, the unit **212** may be integrated with and/or executed as part of the ECUs **214**. The unit **212**, regardless of whether it is integrated with the automotive computer **208** or the ECUs **214**, or whether it operates as an independent computing system in the vehicle **102**, may include a transceiver **240**, a processor **242**, and a computer-readable memory **244**.

[0050] The transceiver **240** may be configured to receive information/inputs from one or more external devices or systems, e.g., the user device **202**, the server **204**, the vehicles **104**, **106**, and/or the like, via the network **206**, vehicle-to-vehicle (V2V) communication and/or vehicle-to-infrastructure (V2I) communication. Further, the transceiver **240** may transmit notifications, requests, signals, etc. to the external devices or systems. In addition, the transceiver **240** may be configured to receive information/inputs from vehicle components such as the vehicle sensory system **232**, one or more ECUs **214**, and/or the like. Further, the transceiver **240** may transmit signals (e.g., command signals) or notifications to the vehicle components such as the BCM **220**, the HMI **238**, and/or the like.

[0051] The processor **242** and the memory **244** may be same as or similar to the processor **216** and the memory **218**, respectively. In some aspects, the processor **242** may utilize the memory **244** to store programs in code and/or to store data for performing operations in accordance with the disclosure. The memory **244** may be a non-transitory computer-readable storage medium or memory storing the dent prevention program code. In some aspects, the memory **244** may additionally store instructions/information/data (e.g., vehicle dimensions) obtained from the server **204**, the user device **202**, the vehicles **104**, **106**, and/or the like. The memory **244** may further store vehicle dimensions (e.g., vehicle door dimensions/length, vehicle height, etc.) associated with the vehicle **102**.

[0052] In operation, the transceiver **240** may receive the vehicle dimensions (vehicle door length/dimensions, vehicle height, and/or the like) associated with the vehicles **104** and/or **106**, when the vehicles **104** and/or **106** may be located/parked adjacent to the vehicle **102**. In some

aspects, the transceiver **240** may receive the vehicle dimensions described above from the server **204** via the network **206**. In other aspects, the transceiver **240** may receive the vehicle dimensions described above from the respective vehicles **104** and/or **106** via the network **206**, V2V communication or V2I communication. The transceiver **240** may transmit the received vehicle dimensions to the processor **242** and/or the memory **244** for storage purpose.

[0053] The processor **242** may obtain the vehicle dimensions from the transceiver **240**. Responsive to obtaining the vehicle dimensions, the processor **242** may obtain inputs from the vehicle sensory system **232** to determine the first distance "dR" and/or the second distance "dL" (depending on whether one or both of the vehicles **104** and **106** are parked adjacent to the vehicle **102**) based on the obtained inputs. The processor **242** may further compare the first distance "dR" with the length "R" of the left vehicle door **110** (if the vehicle **104** may be parked adjacent to the vehicle **102**), and/or the second distance "dL" with the length "L" of the right vehicle door **114** (if the vehicle **106** may be parked adjacent to the vehicle **102**).

[0054] Based on the comparison described above, in one exemplary aspect, the processor **242** may determine that the length "R" may be greater than the first distance "dR", and the length "L" may be less than the second distance "dL". Responsive to such determination, the processor **242** may control operations of the right running board **108***a* (e.g., a "first vehicle component") and the left running board **108***b* (e.g., a "second vehicle component). Specifically, in this case, the processor **242** may transmit a command signal to the BCM **220** to cause the right running board **108***a* to move to the extended position (fully or partially extended position), and keep the left running board **108***b* in the retracted position, as shown in FIG. **3**.

[0055] In some aspects, the processor **242** may cause the right running board **108***a* to extend just enough (or move to a partially extended position, and not to a fully extended position) so that the right running board **108***a* effectively shields the vehicle **102** right doors/body and/or the right side rearview mirror **112** (if the right side rearview mirror **112** is not configured to be auto-folded) from the opening left vehicle door **110**, without causing considerable obstruction in the passage between the vehicles **102** and **104**. In this manner, in the partially extended position, the right running board **108***a* allows better access to shopping carts and/or walkers between the vehicles **102** and **104**, while shielding the vehicle **102** from door dings at the same time.

[0056] In a second exemplary aspect, the processor **242** may determine that the length "L" may be greater than the second distance "dL", and the length "R" may be less than the first distance "dR". Responsive to such determination, the processor **242** may control operations of the right running board **108***a* and the left running board **108***b*, by causing (via the BCM **220**) the left running board **108***b* to move to the extended position (fully or partially extended position), and keeping the right running board **108***a* in the retracted position, as shown in FIG. **4**. In this arrangement, the left running board **108***b* may shield the vehicle **102** left doors/body and/or the left side rearview mirror **116** from the opening right vehicle door **114**.

