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DYNAMIC ASSIGNMENT OF ELECTRIC VEHICLE OPERATIONAL CHARACTERISTICS BASED ON VEHICLE SITE

Abstract

A method of operating a vehicle, wherein the vehicle comprises an onboard controller, the method comprising automatically detecting operation of the vehicle within a site defined by a geographic boundary; and providing to the vehicle operational characteristics associated with the site, wherein the onboard controller causes the vehicle to operate in accordance with the operational characteristics while the vehicle remains within the site.

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Background/Summary

TECHNICAL FIELD

[0001] This disclosure relates in general to the field of fleet management of lightweight utility vehicles, such as golf carts and, more particularly, though not exclusively, to a system for controlling the speed and other operational characteristics of such vehicles based on the respective sites in which the vehicles are located.

BACKGROUND

[0002] Lightweight electric utility vehicles (LEUVs), such as golf carts, are increasingly becoming a popular mode of transportation for both golfers on golf courses as well as for residents of certain communities, particularly gated communities. LEUVs are quiet and eco-friendly, making them a desirable alternative to gas-powered vehicles.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] To provide a more complete understanding of the present disclosure and features and advantages thereof, reference is made to the following description, taken in conjunction with the accompanying figures, in which like reference numerals represent like elements:

[0004] FIG. **1** illustrates an example LEUV in connection with which embodiments described herein for an electric vehicle site-based speed control system may be implemented;

[0005] FIG. **2**A illustrates a simplified block diagram of an example site in which electric vehicle site-based assignment of operational characteristics according to features of embodiments described herein may be implemented;

[0006] FIG. **2**B illustrates a simplified block diagram of an example vehicle in which electric vehicle site-based assignment of operational characteristics according to features of embodiments described herein may be implemented;

[0007] FIG. **3** is a flowchart illustrating example operations that may be performed by an electric vehicle site-based assignment of operational characteristics according to features of embodiments described herein; and

[0008] FIG. **4** is a block diagram of an example computer system that may be used to implement all or some portion of a system for electric vehicle site-based assignment of operational characteristics according to features of embodiments described herein.

DETAILED DESCRIPTION

[0009] The following disclosure describes various illustrative embodiments and examples for implementing the features and functionality of the present disclosure. While particular components, arrangements, and/or features are described below in connection with various example embodiments, these are merely examples used to simplify the present disclosure and are not intended to be limiting. It will of course be appreciated that in the development of any actual embodiment, numerous implementation-specific decisions must be made to achieve the developer's specific goals, including compliance with system, business, and/or legal constraints, which may vary from one implementation to another. Moreover, it will be appreciated that, while such a development effort might be complex and time-consuming; it would nevertheless be a routine undertaking for those of ordinary skill in the art having the benefit of this disclosure.

[0010] In the specification, reference may be made to the spatial relationships between various components and to the spatial orientation of various aspects of components as depicted in the attached drawings. However, as will be recognized by those skilled in the art after a complete reading of the present disclosure, the devices, components, members, apparatuses, etc. described herein may be positioned in any desired orientation. Thus, the use of terms such as “above”, “below”, “upper”, “lower”, “top”, “bottom”, “raised”, “lowered”, or other similar terms to describe a spatial relationship between various components or to describe the spatial orientation of aspects of such components, should be understood to describe a relative relationship between the components or a spatial orientation of aspects of such components, respectively, as the components described herein may be oriented in any desired direction. When used to describe a range of dimensions or other characteristics (e.g., time, pressure, temperature, length, width, etc.) of an element, operations, and/or conditions, the phrase "between X and Y" represents a range that includes X and Y.

[0011] Additionally, as referred to herein in this specification, the terms "forward," "aft," "inboard," and "outboard" may be used to describe relative relationship(s) between components and/or spatial orientation of aspect(s) of a component or components. The term "forward" may refer to a spatial direction that is closer to a front of a vehicle relative to another component or component aspect(s). The term "aft" may refer to a spatial direction that is closer to a rear of a vehicle relative to another component or component aspect(s). The term "inboard" may refer to a location of a component that is within the fuselage of a vehicle and/or a spatial direction that is closer to or along a centerline of the vehicle (wherein the centerline runs between the front and the rear of the vehicle) or other point of reference relative to another component or component aspect. The term "outboard" may refer to a location of a component that is outside the fuselage of a vehicle and/or a spatial direction that is farther from the centerline of the vehicle or other point of reference relative to another component or component aspect.

[0012] Further, the present disclosure may repeat reference numerals and/or letters in the various examples. This repetition is for the purpose of simplicity and clarity and does not in itself dictate a relationship between the various embodiments and/or configurations discussed. Example embodiments that may be used to implement the features and functionality of this disclosure will now be described with more particular reference to the accompanying figures.

[0013] FIG. **1** illustrates a vehicle **100** in connection with which embodiments described herein for an electric vehicle location-based speed control system may be implemented. In particular embodiments, vehicle **100** may be an LEUV. As shown in FIG. **1**, vehicle **100** is generally an open cabin vehicle, such as a golf cart, a utility vehicle, a maintenance vehicle, a cargo vehicle, a shuttle vehicle, a personal transportation vehicle, etc., that includes a main passenger seating area **102**, an auxiliary passenger seating area **104** disposed behind the main passenger seating area **102**, and a canopy **106** primarily disposed over the main passenger seating area **102**. Canopy **106** may be mounted to vehicle **100** and supported over (or above) main passenger seating area **102** via support struts **108**. In particular embodiments support struts **108** may provide a rollover protection system (ROPS) for the vehicle **100**.

