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(54) **ACCIDENT PREDICTION AND CONSEQUENCE MITIGATION CALCULUS**

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B60R 21/0134 (2006.01)

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See application file for complete search history.

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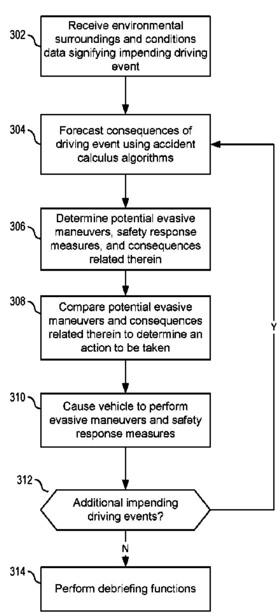
(57) **ABSTRACT**

Systems and methods are disclosed for determining that an adverse driving event is likely to occur and utilizing accident calculus algorithms to determine and cause vehicle driving actions necessary to mitigate consequences of the adverse driving event. After determining that an adverse driving event is likely to occur, a computing device my forecast consequences of the driving event. The computing device may determine potential evasive maneuvers that may be taken responsive to the adverse driving event. Additionally, the computing device may determine consequences associated with the potential evasive maneuvers and assign a weight relative to the consequence. The computing device may compare the potential driving maneuvers based on the weighted consequences to determine a driving maneuver to take.

20 Claims, 3 Drawing Sheets



Related U.S. Application Data

(60) Provisional application No. 62/295,300, filed on Feb. 15, 2016.

(51) **Int. Cl.**

B60W 30/08	(2012.01)
B60W 30/09	(2012.01)
B62D 6/00	(2006.01)
G01S 19/42	(2010.01)

(52) **U.S. Cl.**

CPC ***B60W 30/09*** (2013.01); ***B62D 6/001*** (2013.01); ***G08G 1/165*** (2013.01); ***G08G 1/166*** (2013.01); *G01S 19/42* (2013.01)

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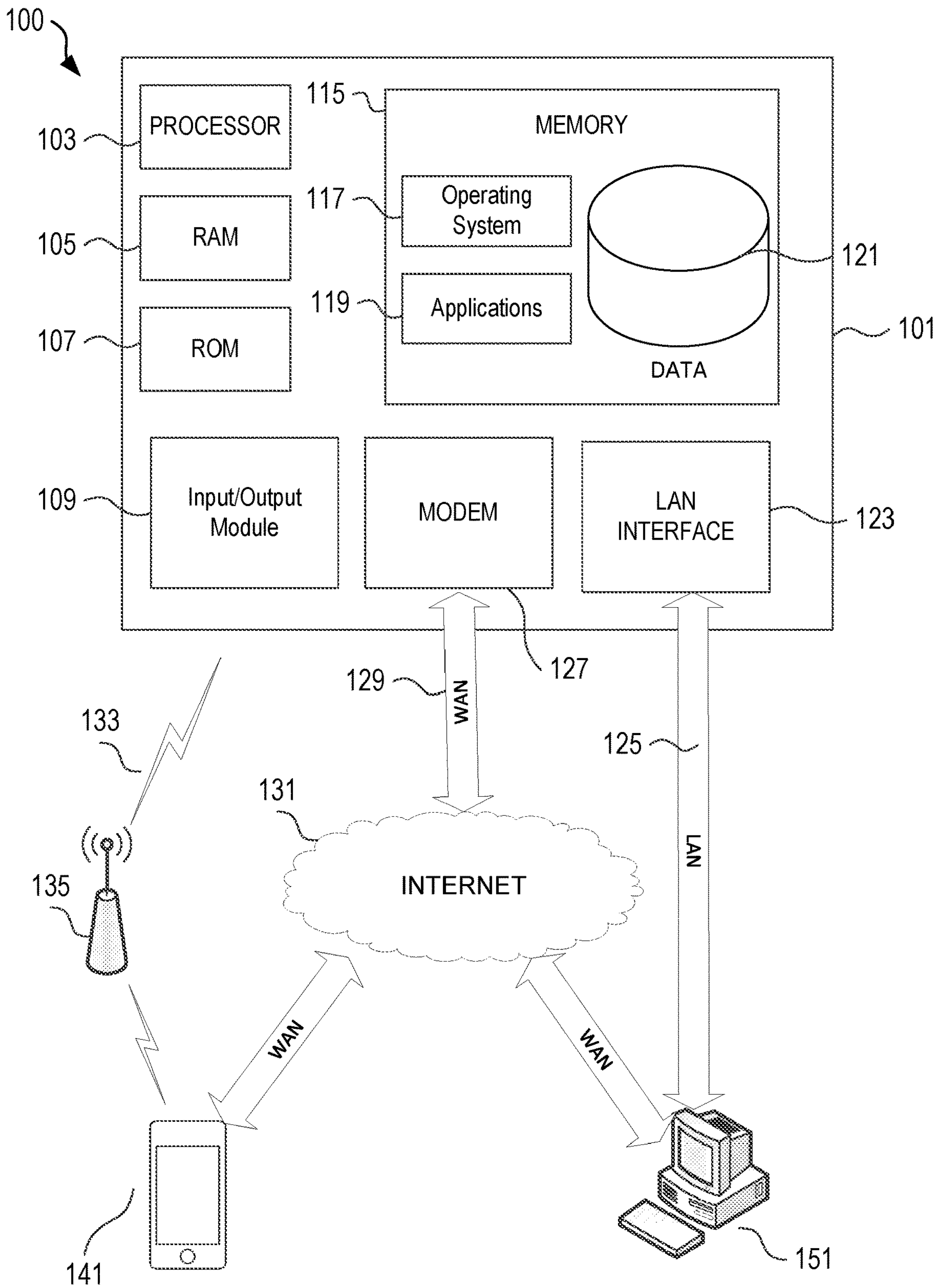
100
PROCESSOR
103
RAM
105
ROM
107
115
MEMORY
117
Operating System
119
Applications
121
DATA
101
109
Input/Output Module
MODEM
LAN INTERFACE
123
129
WAN
127
133
125
131
INTERNET
LAN
135
WAN
WAN
141
151

