

SYSTEM AND METHOD FOR PROVIDING ROUTE PLAN FOR VEHICLE

TECHNICAL FIELD

- 5 Various embodiments relate to a system and a method for providing a route plan information for a vehicle.

BACKGROUND

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The following discussion of the background art is intended to facilitate an understanding of the present disclosure only. It should be appreciated that the discussion is not an acknowledgement or admission that any of the material referred to was published, known or is part of the common general knowledge of the person skilled in the art in any jurisdiction as of the priority date of the disclosure.

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Vehicle operators may be anxious over a driving range during long distance driving. For example, Electric Vehicle (EV) operators may be anxious over the driving range, just in case battery runs flat before reaching a desired destination. This is particularly true for fleet operators operating EVs, such as public transport drivers including taxi drivers or bus drivers.

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For fleet operators who are assigned to conduct long-drive, where route planning and coordination between group of vehicles are highly expected during fleet operations, this can may induce unnecessary pressure to the fleet managers and fleet operators. Fleet operators often operate vehicles along predefined and generally invariant routes. For example, buses frequently operate on predefined routes, according to a predefined time schedule. Preparing a predefined route can be a tedious task. Conventional route planning software is available from a plurality of different vendors. As with any software application, a learning curve is involved. Furthermore, over time such predefined routes must be modified, to take into account of real-time changes, such as local traffic patterns, due to factors such as changes in traffic volumes on certain roads, road closures, and congestion due to

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road repairs and construction, requiring further use of route planning software to update an optimal route. The task of comparing actual driver performance using data collected from vehicles traversing a predefined route with the optimal route can require one or more additional programs be used to perform the comparison.

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Further thereto, depending on location of fleet operations, fleet managers need to comply with local, state and even federal regulations. By way of an example, fleet operators' safety regulations may include policies regarding a restricted number of on-road hours, thus ensure fleet operators to safely stop at the next resting station avoids hefty fines and penalties.

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Optimizing vehicle's health is also of importance for fleet management service providers, either for safety of the fleet operators through prevention of allowing fleet operators to operate on faulty fleet vehicle, or for reducing repair costs and extending lifespan of fleet vehicle.

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Accordingly, there exists a need for an improved system and method for providing a route plan information for the vehicle, that seek to address at least one of the aforementioned issues.

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SUMMARY

According to various embodiments, there is a system 100 for providing a route plan information from an origin location to a target location for a vehicle, the system 100 comprising: at least one sensor 140 operable to obtain data relating to a user; and a controller 120 operable to obtain at least one driving parameter; analyse the obtained data relating to the user and the obtained driving parameter; identify the user based on the analysis of the obtained data relating to the user; and determine a profile of the user based on the analysis of the obtained driving parameter, characterised in that: the controller 120 is further operable to generate a route plan information from the origin location to the target location for the vehicle based on the

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profile of the user and the driving parameter, wherein the route plan information includes a charging schedule information for the vehicle.

5 Advantageously, the system 100 may generate a route plan information for a pre-defined route, i.e. from an origin location to a target location, including a charging schedule information, by taking into consideration of a profile of the user and driving parameter of the vehicle, to optimised route planning.

10 In some embodiments, the controller 120 is further operable to: estimate a driving range of the vehicle based on the profile of the user and the driving parameter; estimate a charging requirement of the vehicle based on the profile of the user, the driving parameter, and the estimated driving range; and generate the route plan information including the charging schedule information, based on the estimated charging requirement.

15 Advantageously, the system 100 estimates a charging requirement of the vehicle from an origin location to a target location base on the user's profile and driving parameter to generate information on charging requirement of the vehicle's battery, when generating the route plan information. The aforesaid technical feature
20 optimises route planning function by providing information estimated based on vehicle battery consumption, which may increase cost efficiency for fleet management service providers, by optimising route plan information and keeping track of electrical consumption of EV trucks. The aforesaid feature may ensure users are in proper operation order, i.e., ensuring sufficient electricity to continue the
25 driving range and may further assist fleet management operators to ensure costs are kept to allocated budget for completion of fleet operation.