[0014] The main passenger seating area **102** generally includes a primary seating structure **110**, a steering wheel **112** for use by an operator (or driver) of the vehicle **100** to control the directional movement of the vehicle, a brake pedal **114** for use by the vehicle operator to control slowing and stopping of the vehicle, and an accelerator pedal **116** for use by the vehicle operator to control the torque delivered by one or more vehicle prime movers (not shown) to one or more rear wheels **118** and one or more front wheels **120**. Auxiliary passenger seating area **104** generally includes an auxiliary seating structure **122** that can be attached to the rear portion of vehicle **100** behind primary seating structure **110** to provide additional seating capacity for the vehicle. More particularly, auxiliary seating structure **122** provides seating capacity in addition to that provided by the primary seating structure **110**. Primary seating structure **110** is generally structured and operable to accommodate a vehicle operator and at least one passenger in a forward-facing (i.e., toward the front of vehicle **100**) position, while auxiliary seating structure **122** is generally structured and operable to accommodate at least two passengers in a rearward-facing (i.e., toward the rear of vehicle **100**) position. In particular embodiments, vehicle **100** includes one or more speakers **124** and a display **126**, all of which may be provided on a dashboard **128** of vehicle **100**. One or more controls associated with speakers **124** and display **126** may also be provided on or near dashboard **128**.

[0015] In accordance with features of embodiments described herein, an intelligent fleet management system may be deployed to manage various operational aspects of a fleet of vehicles, such as vehicle **100**, to increase vehicle and passenger safety, for example. One manner in which such an intelligent fleet management system may increase safety is by controlling the speed of the vehicles managed by the system. A fleet management system may be associated with a defined geographic area, such as a golf course or residential community, referred to herein as a "site." In such cases, a governing body associated with the site may adopt specifications and/or regulations dictating configuration settings, including operational restrictions, of vehicles operating within the site controlled by the governing body. Such configuration settings (alternatively referred to herein as operational characteristics or operational attributes) may include, but are not limited to, maximum vehicle speed, maximum vehicle acceleration, vehicle battery charge/discharge characteristics, inertial measurement unit (IMU) characteristics and restrictions, telemetry data, maximum charge status, motor controller software versions, smart regeneration characteristics, etc. Although embodiments herein will be described primarily with reference to maximum vehicle speed configuration settings, it will be recognized that features of embodiments are equally applicable to other configuration settings, including but not limited to those previously listed.
[0016] Historically, when a vehicle is delivered to a site, it must be manually configured for operation within the site. In contrast, in accordance with features of embodiments described herein, configuration settings may be automatically applied to a vehicle-based on a site ID associated with the site in which the vehicle is to operate. In a related feature, movement of a vehicle from one site to another may result in its configuration settings being automatically updated based on the new site ID. Site-specific configuration may be desirable for many reasons. For example, the topography and/or climate of sites may differ widely (e.g., hilly vs. flat, bumpy vs. smooth, hot vs. cold, etc.) in ways that impact various aspects of the operation of vehicles operating within the boundaries of the site. For example, if a site is predominantly hilly, it may be desirable to impose an operational attribute that restricts the maximum power/charge status of a vehicle to avoid overheating coils. Additionally, there may be regulations that apply to certain sites that do not apply to other sites based on the relative locations of the sites (e.g., certain countries may have particular privacy requirements that may restrict how telemetry may be used, whereas other countries may not have those restrictions). Still further, the governing body of one site may desire that vehicles operating within the site stay within predefined operational limits (e.g., speed, IMU restrictions, etc.), whereas the governing body of another site may have different (more stringent or more relaxed) requirements.
[0017] Example operational characteristics or attributes that may be specified in accordance with features of embodiments described herein include but are not limited to those related to battery characteristics, charge characteristics, smart regen characteristics, motor control software version, IMU characteristics, and regulatory issues. In additional aspects of particular embodiments, operational characteristics/attributes may include identifying an individual or individuals who are authorized to operate a vehicles or vehicles within the site, either by specifying a default list of authorized operators by ID or title and/or enabling a valet mode that may be initiated under particular circumstances to allow any operator to operate a vehicle for a particular distance or amount of time, for example. In some embodiments, moving the vehicle from one site to another results in automatic updating of the operational characteristics/attributes of the vehicle from those associated with the first site to those associated with the second.
[0018] FIG. **2**A illustrates a simplified block diagram of a site **200** according to some embodiments of the present disclosure. In accordance with features of embodiments described herein, site **200** includes a plurality of vehicles **202**, each of which may be substantially similar, if not completely identical, to vehicle **100** (FIG. **1**). Site **200** further includes a fleet management system **204** in communication with vehicles **202** through a network **206**. In various embodiments, network **206** may be a public or private network or may comprise a combination of public and/or private

networks. In other embodiments, site **200** may include fewer, more, or different components. For instance, site **200** may include a different number of vehicles **202**. Alternatively, fleet management system **204** may be associated with multiple sites, such as site **200**. A single vehicle may be referred to herein as vehicle **202**. Multiple vehicles may be referred to collectively as vehicles **202**.

[0019] Vehicle **202** may include one or more onboard sensors that detect various aspects of the environment in which vehicle **202** is operating and generate sensor data indicative of same. In some embodiments, onboard sensors may include one or more of global positioning system (GPS), wheel speed sensors, IMUs, accelerometers, microphones, strain gauges, pressure monitors, barometers, thermometers, altimeters, and ambient light sensors, for example. The sensors may be positioned in various locations on vehicle **202**.