FIG. 1

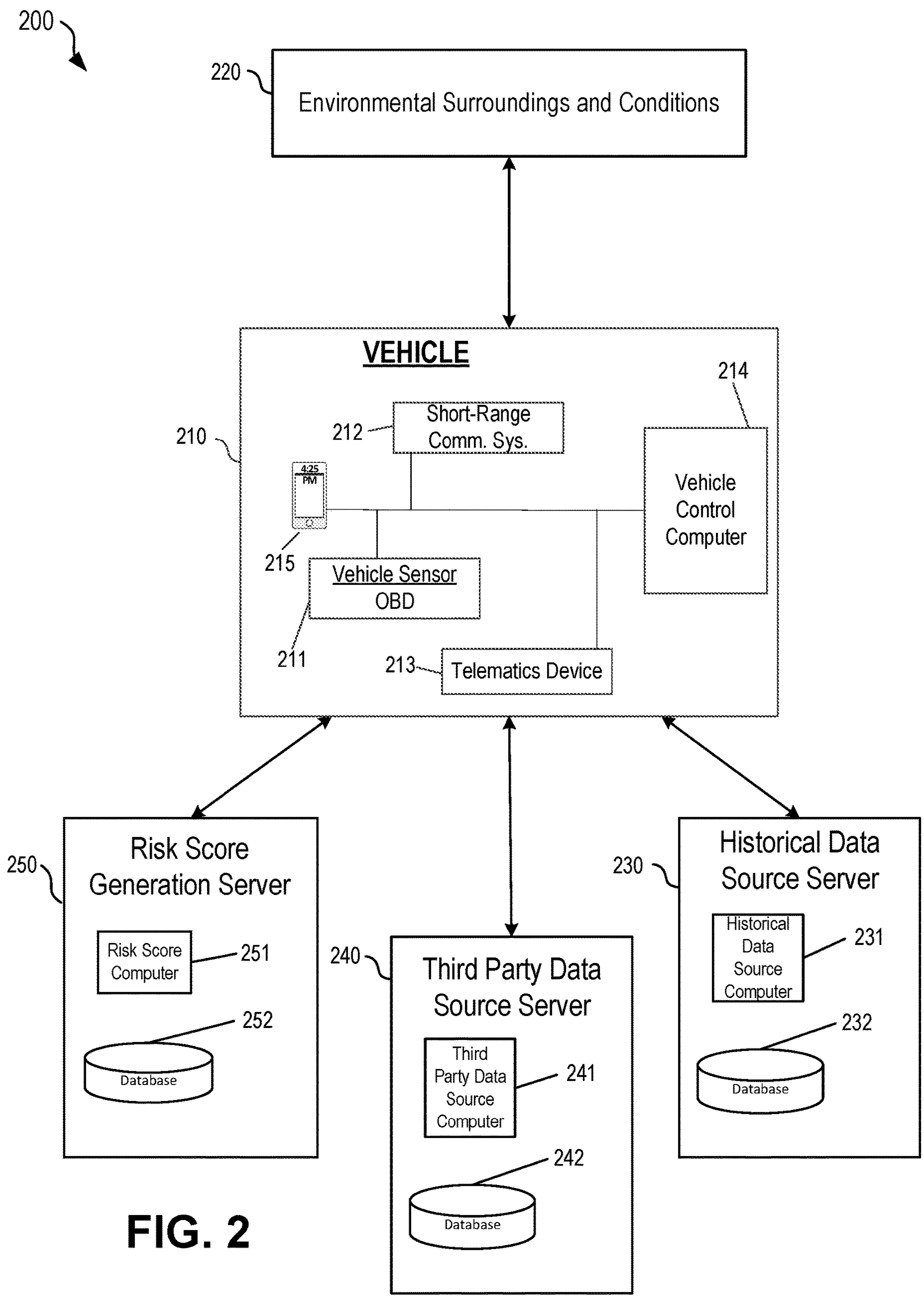
200
220
Environmental Surroundings and Conditions
VEHICLE
210
214
212
Short-Range Comm. Sys.
4:25 PM
Vehicle Control Computer
215
Vehicle Sensor OBD
211
213
Telematics Device
250
Risk Score Generation Server
Risk Score Computer
251
252
Database
240
Third Party Data Source Server
Third Party Data Source Computer
241
242
Database
230
Historical Data Source Server
Historical Data Source Computer
231
232
Database