[0057] In a third exemplary aspect, the processor **242** may determine that the length "L" may be greater than the second distance "dL", and the length "R" may also be greater than the first distance "dR". Responsive to such determination, the processor **242** may cause both the right and left running boards **108***a*, **108***b* to move to the extended position (fully or partially extended position) to shield both sides of the vehicle **102**, as shown in FIG. **1**.

[0058] In a fourth exemplary aspect (not shown), the processor **242** may determine that the length "L" may be less than the second distance "dL", and the length "R" may also be less than the first distance "dR". Responsive to such determination, the processor **242** may keep both the right and left running boards **108***a*, **108***b* in retracted positions.

[0059] In further aspects, the processor **242** may fetch the vehicle dimensions associated with the vehicle **102** from the memory **244**, and may transmit (via the transceiver **240**) the fetched vehicle dimensions to the vehicles **104** and/or **106**, so that the vehicles **104** and/or **106** may perform similar operations (e.g., move their respective running boards to the extended positions) as described

above.

[0060] The processor **242** may be further configured to compare the first distance "dR" and/or the second distance "dL" with door dimensions/length associated with vehicle doors of the vehicle **102**. Responsive to determining that the door length associated with the vehicle **102** doors may be greater than the first distance "dR" and/or the second distance "dL" based on the comparison, the processor **242** may transmit (via the transceiver **240**) an alert notification to the HMI **238**, the user device **202** and/or the vehicles **104**, **106**, indicating that the vehicle **102** door length may be greater than the first distance "dR" and/or the second distance "dL". Responsive to hearing/viewing such an alert notification, a vehicle user associated with the vehicle **102** may exercise caution while opening the vehicle **102** doors. Furthermore, responsive to hearing/viewing such an alert notification, the operators associated with the vehicles **104** and/or **106** may decide to move their vehicles to some other parking location, or the vehicles **104**, **106** may move their respective running boards to the extended position.

[0061] In additional aspects, the processor **242** may adjust the vehicle **102** height based on the vehicle **104** height (and/or the vehicle **106** height), to ensure that the vehicle **102** is effectively shielded from door dings caused due to the vehicle **104** doors. A person ordinarily skilled in the art may appreciate that if the vehicle **104** height is greater than the vehicle **102** height (as shown in FIG. **5**), the doors associated with the vehicle **104** may still contact the vehicle **102** body/doors causing door dings even when the right running board **108***a* may be in the extended position. For example, as shown in FIG. **5**, since the bottom portions of the vehicle **104** doors (shown as a line segment **502**) are above the plane of the right running board **108***a* (shown as a line segment **504**) due to the greater vehicle **104** height as compared to the vehicle **102** height, the doors associated with the vehicle **104** may still contact the vehicle **102** body/doors causing door dings, irrespective of the positional status of the right running board **108***a*. To mitigate such a scenario and to ensure that the right running board **108***a* effectively shields the vehicle **102** from door dings, the processor **242** may adjust the vehicle **102** height, as described below.

[0062] In some aspects, the processor **242** may first determine/obtain the vehicle **102** height from the memory **244**, and the vehicle **104** height from the vehicle **104** and/or the server **204**. In this case, the transceiver **240** may receive the vehicle **104** height from the vehicle **104** and/or the server **204**, and the processor **242** may obtain the vehicle **104** height from the transceiver **240**.

[0063] Responsive to determining/obtaining the vehicle **102** height and the vehicle **104** height, the processor **242** may compare the vehicle **102** height with the vehicle **104** height, and determine that the vehicle **102** height may be less than the vehicle **104** height based on the comparison. Responsive to such determination, the processor **242** may control, via the BCM **220**, a vehicle suspension operation of the vehicle **102** to increase the vehicle **102** height to be equivalent to the vehicle **104** height. In this manner, the processor **242** adjust the vehicle **102** height to be equivalent to the vehicle **104** height, thereby enabling the right running board **108***a* to effectively shield the vehicle **102** from door dings.

[0064] In a scenario where the processor **242** determines that the vehicle **102** height is not configured or capable to be equivalent to the vehicle **104** height even after elevating the vehicle **102** height to its maximum level (or if the vehicle **102** does not have active vehicle suspension), the processor **242** may transmit (via the transceiver **240**) a height adjustment notification to the vehicle **104** to lower the vehicle **104** height to be equivalent to the vehicle **102** height. Responsive to receiving the height adjustment notification from the processor **242**/transceiver **240**, the vehicle **104** may adjust its height, thereby ensuring that both the vehicles **102** and **104** are at equivalent heights. If the vehicles **102** and **104** are still not able to achieve equivalent heights using the methods described above, the processor **242** may transmit a request to the HMI **238** and/or the user device **202**, requesting the vehicle operator to move to another parking spot where adjacent vehicles may have similar heights as the vehicle **102** height.