[0020] Vehicle **202** may also include an onboard controller. The onboard controller controls operations and functionality of vehicle **202**. In some embodiments, the onboard controller may be a general-purpose computer or some portion thereof, but may additionally or alternatively be any suitable computing device. The onboard controller may be adapted for I/O communication with other components of vehicle **202**, such as sensors, and with external systems, such as fleet management system **204**. The onboard controller may be connected to the Internet (e.g., network **206**) via a wireless connection (e.g., via a cellular data connection). Additionally or alternatively, the onboard controller may be coupled to any number of wireless or wired communication systems comprising network **206**. The onboard controller may process sensor data generated by the onboard sensors and/or other data (e.g., data received from fleet management system **204**) to determine a state of vehicle **202**. Onboard controller may be coupled to other components of vehicle **202**, such as onboard sensors, via a controller area network (CAN) bus.

[0021] Vehicle **202** may include a rechargeable battery for powering the vehicle. The rechargeable battery may be a lithium-ion battery, a lithium polymer battery, a lead-acid battery, a nickel-metal hydride battery, a sodium nickel chloride (“zebra”) battery, a lithium-titanate battery, or another type of rechargeable battery suitable for powering vehicle **202**. In some embodiments, vehicle **202** may be a hybrid electric vehicle that may also include an internal combustion engine for powering the vehicle when the battery is in a low charge state, for example. In some embodiments, vehicle **202** may include multiple batteries, in which case one battery may be used to power vehicle propulsion another may be used to power vehicle hardware (e.g., onboard sensors and/or onboard controller **117**). Vehicle **202** may further include components for charging the battery, including for example a charge port configured to make an electrical connection between the battery and a charging station.

[0022] The fleet management system **204** may support operation and management of vehicles **202**. In some embodiments, the fleet management system **204** may also provide vehicle **202** with system backend functions and may include one or more switches, servers, and/or automated response systems (which responses may be provided via vehicle speakers and/or display). Fleet management system **204** may also include one or more databases, represented in FIG. **2**A by a database **208**. Any or all of the aforementioned components of the fleet management system **204** may be coupled to one another via a wired or wireless local area network (LAN). The fleet management system **204** may receive and transmit data via one or more appropriate devices and network from and to the vehicle **202**, such as by wireless systems, such as 882.11x, GPRS, and the like. Database **208** can store configuration information for each of vehicles **202**, such as configuration attributes based on a site ID of site **200** (also referred to herein as site-specific operational attributes) and/or, in some embodiments, configuration attributes based on a vehicle ID or type of vehicle **202** (also referred to herein as vehicle-specific operational attributes). Some of configuration information stored in database **208** for vehicle **202** may be specific to the individual vehicle while other configuration information stored in database **208** may be general to all vehicles **202** of the fleet.

[0023] Database **208** may also store a site map and/or information about site features, which may be in the form of sets of GPS coordinates. For example, if site is a golf course, fleet management system **204** site features stored in database **208** may include greens, pins, holes, fairways, obstacles (e.g., sand traps, water features, etc.). Fleet management system **204** may communicate with vehicle **202** to provide route guidance or location information in response to a request received from the vehicle.

[0024] A geofence may be considered a virtual perimeter for a real-world geographic area. A geofence can be dynamically generated (e.g., a radius around a point location) or match a predefined set of boundaries (e.g., golf course fairway boundaries). The use of a geofence is commonly referred to as geofencing. Presently, fleet management systems for lightweight utility vehicles, such as golf carts, allow for geofences to be defined by a human operator (e.g., a manager) of a site (e.g., a golf course) on which a fleet of vehicles operates. Limitations on operations permitted to be performed by fleet vehicles within a particular geofenced area may be determined by the operator based on his or her experience, as well as his or her familiarity with the geography and topography of the site. Such operational limitations may include limiting the speed of a vehicle, disabling forward motion of a vehicle, disabling any motion of a vehicle, providing audible alerts using a speaker of the vehicle, and providing text, graphics, and/or video messages on a vehicle display.

[0025] Network **206** can support communications between vehicles **202** and fleet management system **204**. Network **206** may comprise any combination of local area and/or wide area networks, using both wired and/or wireless communication systems. In one embodiment, network **206** may use standard communications technologies and/or protocols. For example, the network **206** may include communication links using technologies such as Ethernet, 802.11, worldwide interoperability for microwave access (WiMAX), 3G, 4G, code division multiple access (CDMA), digital subscriber line (DSL), etc. Examples of networking protocols used for communicating via network **206** may include multiprotocol label switching (MPLS), transmission control protocol/Internet protocol (TCP/IP), hypertext transport protocol (HTTP), simple mail transfer protocol (SMTP), and file transfer protocol (FTP). Data exchanged over the network **130** may be represented using any suitable format, such as hypertext markup language (HTML) or extensible markup language (XML). In some embodiments, all or some of the communication links of network **206** may be encrypted using any suitable technique or techniques.

[0026] FIG. **2**B illustrates a more detailed system block diagram of vehicle **202**. As shown in FIG. **2**B, and as described above, vehicle **202** includes an onboard controller **230** including a communications module **232** for communicating with fleet management system **204** (FIG. **2**A) via network **206** (FIG. **2**A). A motor controller **234** for controlling motive operation of vehicle **202** includes an IMU **236** and is connected to onboard controller **230** via a vehicle data network **238**, which may be implemented as a CAN bus. In particular embodiments, motor controller **234** includes wheel speed sensors and other sensors for sensing various operational aspects of vehicle and providing data indicative of same to fleet management system **204** (FIG. **2**A). In alternative embodiments, IMU **236** could be deployed externally to controller **234**. For example, IMU **236** could be deployed internally to onboard controller **230** or another module of vehicle **202** or as a standalone module.