FIG. 2

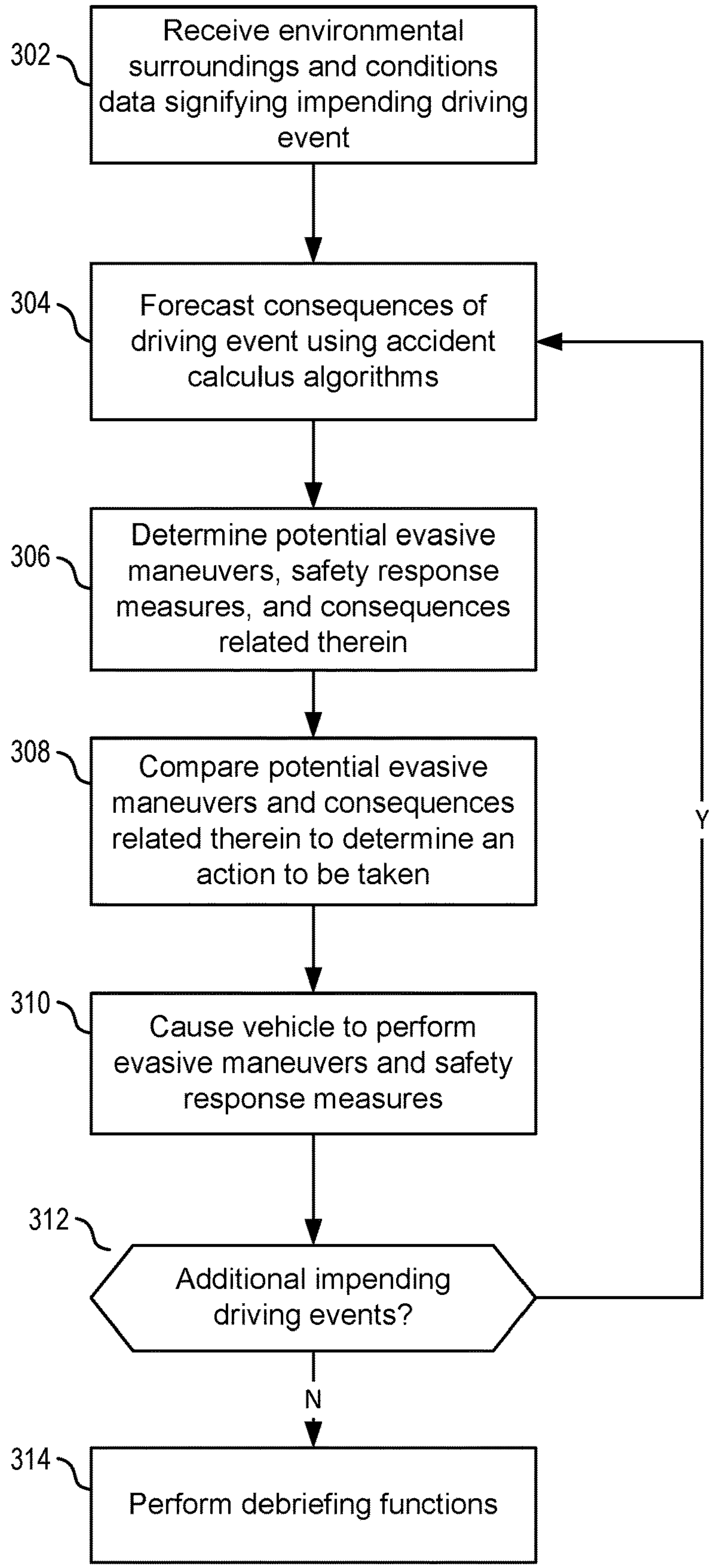
302
Receive environmental surroundings and conditions data signifying impending driving event
304
Forecast consequences of driving event using accident calculus algorithms
306
Determine potential evasive maneuvers, safety response measures, and consequences related therein
308
Compare potential evasive maneuvers and consequences related therein to determine an action to be taken
310
Cause vehicle to perform evasive maneuvers and safety response measures
312
Additional impending driving events?
Y
N
314
Perform debriefing functions

FIG. 3

ACCIDENT PREDICTION AND CONSEQUENCE MITIGATION CALCULUS

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application is a continuation of U.S. Non-Provisional patent application Ser. No. 15/433,090, filed Feb. 15, 2017, entitled "Accident Prediction and Consequence Mitigation Calculus," which claims priority to U.S. Provisional Patent Application No. 62/295,300, filed Feb. 15, 2016, entitled "Accident Calculus." Each of these applications is hereby incorporated by reference in its entirety herein.

FIELD

Aspects described herein generally relate to autonomous and semi-autonomous vehicle control systems. More specifically, aspects relate to utilization of prediction algorithms to mitigate the consequences associated with an adverse driving event experienced by an autonomous or semi-autonomous vehicle.

BACKGROUND

Autonomous and semi-autonomous car systems are becoming more prevalent. However, knowledge of systems, methods, and computing devices configured to respond to adverse driving conditions are insufficient.

BRIEF SUMMARY

The following presents a simplified summary of various aspects described herein. This summary is not an extensive overview, and is not intended to identify key or critical elements or to delineate the scope of the claims. The following summary merely presents some concepts in a simplified form as an introductory prelude to the more detailed description provided below.

Aspects of the disclosure relate to systems, methods, and computing devices configured to predict that an adverse driving event is likely to occur. Using accident prediction algorithms, a computing device may determine a response to the adverse driving event that is likely to mitigate consequences of the event. After determining the response, the computing device may cause the response to occur.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of aspects described herein and the advantages thereof may be acquired by referring to the following description in consideration of the accompanying drawings, in which like reference numbers indicate like features, and wherein:

FIG. **1** illustrates a network environment and computing systems that may be used to implement aspects of the disclosure.

FIG. **2** is a diagram illustrating various example components of an accident calculus system to one or more aspects of the disclosure.

FIG. **3** is a flow diagram illustrating an example method of consequence mitigation measures taken by a vehicle responsive to an adverse driving event according to one or more aspects of the disclosure.

DETAILED DESCRIPTION

In the following description of the various embodiments, reference is made to the accompanying drawings, which form a part hereof, and in which is shown by way of illustration, various embodiments of the disclosure that may be practiced. It is to be understood that other embodiments may be utilized.