In some embodiments, the route plan information further includes a location of a rest stop for the vehicle, and the controller 120 is further operable to generate the route
30 plan information including location of the rest stop along the origin location to the target location, based on the profile of the user and the driving parameter.

Advantageously, the system 100 may generate information to create timely reminders for users driving a long-drive, to take a break at a rest stop, also known as rest area or rest location. More advantageously, for fleet management service providers, the aforesaid feature provides an automated manner of planning a number of on-road hours and suggestion of rest stop for fleet operators to either take a break or to change shift, thus ensuring compliance with safety policies may be automated through such information provided.

In some embodiments, the controller 120 is further operable to: generate a list containing one or more location of rest stops along the origin location to the target location ranked according to a ranking score for each of the one or more location of rest stops; and in response to a rejection input received by the controller (120) with respect to a first location of the rest stop generated on the list, generate a second location of the rest stop based on a ranking score lower than a ranking score of the first location of the rest stop generated.

Advantageously, the system 100 uses a measurement of ranking score to provide a user with back-up suggestion on location of rest stop according to a ranking score, where a first location of rest stop is at the top of the list generated and a second location of rest stop may be ranked at a second scope of the list generated. In this matter, this feature may allow the user to accept or reject the location of rest stop generated by the system 100.

In some embodiments, the user includes a driver of the vehicle, and the sensor 140 is operable to obtain data relating to the driver; and the controller 120 is operable to identify the driver based on the analysis of the obtained data relating to the driver, and determine a profile of the driver based on the analysis of the obtained driving parameter.

Advantageously, the system 100 may provide a more optimised route plan information considering the driver's preference and/or profile of the fleet operator assigned to the fleet operation.

In some embodiments, the profile of the driver includes information about at least one of a driving style and a driving capability of the driver.

5 Advantageously, the system 100 may provide a more optimised route plan information considering the driving style and the driving capability of the driver. Also, the system 100 may help in maintaining the vehicle's health which may depend on the driving style and the driving capability of the driver. In this manner, the system 100 reduces or eliminates conventional reporting of vehicle maintenance and repair
10 needs of fleet vehicles by fleet operator through automated notification on vehicle repair and/or vehicle maintenance requirements to the fleet operation. This in turn allows a fleet management service provider to provide timely maintenance and repairs to fleet vehicles.

15 In some embodiments, the controller 120 is further operable to classify the driver as one of a regular driver and an occasional driver based on the analysis of the obtained data relating to the driver and the obtained driving parameter, to determine the driving capability of the driver.

20 Advantageously, the system 100 may determine the driving style and the driving capability of the driver more accurately and efficiently. The aforesaid feature may be beneficial for fleet managers to assign short-distance or long-distance assignments to fleet operators according to individual driving style and driving capability, to manage learning curve of novice fleet operators.

25 In some embodiments, the controller 120 is further operable to collect the driving parameter in relation to the driver; learn a behaviour of the driver through model drifting algorithm based on the collected driving parameter; and update the profile of the driver.

30 Advantageously, the profile of the driver may be updated and stored in memory of the controller to provide better recommendations over time. The aforesaid feature may be beneficial for fleet managers to allocate assignments to a group of fleet

operators over a period of time, as fleet operators gain more experience operating fleet vehicles.

- 5 In some embodiments, the user further includes at least one of an occupant of the vehicle, and the sensor 140 is further operable to capture an image of the occupant; and the controller 120 is further operable to analyse the captured image of the occupant, identify the occupant based on the analysis of the captured image of the occupant, and create a profile of the occupant.
- 10 Advantageously, the system 100 may provide a more optimised route plan information considering the occupant's preference. More advantageously, this feature uses image processing to obtain information relating to the occupant, which may be used to correlate a reaction or behaviour to certain events occurring within the vehicle. The mapping of behaviour of the occupant to types of events occurring
- 15 may be executed by a trained neural network or executed by an AI processing unit or AI system on chip, to increase accuracy of information. The aforesaid feature may be beneficial for operators of passenger type fleet vehicles such as public transportation ferrying passengers, for example cabs or taxis, or buses on hire by schools and organisations, such that preferences of occupants may be automated
- 20 according to profiles created and stored in memory of the controller.