[0027] It will be recognized that IMU **236** may be implemented as an electronic sensing device that measures and reports the specific force, angular rate and/or orientation of a body on which it is installed. In particular embodiments, an IMU detects linear acceleration of the body using one or more accelerometers and rotational rate of the body using one or more gyroscopes. An IMU may also include one or more magnetometers for use as a heading reference. In a typical configuration, an IMU may include one accelerometer, one gyroscope, and one magnetometer per axis for each of three principal axes (e.g., pitch, roll, yaw (or x, y, z)). As used herein, IMU refers to any combination of accelerometers, gyroscopes and/or magnetometers that together perform the aforementioned purposes of an IMU. Integration of an IMU with a GPS and other sensors, such as a wheel speed sensor, provides the ability to gather data about the vehicle's current speed, turn rate,

heading, inclination and acceleration, which data may collectively be referred to herein as “vehicle motion data.”
[0028] IMU **212** is capable of measuring acceleration in all three coordinate directions (pitch, roll, yaw or x, y, z) and angular speed about all three coordinates. The IMU data is combined with vehicle velocity data (e.g., provided by one or more sensors of motor controller **234**) and providing resultant motion data to fleet management system **204** via communications module **232**, enabling a variety of conditions of vehicle **202** to be determined and monitored by fleet management system **204**. Additionally, global positioning system (GPS) capabilities of onboard controller **230** enable IMU motion data to be correlated to a GPS location, which location information is also provided to fleet management system **204**.
[0029] One or more memory or storage devices **240** may be provided for purposes to be described in greater detail hereinbelow. In FIG. **2**B, memory **240** is shown as being connected to CAN bus **238**; however, in alternative embodiments, memory may be directly connected to onboard controller **230**.
[0030] FIG. **3** is a flowchart **300** illustrating example operations performed by a system for implementing a braking assist feature in an electric vehicle, such as vehicle **202**, according to features of embodiments described herein. In certain embodiments, one or more of the operations illustrated in FIG. **3** may be executed by one or more of the elements shown in FIGS. **2**A and **2**B, for example.
[0031] In operation **302**, a vehicle, such as vehicle **202** (FIG. **2**A), arrives within a geographical area (e.g., site **200** (FIG. **2**A)) having an associated site ID. Detection by fleet management system of a vehicle within the boundaries of the site may be performed in any number of known manners.
[0032] In operation **304**, the fleet management system of the site (e.g., fleet management system **204** (FIG. **2**A)) connects to the onboard controller (e.g., controller **230**) of the vehicle. It will be recognized that in particular implementations, operations **302** and **304** may be performed as a single operation or simultaneous operations.
[0033] In optional operation **306**, the fleet management system determines the vehicle ID and/or vehicle type of the vehicle. Operation **306** allows fleet management system to uniquely identify the vehicle within the system for purposes described in greater detail below.
[0034] In operation **308**, the fleet management system download operational attributes associated with the site (e.g., based on the site ID) to the onboard controller of the vehicle.
[0035] In optional operation **310**, the fleet management system further downloads operational attributes associated with the vehicle ID and/or vehicle type to the onboard controller of the vehicle.
[0036] In operation **312**, the onboard controller of the vehicle controls the operation of the vehicle In accordance and compliance with the operational attributes downloaded in operations **306** and/or **310**.
[0037] It will be recognized that events other than/in addition to detection of a vehicle within the boundaries of a site may trigger performance of operations shown in FIG. **3**. For example, the operations may be performed according to a predefined schedule (e.g., once a day, once a week, once a month), in response to a manual reset implemented at the fleet management system, and/or in response to one or more of the site-specific or vehicle-specific operational attributes being updated at the fleet management system.
[0038] It will be recognized that site-based and vehicle-based attributes to be implemented at vehicles may be modified at the “back end” (i.e., at fleet management system). In some embodiments, such modification may be performed manually by a fleet management system operator, with the updates to the vehicles being effected as described above with reference to FIG. **3**. In alternative embodiments, the modification may be performed automatically, such as by an algorithm implemented in software (e.g., by the fleet management system) in response to feedback and/or other relevant data. In still other embodiments, the modification may be performed

automatically using artificial intelligence (AI), such as a neural network or machine learning model trained to optimize the operational characteristic for the particular site, such that a predictive element may be introduced.

[0039] Although the operations of the example method shown in and described with reference to FIG. **3** are illustrated as occurring once each and in a particular order, it will be recognized that the operations may be performed in any suitable order and repeated as desired. Additionally, one or more operations may be performed in parallel or simultaneously. Furthermore, the operations illustrated in FIG. **3** may be combined or may include more or fewer details than described.

[0040] Additionally, although embodiments have been described herein primarily with specific reference to electric golf carts, it will be recognized that the various features and aspects described may be advantageously applied in connection with other types of electric utility or other vehicles, including but not limited to turf vehicles and ground support equipment (GSE) vehicles.

[0041] FIG. **4** is a block diagram illustrating an example system **400** that may be configured to implement at least portions of techniques in accordance with embodiments described herein, and more particularly as shown in the FIGURES described hereinabove. For example, one or more elements of system **400** may be employed to implement portions of fleet management system **204**, onboard controller **230**, and/or motor controller **234** (FIGS. **2**A and **2**B). As shown in FIG. **4**, the system **400** may include at least one processor **402**, e.g., a hardware processor **402**, coupled to memory elements **404** through a system bus **406**. As such, the system may store program code and/or data within memory elements **404**. Further, the processor **402** may execute the program code accessed from the memory elements **404** via a system bus **406**. In one aspect, the system may be implemented as a computer that is suitable for storing and/or executing program code. It should be appreciated, however, that the system **400** may be implemented in the form of any system including a processor and a memory that is capable of performing the functions described in this disclosure.