As will be appreciated by one of skill in the art upon reading the following disclosure, various aspects described herein may be embodied as a method, a computer system, or a computer program product. Accordingly, those aspects may take the form of an entirely hardware embodiment, an entirely software embodiment or an embodiment combining software and hardware aspects. In addition, aspects may take the form of a computing device configured to perform specified actions. Furthermore, such aspects may take the form of a computer program product stored by one or more computer-readable storage media having computer-readable program code, or instructions, embodied in or on the storage media. Any suitable computer readable storage media may be utilized, including hard disks, CD-ROMs, optical storage devices, magnetic storage devices, and/or any combination thereof. In addition, various signals representing data or events as described herein may be transferred between a source and a destination in the form of electromagnetic waves traveling through signal-conducting media such as metal wires, optical fibers, and/or wireless transmission media (e.g., air and/or space).

FIG. **1** illustrates a block diagram of a computing device **101** in an accident calculus system **100** that may be used according to one or more illustrative embodiments of the disclosure. The computing device **101** may have a processor **103** for controlling overall operation of the computing device **101** and its associated components, including RAM **105**, ROM **107**, input/output module **109**, and memory unit **115**. The computing device **101**, along with one or more additional devices (e.g., terminals **141**, **151**) may correspond to any of multiple systems or devices, such as accident calculus devices or systems, configured as described herein for receiving data from various sources and generating via accident calculus algorithms consequence mitigation measures responsive to an adverse driving event.

Input/Output (I/O) module **109** may include a microphone, keypad, touch screen, and/or stylus through which a user of the computing device **101** may provide input, and may also include one or more of a speaker for providing audio input/output and a video display device for providing textual, audiovisual and/or graphical output. Software may be stored within memory unit **115** and/or other storage to provide instructions to processor **103** for enabling device **101** to perform various functions. For example, memory unit **115** may store software used by the device **101**, such as an operating system **117**, application programs **119**, and an associated internal database **121**. The memory unit **115** includes one or more of volatile and/or non-volatile computer memory to store computer-executable instructions, data, and/or other information. Processor **103** and its associated components may allow the computing device **101** to execute a series of computer-readable instructions to receive data from various sources and generate via accident calculus algorithms consequence mitigation measures.

The computing device **101** may operate in a networked environment **100** supporting connections to one or more remote computers, such as terminals/devices **141** and **151**. Accident calculus computing device **101**, and related terminals/devices **141** and **151**, may include devices installed in vehicles, mobile devices that may travel within vehicles, or devices outside of vehicles that are configured to receive and process vehicle and other sensor data. Thus, the computing device **101** and terminals/devices **141** and **151** may each include personal computers (e.g., laptop, desktop, or tablet computers), servers (e.g., web servers, database servers), vehicle-based devices (e.g., on-board vehicle computers, short-range vehicle communication systems, sensors and telematics devices), or mobile communication devices (e.g., mobile phones, portable computing devices, and the like), and may include some or all of the elements described above with respect to the computing device **101**. The network connections depicted in FIG. **1** include a local area network (LAN) **125** and a wide area network (WAN) **129**, and a wireless telecommunications network **133**, but may also include other networks. When used in a LAN networking environment, the computing device **101** may be connected to the LAN **125** through a network interface or adapter **123**. When used in a WAN networking environment, the device **101** may include a modem **127** or other means for establishing communications over the WAN **129**, such as network **131** (e.g., the Internet). When used in a wireless telecommunications network **133**, the device **101** may include one or more transceivers, digital signal processors, and additional circuitry and software for communicating with wireless computing devices **141** (e.g., mobile phones, short-range vehicle communication systems, vehicle sensing and telematics devices) via one or more network devices **135** (e.g., base transceiver stations) in the wireless network **133**.

It will be appreciated that the network connections shown are illustrative and other means of establishing a communications link between the computers may be used. The existence of any of various network protocols such as TCP/IP, Ethernet, FTP, HTTP and the like, and of various wireless communication technologies such as GSM, CDMA, Wi-Fi, and WiMAX, is presumed, and the various computing devices and multi-dimensional risk score generation system components described herein may be configured to communicate using any of these network protocols or technologies.

Additionally, one or more application programs **119** used by the computing device **101** may include computer executable instructions (e.g., accident calculus algorithms and the like) for receiving data and performing other related functions as described herein.

FIG. **2** is a diagram illustrating various example components of an accident calculus system **200** according to one or more aspects of the disclosure. The accident calculus system **200** may include a vehicle **210**, environmental surroundings and conditions **220**, historical data source server **230**, third party data source server, multi-dimensional risk score generation server **250**, and additional related components. Each component shown in FIG. **2** may be implemented in hardware, software, or a combination of the two. Additionally, each component of the accident calculus system **200** may include a computing device (or system) having some or all of the structural components described above for computing device **101**.

Vehicle **210** may be, for example, an automobile, motorcycle, scooter, bus, recreational vehicle, boat, train, stationary vehicle, or other type of vehicle. Vehicle **210** may be an autonomous or semi-autonomous vehicle. In autonomous driving, the vehicle control computer **214** fulfills all or part of the driving of vehicle **210**.

The vehicle **210** may include vehicle operation sensors **211** capable of detecting various performance and/or operational data of the vehicle. For example, sensors **211** may detect data corresponding to the vehicle's location (e.g., GPS coordinates), time, travel time, speed and direction, rates of acceleration or braking, gas mileage, specific instances of sudden acceleration, braking, swerving, distance traveled, suspension type, tire tread degradation, speed of steering servo motors, actual/implied efficacy of braking systems, and the like. Sensors **211** may detect and store data received from the vehicle's internal systems, such as impact to the body of the vehicle, air bag deployment, headlights usage, brake light operation, door opening and closing, door locking and unlocking, cruise control usage, hazard lights usage, windshield wiper usage, horn usage, turn signal usage, seat belt usage, phone and radio usage within the vehicle, autonomous driving system usage, maintenance performed on the vehicle, and other data collected by the vehicle's computer systems, including the vehicle OBD and the vehicle control computer.