In some embodiments, the controller 120 is further operable to map the profile of the occupant created to a classified behaviour of the occupant when an event occurs.

- 25 Advantageously, the profile of the occupant may be updated and provide better recommendations over time. More advantageously, this feature uses image processing to obtain information relating to the occupant, which may be used to correlate a reaction or behaviour to certain events occurring within the vehicle. The mapping of behaviour of the occupant to types of events occurring may be executed
- 30 by a trained neural network or executed by an AI processing unit or AI system on chip, to increase accuracy of information.

In some embodiments, the driving parameter comprises at least one of vehicle data, environmental data, route information, and charging stations data.

Advantageously, the system 100 may consider various kinds of data collected from various sources, to provide a more accurate route plan information for the vehicle. By way of an example, vehicle data may be collected through sensing devices that are related to operation of the vehicle's health, environmental data may be collected by sensing device mounted on an exterior of the vehicle, such as surround view camera, LiDar or Radar, but not limited thereto. Another example for environmental data collection may be through application programming interface (API) which may be used to exchange data with the vehicle. For route information and charging stations data, such information may be collected or obtained through global positioning systems (GPS) in communication with system 100. In addition, since the system 100 may use AI algorithms and holistically analyse data such as user's preferences, the vehicle data, the environmental data, the route information, and the charging stations data, it may be much more efficient in generating route plan information and providing accurate information on vehicle health.

According to various embodiments, there is a computer-implemented method 200 for providing a route plan information for a vehicle from an origin location to a target location, the method 200 comprising: obtaining 210 data relating to a user; obtaining 220 at least one driving parameter; analysing 230 the obtained data relating to the user and the obtained driving parameter; identifying 240 the user based on the analysis of the obtained data relating to the user; and determining 250 a profile of the user based on the analysis of the obtained driving parameter, characterised in that the method 200 further comprises generating 260 the route plan information for the vehicle based on the profile of the user and the driving parameter, wherein the route plan information includes a charging schedule information for the vehicle.

Advantageously, the method 200 yields a computer implemented process of generating a route plan information for a pre-defined route, i.e. from an origin location to a target location, including a charging schedule information, by taking

into consideration of a profile of the user and driving parameter of the vehicle, to optimised route planning.

- 5 In some embodiments, the method 200 further comprises: estimating a driving range of the vehicle based on the profile of the user and the driving parameter; estimating a charging requirement of the vehicle based on the profile of the user, the driving parameter, and the estimated driving range; and generating the route plan information including the charging schedule information, based on the estimated
10 charging requirement.

Advantageously, the method 200 may yields a computer implemented process of estimating a charging requirement of the vehicle from an origin location to a target location base on the user's profile and driving parameter to generate information on
15 charging requirement of the vehicle's battery, when generating the route plan information. The aforesaid technical feature optimises route planning function by providing information estimated based on vehicle battery consumption, which may increase cost efficiency for fleet management service providers, by optimising route plan information and keeping track of electrical consumption of EV trucks. The
20 aforesaid feature may ensure users are in proper operation order, i.e. ensuring sufficient electricity to continue the driving range and may further assist fleet management operators to ensure costs are kept to allocated budget for completion of fleet operation.

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In some embodiments, the route plan information further includes a suggestion for a rest stop for the vehicle, and the method 200 further comprises generating the route plan information including a location for a rest stop along the origin location to the target location for the vehicle, based on the profile of the user and the driving
30 parameter.

Advantageously, the s method 200 yields a computer implemented method of creating timely reminders for users driving a long-drive to take a break at a rest stop,

also known as rest area or rest location, by generating locations of rest stops along the origin location to the target location. More advantageously, for fleet management service providers, the aforesaid feature provides an automated manner of planning a number of on-road hours and suggestion of rest stop for fleet operators to either take a break or to change shift, thus ensuring compliance with safety policies, for example, to fulfil local, state and/or federal regulations for fleet operators.