[0042] In some embodiments, the processor **402** can execute software or an algorithm to perform the activities as discussed in this specification; in particular, activities related to embodiments described herein. The processor **402** may include any combination of hardware, software, or firmware providing programmable logic, including by way of non-limiting example a microprocessor, a digital signal processor (DSP), a field-programmable gate array (FPGA), a programmable logic array (PLA), an integrated circuit (IC), an application specific IC (ASIC), or a virtual machine processor. The processor **402** may be communicatively coupled to the memory element **404**, for example in a direct-memory access (DMA) configuration, so that the processor **402** may read from or write to the memory elements **404**.

[0043] In general, the memory elements **404** may include any suitable volatile or non-volatile memory technology, including double data rate (DDR) random access memory (RAM), synchronous RAM (SRAM), dynamic RAM (DRAM), flash, read-only memory (ROM), optical media, virtual memory regions, magnetic or tape memory, or any other suitable technology. Unless specified otherwise, any of the memory elements discussed herein should be construed as being encompassed within the broad term “memory.” The information being measured, processed, tracked or sent to or from any of the components of the system **400** could be provided in any database, register, control list, cache, or storage structure, all of which can be referenced at any suitable timeframe. Any such storage options may be included within the broad term “memory” as used herein. Similarly, any of the potential processing elements, modules, and machines described herein should be construed as being encompassed within the broad term “processor.” Each of the elements shown in the present figures may also include suitable interfaces for receiving, transmitting, and/or otherwise communicating data or information in a network environment so that they can communicate with, for example, a system having hardware similar or identical to another one of these elements.

[0044] In certain example implementations, mechanisms for implementing embodiments as outlined herein may be implemented by logic encoded in one or more tangible media, which may be inclusive of non-transitory media, e.g., embedded logic provided in an ASIC, in DSP instructions, software (potentially inclusive of object code and source code) to be executed by a processor, or other similar machine, etc. In some of these instances, memory elements, such as e.g., the memory elements **404** shown in FIG. **4** can store data or information used for the operations described herein. This includes the memory elements being able to store software, logic, code, or processor instructions that are executed to carry out the activities described herein. A processor can execute any type of instructions associated with the data or information to achieve the operations detailed herein. In one example, the processors, such as e.g., the processor **402** shown in FIG. **4**, could transform an element or an article (e.g., data) from one state or thing to another state or thing. In another example, the activities outlined herein may be implemented with fixed logic or programmable logic (e.g., software/computer instructions executed by a processor) and the elements identified herein could be some type of a programmable processor, programmable digital logic (e.g., an FPGA, a DSP, an erasable programmable read-only memory (EPROM), an electrically erasable programmable read-only memory (EEPROM)) or an ASIC that includes digital logic, software, code, electronic instructions, or any suitable combination thereof.

[0045] The memory elements **404** may include one or more physical memory devices such as, for example, local memory **408** and one or more bulk storage devices **140**. The local memory may refer to RAM or other non-persistent memory device(s) generally used during actual execution of the program code. A bulk storage device may be implemented as a hard drive or other persistent data storage device. The processing system **400** may also include one or more cache memories (not shown) that provide temporary storage of at least some program code in order to reduce the number of times program code must be retrieved from the bulk storage device **140** during execution.

[0046] As shown in FIG. **4**, the memory elements **404** may store a braking assist module **420**. In various embodiments, the module **420** may be stored in the local memory **408**, the one or more bulk storage devices **140**, or apart from the local memory and the bulk storage devices. It should be appreciated that the system **400** may further execute an operating system (not shown in FIG. **4**) that can facilitate execution of the module **420**. The module **420**, being implemented in the form of executable program code and/or data, can be read from, written to, and/or executed by the system **400**, e.g., by the processor **402**. Responsive to reading from, writing to, and/or executing the module **420**, the system **400** may be configured to perform one or more operations or method steps described herein (e.g., in FIG. **3**).

[0047] Input/output (I/O) devices depicted as an input device **412** and an output device **414**, optionally, may be coupled to the system. Examples of input devices may include, but are not limited to, a keyboard, a pointing device such as a mouse, or the like. Examples of output devices may include, but are not limited to, a monitor or a display, speakers, or the like. In some implementations, the system may include a device driver (not shown) for the output device **414**. Input and/or output devices **412**, **414** may be coupled to the system **400** either directly or through intervening I/O controllers. Additionally, sensors **415** may be coupled to the system **400** either directly or through intervening controllers and/or drivers.

[0048] In an embodiment, the input and the output devices may be implemented as a combined input/output device (illustrated in FIG. **4** with a dashed line surrounding the input device **412** and the output device **414**). An example of such a combined device is a touch sensitive display, also sometimes referred to as a “touch screen display” or simply “touch screen.” In such an embodiment, input to the device may be provided by a movement of a physical object, such as, e.g., a stylus or a finger of a user, on or near the touch screen display.

[0049] A network adapter **416** may also, optionally, be coupled to the system **400** to enable it to become coupled to other systems, computer systems, remote network devices, and/or remote storage devices through intervening private or public networks. The network adapter may comprise a data receiver for receiving data that is transmitted by said systems, devices and/or networks to the system **400**, and a data transmitter for transmitting data from the system **400** to said systems, devices and/or networks. Modems, cable modems, and Ethernet cards are examples of different types of network adapter that may be used with the system **400**.