Additionally, sensors **211** may detect information associated with environmental surroundings and conditions **220** around vehicle **210**. For example, vehicle sensors **211** may include external cameras and proximity sensors which may detect environmental surroundings and conditions **220** including other nearby vehicles, vehicle spacing, traffic levels, road conditions, traffic obstructions, animals, cyclists, pedestrians, external temperature, rain, snow, light levels, sun position, and other conditions that may factor into driving operations of vehicle **210**.

Sensors **211** also may detect data relating to moving violations and the observance of traffic signals and signs by the vehicles **210**. Additional sensors **211** may detect data relating to the maintenance of the vehicle **210**, such as the engine status, oil level, engine coolant temperature, odometer reading, the level of fuel in the fuel tank, engine revolutions per minute (RPMs), software upgrades, and/or tire pressure.

Certain vehicle sensors **211** may determine when and how often the vehicle **210** stays in a single lane or strays into other lanes. A Global Positioning System (GPS) and/or locational sensors positioned inside the vehicle **210**, and/or locational sensors or devices external to the vehicle **210** may be used to determine the lane position, road-type (e.g. highway, entrance/exit ramp, residential area, etc.) and other vehicle position/location data. Vehicle **210** may include other vehicle sensors **211** for monitoring other vehicle performance and operational phenomena, as well as other internal and external phenomena.

In response to detecting the above-mentioned data regarding vehicle **210** and environmental surroundings and conditions **220**, vehicle sensors **211** may be configured to transmit the data to one or more internal computing systems including telematics device **213** and/or vehicle control computer **214**. Additionally, vehicle sensors **212** may be configured to transmit the above-mentioned data to one or more external computing systems including mobile device **215**, historical data source server **230**, third party data source server **240**, and/or risk score generation server **250** via short-range communication systems **212** and/or telematics device **213**.

Short-range communication systems **212** are vehicle-based data transmission systems configured to transmit environmental surroundings and conditions and vehicle performance and operational data to external computing systems and/or other nearby vehicles and infrastructure, and to receive data from external computing systems and/or other nearby vehicles and infrastructure. In some examples, communication systems **212** may use the dedicated short-range communications (DSRC) protocols and standards to perform wireless communications between vehicles and/or external infrastructure such as bridges, guardrails, barricades, and the like.

Short-range communication systems **212** may be implemented using other short-range wireless protocols in other examples, such as WLAN communication protocols (e.g., IEEE 802.11), Bluetooth (e.g., IEEE 802.15.1), or one or more of the Communication Access for Land Mobiles (CALM) wireless communication protocols and air interfaces. In certain systems, short-range communication systems **212** may include specialized hardware installed in vehicle **210** (e.g., transceivers, antennas, etc.), while in other examples the communication systems **212** may be implemented using existing vehicle hardware components (e.g., radio and satellite equipment, navigation computers) or may be implemented by software running on the mobile device **215** of drivers and passengers within the vehicle **210**.

Telematics device **213** may be a computing device containing many or all of the hardware/software components as the computing device **101** depicted in FIG. **1**. The telematics device **213** may receive vehicle performance and operational data from vehicle sensors **211**, and may be configured to transmit the data to one or more external computer systems over a wireless transmission network.

Telematics device **213** also may be configured to detect or determine additional types of data relating to real-time driving and the condition of the vehicle **210**. The telematics device **213** may store the type of vehicle **210**, for example, as well as the make, model, trim (or sub-model), year, and/or engine specifications, and autonomous driving system specifications. Additionally, other information such as vehicle owner or driver information, insurance information, and financing information for the vehicle **210** may be stored on telematics device **213**.

Telematics device **213** may be configured to receive and transmit data from certain vehicle sensors **211**, while other sensors or systems may be configured to directly receive and/or transmit data to external computing systems (e.g., historical data source server **230**, third party data source server **240**, risk score generation server **250**) without using the telematics device. Thus, telematics device **213** may be optional in certain embodiments.

Vehicle control computer **214** (e.g., autonomous vehicle driving system) may contain some or all of the hardware/software components as the computing device **101** depicted in FIG. **1**, and may be configured to operate aspects of the driving of vehicle **210**, including but not limited to acceleration, braking, steering, and/or route navigation. Additionally, vehicle control computer may be configured to perform the accident calculus algorithms described in further detail below. In order to perform autonomous driving functions, vehicle control computer **214** may be configured to receive, analyze, and act upon vehicle performance and operational data and environmental surroundings and conditions data provided by vehicle sensors **211**.

Additionally, vehicle control computer **214** may be configured to receive, analyze, and act upon historical data from historical data source server **230**, third party data from third party data source server **240**, and risk score data from risk score generation server **250**. Such data may be received through short-range communication systems **212** and/or other on-board communication systems. In certain embodiments, vehicle control computer **214** may also be configured to receive, analyze, and act upon data provided by telematics device **213** and mobile device **215**. Such data may be used by vehicle control computer **214** to perform autonomous driving functions for vehicle **210**, including performance of accident calculus algorithms.

In certain embodiments, mobile computing device **215** within the vehicle **210** may be used to collect vehicle driving data and/or to receive vehicle driving data from vehicle communication systems and then to transmit the vehicle driving data to external computing devices. Mobile computing device **215** may be, for example, a mobile phone, personal digital assistant (PDA), or tablet computer of the driver or passenger(s) of vehicle **210**. Software applications executing on mobile device **215** may be configured to detect certain driving data independently and/or may communicate with vehicle sensors **211**, telematics device **213**, autonomous driving systems, or other vehicle communication systems to receive additional driving data. For example, mobile device **215** may be equipped with GPS functionality and may determine vehicle location, speed, direction and other basic driving data without needing to communicate with the vehicle sensors **211** or any vehicle system.