In some embodiments, the method 200 further comprises: generating a list of one or more location of rest stops along the origin location to the target location ranked according to a ranking score for each of the one or more location of rest stops; and in response to receiving, by way of the controller, a rejection input with respect to a first location of the rest stop generated on the list, generating a second location of the rest stop based on a ranking score lower than a ranking score of the first location of rest stop generated.

Advantageously, the method 200 uses a measurement of ranking score to provide a user with back-up suggestion on location of rest stop according to a ranking score, where a first location of rest stop is at the top of the list generated and a second location of rest stop may be ranked at a second scope of the list generated. In this matter, this feature may allow the user to accept or reject the location of rest stop generated by the method 200.

According to various embodiments, a data processing apparatus operable to perform the method 200 of any one of the above embodiments is provided.

According to various embodiments, a computer program element comprising program instructions, which, when executed by one or more processors, cause the one or more processors to perform the method 200 of any one of the above embodiments is provided.

According to various embodiments, a computer-readable medium comprising program instructions, which, when executed by one or more processors, cause the

one or more processors to perform the method 200 of any one of the above embodiments is provided. The computer-readable medium may include a non-transitory computer-readable medium.

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BRIEF DESCRIPTION OF DRAWINGS

The invention will be better understood with reference to the detailed description when considered in conjunction with the non-limiting examples and the
10 accompanying drawings, in which:

FIG. 1 illustrates a block diagram of a system 100 for providing a route plan information for a vehicle according to various embodiments.

15 FIG. 2 illustrates a flowchart of a method 200 for providing a route plan information for a vehicle according to various embodiments.

FIG. 3 illustrates a data flow diagram showing an architecture of Artificial Intelligence model of a system 100 for providing a route plan information for a
20 vehicle according to various embodiments.

DETAILED DESCRIPTION

25 The following detailed description refers to the accompanying drawings that show, by way of illustration, specific details and embodiments in which the disclosure may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the disclosure. Other embodiments may be utilized, and structural and logical changes may be made without departing from the scope of the
30 disclosure. The various embodiments are not necessarily mutually exclusive, as some embodiments can be combined with one or more other embodiments to form new embodiments.

Embodiments described in the context of one of a system and a method are analogously valid for the other of the system and method. Similarly, embodiments described in the context of a system are analogously valid for a method, and vice-versa.

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Features that are described in the context of an embodiment may correspondingly be applicable to the same or similar features in the other embodiments. Features that are described in the context of an embodiment may correspondingly be applicable to the other embodiments, even if not explicitly described in these other
10 embodiments. Furthermore, additions and/or combinations and/or alternatives as described for a feature in the context of an embodiment may correspondingly be applicable to the same or similar feature in the other embodiments.

In the context of various embodiments, the articles “a”, “an” and “the” as used with regard to a feature or element include a reference to one or more of the features or
15 elements.

As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed items.

While terms such as “first”, “second” etc., may be used to describe various
20 directions, such directions are not limited by the above terms. The above terms are used only to distinguish one direction from another, and do not define an order and/or significance of the directions.

Throughout the description, the term “module” may be understood as an application
25 specific integrated circuit (ASIC), an electronic circuit, a combinational logic circuit, a field programmable gate array (FPGA), a processor which executes code, other suitable hardware components which provide the described functionality, or any combination thereof. The term of “module” may include a memory which stores code executed by a controller.

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In the following, embodiments will be described in detail.

FIG. 1 illustrates a block diagram of a system 100 for providing a route plan information for a vehicle according to various embodiments.

5 In some embodiments, the vehicle may include three or more wheels capable of transporting people and/or cargo. The vehicle may include, but is not limited to, a car, a truck, and a bus. In some embodiments, the vehicle may be operated by a driver. In some embodiments, the vehicle may include an autonomous vehicle. In some embodiments, the vehicle may include, but is not limited to, an Electric Vehicle (EV), a conventional vehicle, and a hybrid vehicle. The convention vehicle may refer
10 to a vehicle that uses an internal combustion engine fuelled by diesel, gas or gasoline to power the wheels.

In some embodiments, with reference to FIG. 1, the system 100 may include, but is not limited to, a communication interface 110, a controller 120, a memory 130, and a
15 sensor 140.