[0050] Example 1 provides a method of operating a vehicle, in which the vehicle includes an onboard controller, the method including automatically detecting operation of the vehicle within a site defined by a geographic boundary; providing to the vehicle operational characteristics associated with the site; in which the onboard controller causes the vehicle to operate in accordance with the operational characteristics while the vehicle remains within the site.

[0051] Example 2 provides the method of example 1, in which the vehicle is an electrical vehicle.

[0052] Example 3 provides the method of example 1 or 2, further including automatically detecting at least one of an identity of the vehicle and a type of the vehicle; and providing to the vehicle operational characteristics associated with the at least one of the identity of the vehicle and the type of the vehicle.

[0053] Example 4 provides the method of any one of examples 1-3, further including updating the vehicle operational characteristics associated with the site; and providing the updated vehicle operational characteristics associated with the site to the vehicle.

[0054] Example 5 provides the method of example 4, in which the onboard controller ceases causing the vehicle to operate in accordance with the operational characteristics while the vehicle remains within the site and causes the vehicle to operate in accordance with the updated operational characteristics while the vehicle remains within the site.

[0055] Example 6 provides the method of example 4 or 5, in which the updating occurs automatically and periodically throughout operation of the vehicle.

[0056] Example 7 provides the method of any one of examples 4-6, in which the updating is performed using artificial intelligence.

[0057] Example 8 provides the method of any one of examples 4-7, in which the updating is performed manually by an operator of the site.

[0058] Example 9 provides the method of any one of examples 1-8, in which the site includes a first site and the geographic boundary includes a first geographic boundary, the method further including automatically detecting that the vehicle is no longer operating within the first site and is operating within a second site defined by a second geographic boundary; and providing to the vehicle operational characteristics associated with the second site; in which the onboard controller causes the vehicle to operate in accordance with the operational characteristics of the second site while the vehicle remains within the second site.

[0059] Example 10 provides the method of any one of examples 1-9, in which the operational characteristics include at least one of a maximum vehicle speed, a maximum vehicle speed, vehicle battery charge characteristics, vehicle battery discharge characteristics, inertial measurement unit characteristics, data privacy requirements, a motor controller software version, and smart regeneration characteristics.

[0060] Example 11 provides an electric vehicle (EV) for operation within a site defined by a geographic boundary, the EV including a motor controller for controlling application of rotational torque to wheels of the EV; an onboard controller for controlling operation of the motor controller, the onboard controller further configured to receive operational characteristics from a fleet management system, in which the operational characteristics are associated with the site; in which the onboard controller causes the EV to operate in accordance with the operational characteristics while the EV remains within the site.

[0061] Example 12 provides the EV of example 11, in which the EV includes a golf cart and the site includes a golf course.

[0062] Example 13 provides the EV of example 11 or 12, in which the onboard controller is further configured to receive additional operational characteristics from a fleet management system, in which the additional operational characteristics are associated with at least one of an identity of the EV and a type of the EV; in which the onboard controller further causes the EV to operate in

accordance with the additional operational characteristics while the EV remains within the site.
[0063] Example 14 provides the EV of any one of examples 11-13, in which the site includes a first site and the geographic boundary includes a first geographic boundary, and in which when the EV ceases operation within the first site and begins operation within a second site defined by a second geographic boundary, the onboard controller is further configured to receive from the fleet management system operational characteristics associated with the second site; in which the onboard controller causes the EV to cease operating in accordance with the operational characteristics associated with the first site and to operate in accordance with the operational characteristics associated with the second site while the EV remains within the second site.
[0064] Example 15 provides the EV of any one of examples 11-14, in which the operational characteristics include at least one of a maximum vehicle speed, a maximum vehicle speed, vehicle battery charge characteristics, vehicle battery discharge characteristics, inertial measurement unit characteristics, data privacy requirements, a motor controller software version, and smart regeneration characteristics.
[0065] Example 16 provides a fleet management system for managing a plurality of EVs including onboard computers for controlling operation of the EVs, the fleet management system configured to: automatically detecting operation of the EVs within a site defined by a geographic boundary; providing to the EVs operational characteristics associated with the site; in which the onboard controllers of the EVs cause the EVs to operate in accordance with the operational characteristics while the EVs remain within the site.
[0066] Example 17 provides the fleet management system of example 16, in which the fleet management system is further configured to, for at least one of the EVs: automatically at least one of an identity of the EV and a type of the EV; and provide to the at least one of the EVs operational characteristics associated with the at least one of the identity of the EV and the type of the EV.
[0067] Example 18 provides the fleet management system of example 16 or 17, in which the fleet management system is further configured to: determine updated the vehicle operational characteristics associated with the site; and provide the updated vehicle operational characteristics associated with the site to the EVs; in which subsequent to receipt of the updated vehicle operational characteristics associated with the site, the onboard controllers of the EVs cease causing the EVs to operate in accordance with the operational characteristics associated with the site and to cause the EVs to operate in accordance with the updated operational characteristics associated with the site while the vehicle remains within the site.
[0068] Example 19 provides the method of any one of examples 4-8, in which the determining the updated vehicle operational characteristics occurs automatically and periodically throughout operation of the EV.
[0069] Example 20 provides the fleet management system of any one of examples 16-18, in which the site includes a first site and the geographic boundary includes a first geographic boundary, and in which the fleet management system is further configure to: automatically detecting that at least one of the EVs is no longer operating within the first site and is operating within a second site defined by a second geographic boundary; and providing to the at least one of the EVs operational characteristics associated with the second site; in which the onboard controller of the at least one EV causes the at least one EV to operate in accordance with the operational characteristics of the second site while the at least one EV remains within the second site.
[0070] At least one embodiment is disclosed, and variations, combinations, and/or modifications of the embodiment(s) and/or features of the embodiment(s) made by a person having ordinary skill in the art are within the scope of the disclosure. Alternative embodiments that result from combining, integrating, and/or omitting features of the embodiment(s) are also within the scope of the disclosure. Where numerical ranges or limitations are expressly stated, such express ranges or limitations should be understood to include iterative ranges or limitations of like magnitude falling within the expressly stated ranges or limitations (e.g., from about 1 to about 10 includes, 2, 3, 4,