[0065] When the vehicle **102** and the vehicle **104** (or any other vehicle adjacent to the vehicle **102**)

may be at equivalent heights, the processor **242** may determine that a door associated with the vehicle **104** (specifically the vehicle **104** door facing the vehicle **102**) may be opening. In some aspects, the processor **242** may determine that the vehicle **104** door may be opening based on inputs obtained from the vehicle sensory system **232** and/or directly from the vehicle **104** (e.g., via V2V or V2I communication). Responsive to such determination, the processor **242** may control, via the BCM **220**, the vehicle suspension operation associated with the vehicle **102** to increase the vehicle **102** height to be greater than the vehicle **104** height. A person ordinarily skilled in the art may appreciate that when the vehicle **102** height is greater than the vehicle **104** height, the vehicle **104** door may contact the right running board **108***a* in the extended position, instead of contacting the vehicle **102** body/doors, thereby preventing door dings on the vehicle **102**.

[0066] In a similar manner, when the vehicle **102** and the vehicle **104** (or any other vehicle adjacent to the vehicle **102**) may be at equivalent heights, the processor **242** may determine that a door associated with the vehicle **102** (specifically the vehicle **102** door facing the vehicle **104**) may be opening, e.g., based on inputs obtained from the VCU **210**. Responsive to such determination, the processor **242** may transmit, via the transceiver **240**, a height increase notification to the vehicle **104** to increase the vehicle **104** height to be greater than the vehicle **102** height, thereby enabling the running boards associated with the vehicle **104** to effectively shield the vehicle **104** body from the opening vehicle **102** door.

[0067] In some aspects, the process described above is dynamic in nature, and the processor **242** implements a similar process as described above when the vehicle **104** departs and another vehicle gets parked adjacent to the vehicle **102**.

[0068] In accordance with additional aspects of the present disclosure, the processor **242** may be configured to obtain (e.g., via the transceiver **240** and V2V communication) information associated with a count of passengers that may be present in the vehicle **102** and an adjacent vehicle (e.g., the vehicle **104** and/or the vehicle **106**) and an orientation of the vehicle **102** relative to the adjacent vehicle, and control the operation of the running boards **108** based on the count of passengers and the orientation. As an example, the processor **242** may not cause the running boards **108** to move to the extended positions when there may only be a driver present in the vehicle **102** and the adjacent vehicle may also only have a driver, and the vehicle **102** and the adjacent vehicle may be oriented in opposite directions (e.g., the vehicle **102** oriented towards East direction and the adjacent vehicle oriented towards West direction). In this case, the processor **242** may not cause the running boards **108** to move to the extended positions since the probability of door ding/dent may be low.

[0069] In some aspects, the processor **242** may obtain the information associated with the count of passengers from the vehicle's onboard sitting area occupancy load cells or sitting area sensors, vehicle interior cameras, and/or the like. Further, the processor **242** may obtain the vehicle's orientation information from vehicle's onboard compass.

[0070] FIG. **6** depicts a flow diagram of an example method **600** for preventing door dings in accordance with the present disclosure. FIG. **6** 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.

[0071] The method **600** starts at step **602**. At step **604**, the method **600** may include comparing, by the processor **242**, the first distance "dR" with the length "R". At step **606**, the method **600** may include determining, by the processor **242**, that the length "R" may be greater than the first distance "dR", based on the comparison. At step **608**, the method **600** may include controlling, by the processor **242**, the operation of a vehicle component associated with the vehicle **102** or the right running board **108***a*, responsive to determining that the length "R" may be greater than the first distance "dR". Specifically, as described above in conjunction with FIG. **2**, the processor **242** may cause the right running board **108***a* to move to the fully or partially extended position, when the

length "R" may be greater than the first distance "dR".

[0072] The method **600** may end at step **610**.

[0073] 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.

[0074] 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.

[0075] 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.

[0076] 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.

[0077] 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.

[0078] 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.

[0079] 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 first vehicle comprising: a detection unit configured to detect a first distance between the first vehicle and a second vehicle located adjacent to the first vehicle; a transceiver configured to receive a second vehicle door dimension; and a processor communicatively coupled with the detection unit and the transceiver, wherein the processor is configured to: compare the first distance with the second vehicle door dimension; determine that the second vehicle door dimension is greater than the first distance; and control an operation of a first vehicle component responsive to determining that the second vehicle door dimension is greater than the first distance.