In some embodiments, the communication interface 110 may allow the system 100, for example, the controller 120 of the system 100, to communicate with a server, a wireless communication system and/or a computing device via a network. In some
20 embodiments, the communication interface 110 may transmit signals to the server, the wireless communication system and/or the computing device, and/or receive signals from to the server, the wireless communication system and/or the computing device via the network.

25 In some embodiments, the memory 130 (also referred to as a “database”) may store input data and/or output data temporarily or permanently. In some embodiments, the memory 130 may store program code which allows the system 100 to perform a method 200 (as will be described with reference to FIG. 2). In some embodiments, the program code may be embedded in a Software Development Kit (SDK). The
30 memory 130 may include an internal memory of the system 100 and/or an external memory. The external memory may include, but is not limited to, an external storage medium, for example, a memory card, a flash drive, and a web storage.

In some embodiments, the sensor 140 may detect or measure a property of an object and obtain data relating to the object. In some embodiments, the sensor 140 may include, but is not limited to, a camera 141 and a microphone 142. In some embodiments, the system 100 may include a plurality of sensors 140.

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In some embodiments, the camera 141 may capture an image of the object. The captured image may include at least one of a static image (also referred to as a “still image”) and a dynamic image (also referred to as a “video” or “moving image”). The camera 141 may generate raw data associated with the captured image. The camera 141, for example, a processor of the camera 141, may then process the raw data to obtain an image file. The obtained image file may be stored in the memory 130. In some embodiments, the sensor 140 may include a plurality of cameras 141, for example, a front camera positioned at a front portion of the vehicle, a rear camera positioned at a rear portion of the vehicle, and/or one or more side-view cameras positioned at each side portion of the vehicle. In some embodiments, the sensor 140 may include a plurality of cameras 141, for example, a first camera directed to the driver’s seat, a second camera directed to a front occupant’s seat, and/or one or more third cameras directed to rear occupants’ seats.

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In some embodiments, the microphone 142 may receive an audio input from the object. The microphone 142 may generate raw data associated with the audio input. The microphone 142, for example, a processor of the microphone 142, may then process the raw data to obtain an audio file. The obtained audio file may be stored in the memory 130. In some embodiments, the sensor 140 may include a plurality of microphones 142.

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In some embodiments, the sensor 140, for example, the camera 141 and/or the microphone 142, may be installed in a ceiling of the vehicle. In some other embodiments, the sensor 140, for example, the camera 141 and/or the microphone 142, may be installed in a rear surface of a backrest of a front seat of the vehicle. In some other embodiments, the sensor 140, for example, the camera 141 and/or the microphone 142, may be installed in a steering wheel of the vehicle. It may be

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appreciated that the plurality of sensors 140 may be installed in various positions within the vehicle.

5 In some embodiments, the controller 120 (also referred to as a “processor” or a “control unit”) may include, but is not limited to, a microprocessor, an analogue circuit, a digital circuit, a mixed-signal circuit, a logic circuit, an integrated circuit, a Central Processing Unit (CPU), a Graphics Processing Unit (GPU), a Digital Signal Processor (DSP), a Field Programmable Gate Array (FPGA), an Application Specific Integrated Circuit (ASIC), or any combination thereof. Any other kind of
10 implementation of the respective functions, which will be described below in further detail, may also be understood as the controller 120.

In some embodiments, the sensor 140 may obtain data relating to a user. For example, the user may include a driver and/or at least one occupant of the vehicle.
15 In some embodiments, the camera 141 may capture an image of the user, generate raw data associated with the captured image of the user, and process the raw data to obtain an image file for the user. In some embodiments, the controller 120 may be arranged in data communication with the camera 141 to obtain or receive the image file, and may store the image file in the memory 130. In some embodiments, the
20 microphone 142 may receive an audio input from the user, generate raw data associated with the audio input of the user, and process the raw data to obtain an audio file for the user. In some embodiments, the controller 120 may be arranged in data communication with the microphone 142 to obtain or receive the audio file, and may store the audio file in the memory 130.