etc.; greater than 0.10 includes 0.11, 0.12, 0.13, etc.). For example, whenever a numerical range with a lower limit, Rl, and an upper limit, Ru, is disclosed, any number falling within the range is specifically disclosed. In particular, the following numbers within the range are specifically disclosed: R=Rl+k*(Ru−Rl), wherein k is a variable ranging from 1 percent to 100 percent with a 1 percent increment, i.e., k is 1 percent, 2 percent, 3 percent, 4 percent, 5 percent, . . . 50 percent, 51 percent, 52 percent, . . . , 95 percent, 96 percent, 95 percent, 98 percent, 99 percent, or 100 percent. Moreover, any numerical range defined by two R numbers as defined in the above is also specifically disclosed. Use of the term “optionally” with respect to any element of a claim means that the element is required, or alternatively, the element is not required, both alternatives being within the scope of the claim. Use of broader terms such as comprises, includes, and having should be understood to provide support for narrower terms such as consisting of, consisting essentially of, and comprised substantially of. Accordingly, the scope of protection is not limited by the description set out above but is defined by the claims that follow, that scope including all equivalents of the subject matter of the claims. Each and every claim is incorporated as further disclosure into the specification and the claims are embodiment(s) of the present invention. Also, the phrases “at least one of A, B, and C” and “A and/or B and/or C” should each be interpreted to include only A, only B, only C, or any combination of A, B, and C. The terms “substantially,” “close,” “approximately,” “near,” and “about,” generally refer to being within +/−5-20% of a target value based on the context of a particular value as described herein or as known in the art. Similarly, terms indicating orientation of various elements, e.g., “coplanar,” “perpendicular,” “orthogonal,” “parallel,” or any other angle between the elements, generally refer to being within +/−5-20% of a target value based on the context of a particular value as described herein or as known in the art.

[0071] The diagrams in the FIGURES illustrate the architecture, functionality, and/or operation of possible implementations of various embodiments of the present disclosure. Although several embodiments have been illustrated and described in detail, numerous other changes, substitutions, variations, alterations, and/or modifications are possible without departing from the spirit and scope of the present disclosure, as defined by the appended claims. The particular embodiments described herein are illustrative only and may be modified and practiced in different but equivalent manners, as would be apparent to those of ordinary skill in the art having the benefit of the teachings herein. Those of ordinary skill in the art would appreciate that the present disclosure may be readily used as a basis for designing or modifying other embodiments for carrying out the same purposes and/or achieving the same advantages of the embodiments introduced herein. For example, certain embodiments may be implemented using more, less, and/or other components than those described herein. Moreover, in certain embodiments, some components may be implemented separately, consolidated into one or more integrated components, and/or omitted. Similarly, methods associated with certain embodiments may be implemented using more, less, and/or other steps than those described herein, and their steps may be performed in any suitable order.

[0072] Numerous other changes, substitutions, variations, alterations, and modifications may be ascertained to one of ordinary skill in the art and it is intended that the present disclosure encompass all such changes, substitutions, variations, alterations, and modifications as falling within the scope of the appended claims.

[0073] One or more advantages mentioned herein do not in any way suggest that any one of the embodiments described herein necessarily provides all the described advantages or that all the embodiments of the present disclosure necessarily provide any one of the described advantages. Note that in this specification, references to various features included in “one embodiment”, “example embodiment”, “an embodiment”, “another embodiment”, “certain embodiments”, “some embodiments”, “various embodiments”, “other embodiments”, “alternative embodiment”, and the like are intended to mean that any such features are included in one or more embodiments of the

present disclosure but may or may not necessarily be combined in the same embodiments.
[0074] As used herein, unless expressly stated to the contrary, use of the phrase “at least one of,” “one or more of” and “and/or” are open ended expressions that are both conjunctive and disjunctive in operation for any combination of named elements, conditions, or activities. For example, each of the expressions “at least one of X, Y and Z”, “at least one of X, Y or Z”, “one or more of X, Y and Z”, “one or more of X, Y or Z” and “A, B and/or C” can mean any of the following: 1) X, but not Y and not Z; 2) Y, but not X and not Z; 3) Z, but not X and not Y; 4) X and Y, but not Z; 5) X and Z, but not Y; 6) Y and Z, but not X; or 7) X, Y, and Z. Additionally, unless expressly stated to the contrary, the terms “first,” “second,” “third,” etc., are intended to distinguish the particular nouns (e.g., blade, rotor, element, device, condition, module, activity, operation, etc.) they modify. Unless expressly stated to the contrary, the use of these terms is not intended to indicate any type of order, rank, importance, temporal sequence, or hierarchy of the modified noun. For example, “first X” and “second X” are intended to designate two X elements that are not necessarily limited by any order, rank, importance, temporal sequence, or hierarchy of the two elements. As referred to herein, “at least one of,” “one or more of,” and the like can be represented using the “(s)” nomenclature (e.g., one or more element(s)).
[0075] In order to assist the United States Patent and Trademark Office (USPTO) and, additionally, any readers of any patent issued on this application in interpreting the claims appended hereto, Applicant wishes to note that the Applicant: (a) does not intend any of the appended claims to invoke paragraph (f) of 35 U.S.C. Section 112 as it exists on the date of the filing hereof unless the words “means for” or “step for” are specifically used in the particular claims; and (b) does not intend, by any statement in the specification, to limit this disclosure in any way that is not otherwise reflected in the appended claims.