In other examples, software on the mobile device **215** may be configured to receive some or all of the driving data collected by vehicle sensors **211**. Mobile computing device **215** may also be involved with aspects of autonomous driving, including receiving, collecting, and transmitting vehicle operational data regarding autonomous driving and autonomous driving relationships between multiple vehicles.

The accident calculus system **200** may include a historical data source server **230**, containing some or all of the hardware/software components as the computing device **101** depicted in FIG. **1**. Historical data source **230** may comprise a historical data source computer **231** for receiving and/or processing historical data including insurance claims, accident reports, historical environmental surroundings and conditions and/or historical vehicle operation and performance data associated with insurance claims and accident reports. The historical data source **230** may also comprise a database **232** used to store the historical data collected by the historical data source computer **231**. The historical data source computer **231** may transmit the historical data to vehicle **210** for aiding in the performance of accident calculus algorithms as described herein.

The system **200** may include a third party data source server **240**, containing some or all of the hardware/software components as the computing device **101** depicted in FIG. **1**. Third party data source server **240** may comprise a third party data source computer **241** for receiving and/or processing third party data including current weather condition data, forecasted weather condition data, traffic flow data, road closure data, and/or other data affecting external driving conditions. The third party data source server **240** may also comprise a database **242** used to store the third party data collected by the third party data source computer **241**. The third party data source computer **241** may transmit the historical data to the vehicle **210** for aiding in the performance of accident calculus algorithms discussed in further detail below.

The system **200** may include a multi-dimensional risk score generation server **250**, containing some or all of the hardware/software components as the computing device **101** depicted in FIG. **1**. The multi-dimensional risk score generation server **250** may include a database **252**, which may include additional data for the multi-dimensional risk score generation server **250** to process to, for example, generate one or more multi-dimensional risk scores. The multi-dimensional risk score generation computer **251** may analyze data received from the various data sources. The multi-dimensional risk score generation server **250** may initiate communication with and/or retrieve data from the vehicle **210** and other components within system **200**.

Multi-dimensional risk scores and profiles may comprise a framework that identifies risk-related information and identifies a method to quantify data related to geo-spatial, environmental, and/or driver behavior. This framework may allow an autonomous vehicle driving system to understand and act on how, when, and why adverse events occur on roads or other locations.

The multi-dimensional risk score generation server **250** may identify and quantify one or more variables. For example, the server may determine which risk factors on road segments can impact a vehicle and occupants included therein. The system may determine (e.g., quantify and/or create) a probability of an adverse event occurring. The probability may be range bound. The server may determine the potential cost (e.g., in dollars) of an adverse event, such as an accident. The server may determine potential human impact of an adverse event. The server may create, quantify, and/or represent one or more links between a vehicle attribute (e.g., a type, a make, an age, a condition, etc.) and the environment in which the vehicle is being operated, so that the adverse events may be predicted in a structured and interconnected way.

Vehicle control computer **214** may pull data, seamlessly and in real-time, from any one, or combination of, vehicle sensors **211**, telematics device **213**, mobile device **215**, historical data source server **230**, third party data source server **240**, and/or multi-dimensional risk score generation server **250**. The data provided may enable vehicle control computer **214** to perform autonomous driving actions for vehicle **210** as well as perform accident calculus algorithms when an adverse driving event occurs.

During adverse driving circumstances and/or events wherein vehicle **210** is likely to be or predicted to be involved in an accident, vehicle control computer **214**, based on a plurality of criteria and/or factors and through the utilization of accident calculus algorithms, may be configured to determine and cause vehicle driving actions necessary to mitigate accident consequences.

FIG. **3** is a flow diagram illustrating an example method of consequence mitigation measures taken by a vehicle responsive to an adverse driving event according to one or more aspects of the disclosure.

At step **302**, vehicle control computer **214** may receive environmental surroundings and conditions data from vehicle sensors **211** indicating that vehicle **210** is likely to be involved in an adverse driving event (e.g., accident). The data provided by vehicle sensors **211** may include direct involvement data indicating what type of vehicle and/or entity will be directly involved in the event (e.g., bicycle, motorcycle, truck, 18 wheeler, train, building, pedestrian, etc.) and a relative mass, velocity, acceleration, and trajectory of the involved vehicle, peripheral involvement data indicating immediate by-standing vehicles, pedestrians, and/or infrastructure, and relative masses, velocities, accelerations, and trajectories thereof, and environmental data including temperature, precipitation levels or lack thereof, road quality and type (e.g., iced mountain road with significant curvature and minimal guard rails). Other types of data within the direct involvement, peripheral involvement, and environmental categories may be provided. In some instances, vehicle control computer **214** may receive such data from any one, or combination of, sensors **211**, telematics device **213**, mobile device **215**, historical data source server **230**, third party data source server **240**, and/or risk generation score server **250**. In other instances, risk score generation server **250** may receive such data.

Additionally, ancillary data regarding immediately and peripherally involved entities (e.g., bicycle, motorcycle, truck, 18 Wheeler, train, building, external infrastructure, etc.) may be provided to the vehicle control computer **214** of vehicle **210** through short-range communication systems **212**. For example, ancillary data may include information such as, but not limited to, vehicle performance and/or operational data and passenger and/or cargo data of immediately and peripherally involved vehicles, as well as infrastructure type and function data of immediately and peripherally involved infrastructure. Such data may be received by short-rand communication systems **212** continuously and in real-time and may be utilized in the accident calculus algorithms described in further detail below during an adverse driving event.