2. The first vehicle of claim 1, wherein the transceiver receives the second vehicle door dimension from the second vehicle.

3. The first vehicle of claim 1, wherein the second vehicle is located at a right side of the first vehicle.

4. The first vehicle of claim 3, wherein the first vehicle component is a first vehicle right running board configured to move between a retracted position and an extended position.

5. The first vehicle of claim 4, wherein the first vehicle right running board extends away from a first vehicle right side body shielding first vehicle right side doors or first vehicle right side mirrors when the first vehicle right running board is in the extended position, and wherein the first vehicle right running board does not extend away from the first vehicle right side body when the first vehicle right running board is in the retracted position.

6. The first vehicle of claim 4, wherein the processor controls the operation of the first vehicle right running board by causing the first vehicle right running board to move to the extended position, responsive to determining that the second vehicle door dimension is greater than the first distance.

7. The first vehicle of claim 6, wherein the detection unit is further configured to detect a second distance between the first vehicle and a third vehicle located adjacent to the first vehicle and at a left side of the first vehicle, and wherein the transceiver is further configured to receive a third vehicle door dimension.

8. The first vehicle of claim 7, wherein the processor is further configured to: compare the second distance with the third vehicle door dimension; determine that the third vehicle door dimension is greater than the second distance; and control an operation of a second vehicle component responsive to determining that the third vehicle door dimension is greater than the second distance.

9. The first vehicle of claim 8, wherein the second vehicle component is a first vehicle left running board configured to move between a retracted position and an extended position, and wherein the processor controls the operation of the first vehicle left running board by causing the first vehicle left running board to move to the extended position, responsive to determining that the third vehicle door dimension is greater than the second distance.

10. The first vehicle of claim 1, wherein the processor is further configured to: compare the first distance with a first vehicle door dimension; determine that the first vehicle door dimension is greater than the first distance; and transmit an alert notification to at least one of a first vehicle Human-Machine Interface (HMI), a user device or the second vehicle, responsive to determining that the first vehicle door dimension is greater than the first distance.

11. The first vehicle of claim 1, wherein the processor is further configured to: determine a first vehicle height and a second vehicle height; determine that the first vehicle height is less than the

second vehicle height; and control a first vehicle suspension operation to increase the first vehicle height to be equivalent to the second vehicle height.

12. The first vehicle of claim 11, wherein the transceiver is further configured to receive the second vehicle height from the second vehicle, and wherein the processor is further configured to obtain the second vehicle height from the transceiver.

13. The first vehicle of claim 11, wherein the processor is further configured to: determine that the first vehicle height is not configured to be equivalent to the second vehicle height; and transmit a height adjustment notification to the second vehicle to lower the second vehicle height to be equivalent to the first vehicle height.

14. The first vehicle of claim 11, wherein the processor is further configured to: determine that a second vehicle door is opening based on inputs obtained from the detection unit or the second vehicle; and control the first vehicle suspension operation to increase the first vehicle height to be greater than the second vehicle height, responsive to determining that the second vehicle door is opening.

15. The first vehicle of claim 11, wherein the processor is further configured to: determine that a first vehicle door is opening; and transmit a height increase notification to the second vehicle to increase the second vehicle height to be greater than the first vehicle height, responsive to determining that the first vehicle door is opening.

16. A method for preventing door ding in a first vehicle, the method comprising: comparing, by a processor, a distance between the first vehicle and a second vehicle located adjacent to the first vehicle with a second vehicle door dimension; determining, by the processor, that the second vehicle door dimension is greater than the distance; and controlling, by the processor, an operation of a first vehicle component responsive to determining that the second vehicle door dimension is greater than the distance.

17. The method of claim 16, wherein the first vehicle component is a first vehicle running board configured to move between a retracted position and an extended position.

18. The method of claim 17, wherein the first vehicle running board extends away from a first vehicle side body shielding first vehicle side doors or first vehicle side mirrors when the first vehicle running board is in the extended position, and wherein the first vehicle running board does not extend away from the first vehicle side body when the first vehicle running board is in the retracted position.

19. The method of claim 17, wherein controlling the operation of the first vehicle running board comprises causing the first vehicle running board to move to the extended position, responsive to determining that the second vehicle door dimension is greater than the distance.

20. A non-transitory computer-readable storage medium having instructions stored thereupon which, when executed by a processor, cause the processor to: compare a distance between a first vehicle and a second vehicle located adjacent to the first vehicle with a second vehicle door dimension; determine that the second vehicle door dimension is greater than the distance; and control an operation of a first vehicle component responsive to determining that the second vehicle door dimension is greater than the distance.