Claims

1. A method of operating a vehicle, wherein the vehicle comprises an onboard controller, the method comprising: automatically detecting operation of the vehicle within a site defined by a geographic boundary; and providing to the vehicle operational characteristics associated with the site; wherein the onboard controller causes the vehicle to operate in accordance with the operational characteristics while the vehicle remains within the site.
2. The method of claim 1, wherein the vehicle is an electrical vehicle.
3. The method of claim 1, further comprising: automatically detecting at least one of an identity of the vehicle and a type of the vehicle; and providing to the vehicle operational characteristics associated with the at least one of the identity of the vehicle and the type of the vehicle.
4. The method of claim 1, further comprising: updating the vehicle operational characteristics associated with the site; and providing the updated vehicle operational characteristics associated with the site to the vehicle.
5. The method of claim 4, wherein the onboard controller ceases causing the vehicle to operate in accordance with the operational characteristics while the vehicle remains within the site and causes the vehicle to operate in accordance with the updated operational characteristics while the vehicle remains within the site.
6. The method of claim 4, wherein the updating occurs automatically and periodically throughout operation of the vehicle.
7. The method of claim 4, wherein the updating is performed using artificial intelligence.
8. The method of claim 4, wherein the updating is performed manually by an operator of the site.
9. The method of claim 1, wherein the site comprises a first site and the geographic boundary comprises a first geographic boundary, the method further comprising: automatically detecting that the vehicle is no longer operating within the first site and is operating within a second site defined by a second geographic boundary; and providing to the vehicle operational characteristics

associated with the second site; wherein the onboard controller causes the vehicle to operate in accordance with the operational characteristics of the second site while the vehicle remains within the second site.

10. The method of claim 1, wherein the operational characteristics comprise at least one of a maximum vehicle speed, a maximum vehicle speed, vehicle battery charge characteristics, vehicle battery discharge characteristics, inertial measurement unit characteristics, data privacy requirements, a motor controller software version, and smart regeneration characteristics.

11. An electric vehicle (EV) for operation within a site defined by a geographic boundary, the EV comprising: a motor controller for controlling application of rotational torque to wheels of the EV; and an onboard controller for controlling operation of the motor controller, the onboard controller further configured to receive operational characteristics from a fleet management system, wherein the operational characteristics are associated with the site; wherein the onboard controller causes the EV to operate in accordance with the operational characteristics while the EV remains within the site.

12. The EV of claim 11, wherein the EV comprises a golf cart and the site comprises a golf course.

13. The EV of claim 11, wherein the onboard controller is further configured to receive additional operational characteristics from a fleet management system, wherein the additional operational characteristics are associated with at least one of an identity of the EV and a type of the EV, and wherein the onboard controller further causes the EV to operate in accordance with the additional operational characteristics while the EV remains within the site.

14. The EV of claim 11, wherein the site comprises a first site and the geographic boundary comprises a first geographic boundary, wherein when the EV ceases operation within the first site and begins operation within a second site defined by a second geographic boundary, the onboard controller is further configured to receive from the fleet management system operational characteristics associated with the second site, and wherein the onboard controller causes the EV to cease operating in accordance with the operational characteristics associated with the first site and to operate in accordance with the operational characteristics associated with the second site while the EV remains within the second site.

15. The EV of claim 11, wherein the operational characteristics comprise at least one of a maximum vehicle speed, a maximum vehicle speed, vehicle battery charge characteristics, vehicle battery discharge characteristics, inertial measurement unit characteristics, data privacy requirements, a motor controller software version, and smart regeneration characteristics.

16. A fleet management system for managing a plurality of electric vehicles (EVs) comprising onboard computers for controlling operation of the EVs, the fleet management system configured to: automatically detecting operation of the EVs within a site defined by a geographic boundary; and providing to the EVs operational characteristics associated with the site; wherein the onboard controllers of the EVs cause the EVs to operate in accordance with the operational characteristics while the EVs remain within the site.

17. The fleet management system of claim 16, wherein the fleet management system is further configured to, for at least one of the EVs: automatically at least one of an identity of the EV and a type of the EV; and provide to the at least one of the EVs operational characteristics associated with the at least one of the identity of the EV and the type of the EV.

18. The fleet management system of claim 16, wherein the fleet management system is further configured to: determine updated the vehicle operational characteristics associated with the site; and provide the updated vehicle operational characteristics associated with the site to the EVs; wherein subsequent to receipt of the updated vehicle operational characteristics associated with the site, the onboard controllers of the EVs cease causing the EVs to operate in accordance with the operational characteristics associated with the site and to cause the EVs to operate in accordance with the updated operational characteristics associated with the site while the vehicle remains within the site.

19. The method of claim 16, wherein the determining the updated vehicle operational characteristics occurs automatically and periodically throughout operation of the EV.

20. The fleet management system of claim 16, wherein the site comprises a first site and the geographic boundary comprises a first geographic boundary, and wherein the fleet management system is further configure to: automatically detecting that at least one of the EVs is no longer operating within the first site and is operating within a second site defined by a second geographic boundary; and providing to the at least one of the EVs operational characteristics associated with the second site; wherein the onboard controller of the at least one EV causes the at least one EV to operate in accordance with the operational characteristics of the second site while the at least one EV remains within the second site.