At step **304**, through the utilization of multivariable accident calculus algorithms, vehicle control computer **214** may process and/or analyze the direct involvement, peripheral involvement, environmental data, and/or ancillary data received from vehicle sensors **211** and/or short-range communication systems **212** in tandem with vehicle performance and/or operational data of vehicle **210** (e.g., real-time velocity, acceleration, mass, break activation, tire tread life, speed of steering servo motor, actual/implied efficacy of braking systems, suspension, steer column orientation, number of passengers, positioning of passengers, type of cargo onboard, etc.) to determine, predict, and/or forecast probable consequences if the accident were left to occur without any intervention by vehicle driving system **214** (e.g., swerving out of the way of an oncoming vehicle, forcefully applying brakes, and the like).

The forecasting of probable consequences may entail determining the initial effects caused by the immediately involved vehicle, cascading effects caused to other entities responsive to the initial effects, as well as the degree to which all involved entities will be affected (e.g., minor damage to vehicle **210**, moderate to severe injuries to occupants of an external vehicle, death of a pedestrian, and the like).

In some instances, vehicle control computer **214** may perform such calculations alone, or in tandem with risk score generation server **250**. For example, depending on the complexity of the multivariable accident calculus equations and processing power necessary to solve such equations, risk score generation server **250** may aid vehicle control computer **214** in generating solutions and/or generate complete solutions for vehicle control computer **214**.

At step **306**, which may be performed concurrently with, or subsequent to, step **304**, vehicle control computer **214** may formulate a plurality of potential evasive maneuvers that may be taken by vehicle **210** prior to impact of the directly involved vehicle and/or entity via accident calculus algorithms. In certain embodiments, vehicle control computer **214** may additionally formulate safety response measures associated with each potential evasive maneuver of the plurality of evasive maneuvers to mitigate the probability of injury to passengers within vehicle **210**. For example, depending on the formulated evasive maneuver, vehicle control computer **214** may alert passengers to the impending adverse driving incident, tighten passenger seatbelts, activate airbags and fire retardant systems, turn on interior vehicle lights, unlock doors, roll up and/or roll down windows, and the like.

In certain instances, projected and/or forecasted consequences of the potential evasive maneuvers may also be determined. The formulated potential evasive maneuvers and associated consequences may be populated in an evasive maneuver determination matrix for streamlining and consolidating decision making of vehicle computer **214**.

Potential evasive maneuvers may be calculated via accident calculus algorithms and the forecasted consequences associated with such maneuvers may be weighted based on considerations including type, amount, and cost of vehicle and infrastructure damage likely to be incurred, as well as type, amount, and severity of injuries likely to occur to occupants of vehicle **210**, external vehicles, and pedestrians.

In certain embodiments, the potential evasive maneuvers may be made by comparing and/or matching the above-mentioned data (e.g., direct involvement, peripheral involvement, environmental, and/or vehicle performance and/or operational) to prior incident data stored in historical data source server **230** and/or multi-dimensional risk score generation server **250** to determine a set of maneuvers of known outcomes.

In some instances, vehicle control computer **214** may perform such calculations alone, or in tandem with risk score generation server **250**. For example, depending on the complexity of the multivariable accident calculus equations and processing power necessary to solve such equations, risk score generation server **250** may aid vehicle control computer **214** in generating solutions and/or generate complete solutions for vehicle control computer **214**.

At step **308**, vehicle control computer **214** may determine from the totality of potential evasive maneuvers an action, or lack thereof, to be made and/or taken, as well as associated safety response measures. In some instances, the determination of an evasive maneuver to be taken may be made by comparing the various generated potential evasive maneuvers and consequences related thereto to determine an option likely to incur the least amount of damage to vehicle **210** and/or injury to occupants riding therein, as well as damage to external vehicles and/or injury to accompanying occupants, and injury to pedestrians. Such an option may be considered a safe accident option and may entail getting into an accident that is safer for the passengers and/or pedestrians involved, but more damaging to the vehicles involved. Depending on the vehicles involved in the adverse driving incident (e.g., autonomous or semi-autonomous vehicles with the capacity for computer automated intervention), the vehicles may work collaboratively in achieving such a safe accident.

In some embodiments, the determination of an evasive maneuver to be taken may be defined by vehicle tenets. Such vehicle tenets may form guiding logical rules (e.g., human injury is invaluable in comparison to property damage, human in vehicle **210** is more valuable than human in directly involved vehicle, etc.) that must be abided by when selecting an evasive maneuver to be taken. In some instances, vehicle control computer **214** may perform such calculations alone, or in tandem with risk score generation server **250**.

In other embodiments, after determining evasive maneuvers and safety response measures to be taken, vehicle control computer **214** may broadcast the chosen maneuver via short-range communication systems **212** to directly and peripherally involved vehicles and/or infrastructure. Additionally, vehicle control computer **214** may be configured to receive information relating to chosen evasive maneuvers from directly and peripherally involved vehicles. Through the utilization of such information relating to the chosen evasive actions of all vehicles involved, involved entities may be able to coordinate actions to further mitigate consequences of an adverse driving event.

At step **310**, vehicle control computer **214** may cause vehicle **210** to perform the actions necessitated by the chosen evasive maneuver, as well as the safety response measures associated with the chosen evasive maneuver. While performing the evasive actions and safety response measures, vehicle control computer **214** may be receiving environmental surroundings and conditions data from vehicle sensors **211** seamlessly and in real-time. Such data may be transmitted from sensors **211** to vehicle control computer **214** under any circumstances resulting from the chosen evasive maneuver (e.g., evasive maneuver resulting in an adverse incident and/or accident, avoidance of an accident, etc.).

At step **312**, vehicle control computer **214** may determine whether or not the received environmental surroundings and conditions data indicate if an additional adverse driving event may occur. For example, if after swerving out the way of an oncoming vehicle, received environmental surroundings and conditions data may indicate that vehicle **210** is now presented with an additional adverse driving event (e.g., that after completion of the first evasive maneuver vehicle **210** is now inline to hit immediate infrastructure). In such instances, vehicle control computer **214** return to step **304**.

Alternatively, if vehicle control computer **214** determines that the received environmental surroundings and conditions data indicates that that no other adverse driving events are immediately pending, vehicle control computer **214** may proceed to step **314**. In such an instance, vehicle control computer **214** may be configured to debrief from the adverse driving event by, for example, assessing damage to vehicle **210**, external vehicles and infrastructure, and the like. Additionally, based on the debriefing assessment, vehicle control computer **214** may be configured to alert emergency response teams and/or call a tow truck. Other responses may be possible. For instance, vehicle control computer **214** may be configured to create a driving incident report that compiles relevant data (e.g., vehicle performance and/or operational data of vehicle **210**, immediately involved vehicles, and peripherally involved vehicles) regarding the adverse driving incident. Such information may be provided to emergency response teams in order to provide insight into the fault surrounding the adverse driving incident.

In some instances, vehicle control computer **214** may retrospectively analyze the totality of adverse driving incident data and information related to the taken evasive maneuver to apply and/or vary respective weights associated with the input variables of the accident calculus algorithms in order to provide safer evasive maneuvers in the event of future adverse driving incidents. In doing so, vehicle control computer **214** may be able to self-improve and provide better vehicle responses to future adverse driving events. Alternatively, risk score generation server **250** may be able to perform such a retrospective analysis.

Although the subject matter has been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims.

We claim:

1. A method comprising:

receiving, from at least one sensor associated with a vehicle, data signifying an impending driving event;

determining a plurality of potential evasive maneuvers;

determining one or more consequences for performing each of the plurality of potential evasive maneuvers;

comparing, based on a weight associated with each of the one or more consequences of each of the plurality of potential evasive maneuvers, the plurality of potential evasive maneuvers;

determining, based on the comparison, an evasive maneuver of the plurality of potential evasive maneuvers to perform;

selecting, from a plurality of safety response measures, one or more safety response measures associated with the evasive maneuver; and

causing, via a vehicle control computer, the vehicle to perform both the evasive maneuver and the one or more safety response measures.

2. The method of claim **1** further comprising:

determining an additional adverse driving event will occur after the evasive maneuver is performed.

3. The method of claim **1** further comprising generating a report based on the impending driving event and the evasive maneuver.

4. The method of claim **1**, wherein the impending driving event is an accident.

5. The method of claim **1**, wherein the data indicates at least one of a type of vehicle or entity will be involved in the impending driving event.

6. The method of claim **1**, wherein the data indicates at least one of a temperature, a precipitation level, a road quality or a road type associated with the vehicle.

7. The method of claim **1**, wherein the at least one sensor includes at least one of a camera or a proximity sensor.

8. A system comprising:

a processor; and

memory storing computer-executable instructions that, when executed by the processor, cause the processor to:

receive, from a vehicle sensor, data indicating an adverse driving event associated with a vehicle is likely to occur;

determine a plurality of potential evasive maneuvers;

predict one or more consequences for performing each of the plurality of potential evasive maneuvers;

compare, based on a weight associated with each of the one or more consequences for each of the plurality of potential evasive maneuvers, the plurality of potential evasive maneuvers;

select, based on the comparison, an evasive maneuver of the plurality of potential evasive maneuvers;

select, from a plurality of safety response measures, a safety response measure associated with the evasive maneuver; and

cause a vehicle control computer to control the vehicle to perform both the evasive maneuver and the safety response measure.

9. The system of claim **8**, wherein the memory storing further computer-executable instructions that, when executed by the processor, further cause the processor to:

predict an additional adverse driving event will occur after the evasive maneuver is performed.

10. The system of claim **8**, wherein the memory storing further computer-executable instructions that, when executed by the processor, further cause the processor to:

output a report based on the adverse driving event and the evasive maneuver.

11. The system of claim **8**, wherein the adverse driving event is an accident.

12. The system of claim **8**, wherein the data indicates at least one of a type of vehicle or entity will be involved in the adverse driving event.

13. The system of claim **8**, wherein the data indicates at least one of a temperature, a precipitation level, a road quality or a road type associated with the vehicle.

14. The system of claim **8**, wherein the vehicle sensor includes at least one of a camera or a proximity sensor.

15. One or more non-transitory, computer-readable storage media storing computer-readable instructions that, when executed, cause a processor to:

receive, from a sensor associated with a vehicle, data indicating a driving event associated with the vehicle is impending;

determine a plurality of potential evasive maneuvers in response to the driving event;

forecast one or more outcomes for performing each of the plurality of potential evasive maneuvers;

compare each of the one or more outcomes for each of the plurality of potential evasive maneuvers;

determine an evasive maneuver of the plurality of potential evasive maneuvers;

determine, from a plurality of safety response measures, a safety response measure associated with the evasive maneuver; and

cause a vehicle control computer to control the vehicle to execute both the evasive maneuver and the safety response measure.

16. The one or more non-transitory, computer-readable storage media of claim **15**, storing further instructions that, when executed, further cause the processor to:

forecast an additional adverse driving event will occur after the evasive maneuver is executed.

17. The one or more non-transitory, computer-readable storage media of claim **15**, storing further instructions that, when executed, further cause the processor to:

output a report based on the driving event and the evasive maneuver.

18. The one or more non-transitory, computer-readable storage media of claim **15**, wherein the data indicates at least one of a type of vehicle or entity will be involved in the driving event.

19. The one or more non-transitory, computer-readable storage media of claim **15**, wherein the data indicates at least one of a temperature, a precipitation level, a road quality or a road type associated with the vehicle.

20. The one or more non-transitory, computer-readable storage media of claim **15**, wherein the sensor includes at least one of a camera or a proximity sensor.

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