25 Although not shown, in some embodiments, the sensor 140 may further include, but is not limited to, a fingerprint sensor (not shown) operable to detect a finger print of the user to identify the user, and an iris scan sensor (not shown) operable to recognise an iris of the user to identify the user. Although not shown, in some
30 embodiments, the sensor 140 may further include a user input module (not shown) operable to receive the user’s input, for example, a user ID (identification) and/or a password, to identify the user.

In some embodiments, the controller 120 may obtain at least one driving parameter. In some embodiments, the driving parameter may include, but is not limited to, at least one of vehicle data, environmental data, route information, and charging stations data.

- 5 In some embodiments, the controller 120 may obtain the driving parameter, for example, the vehicle data, based on the user's control of the vehicle. In some other embodiments, the controller 120 may obtain the driving parameter, for example, the vehicle data, from another controller or processor (not shown) of the vehicle.
- 10 In some embodiments, the vehicle may include at least one external sensor (not shown), including, but not limited to, a temperature sensor and an illumination sensor. In some embodiments, the external sensor may obtain the driving parameter, for example, the environmental data, from an external environment. In some embodiments, the controller 120 may be arranged in data communication with
- 15 the external sensor to obtain or receive the driving parameter, and store the driving parameter in the memory 130.

- In some embodiments, the communication interface 110 may receive the driving parameter, for example, the route information and the charging stations data, from
- 20 the server via the network. In some embodiments, the controller 120 may be arranged in data communication with the communication interface 110 to obtain or receive the driving parameter, and store the driving parameter in the memory 130.

- In some embodiments, the communication interface 110 and/or the external sensor
- 25 may obtain raw data relating to the driving parameter, including, but is not limited to, raw data relating to at least one of the vehicle data, the environmental data, the route information, and the charging stations data. The controller 120 may be arranged in data communication with the communication interface 110 and/or the external sensor to obtain or receive the raw data relating to the driving parameter,
- 30 and process the raw data to obtain the driving parameter.

In some embodiments, the vehicle data may include, but is not limited to, HVAC data (Heating, Ventilation, and Air Conditioning), ambient lighting data, infotainment

data, CAN (Controller Area Network) data, BMS (Battery Management System) data, and fuel gauge data.

5 In some embodiments, the environmental data may include, but is not limited to, ambient lighting outside vehicle data, weather data, time data, and location data.

In some embodiments, the route information may include, but is not limited to, a start and end location data, terrain data (plains/mountainous), facilities data across the route.

10 In some embodiments, the charging stations data may include, but is not limited to, charging stations location data, fast/slow charging data, charging slots numbers data, and charging time slots data.

15 In some embodiments, the controller 120 may analyse the obtained data relating to the user and the obtained driving parameter. In some embodiments, the controller 120 may analyse the obtained data relating to the user, for example, using one or more image processing algorithms and/or one or more voice recognition algorithms. In some embodiments, the controller 120 may analyse the obtained driving parameter, for example, to understand the user's behaviour and/or preference.

20 In some embodiments, the controller 120 may analyse the obtained data relating to the driver and the obtained driving parameter. In some embodiments, the controller 120 may analyse the obtained data relating to the occupant and the obtained driving parameter.

25 In some embodiments, the controller 120 may identify the user based on the analysis of the obtained data relating to the user.

30 In some embodiments, the sensor 140 may capture an image of the driver. The controller 120 may identify the driver based on the captured image of the driver using the one or more image processing algorithms, and create or extract a profile of the driver, of which the profile of the driver may be stored in a memory of the controller 120 and retrievable from memory as required by the system 100 For

example, the camera 141, for example, the first camera, may capture the image of the driver. As another example, the camera 141, for example, both of the first camera and the second camera, may capture the images of the driver. The controller 120 may process the image(s) of the driver to detect a face of the driver.

5 The controller 120 may then compare the detected face of the driver of the captured image with a plurality of faces of drivers stored in the memory 130, to determine if the driver is a new driver or a previously recorded driver. If it is determined that the driver is the new driver, the controller 120 may create a profile of the new driver. The controller 120 may store the image file of the driver in the memory 130, to create the
10 profile of the new driver. If it is determined that the driver is the previously recorded driver, the controller 120 may extract a profile of the driver from the memory 130. The controller 120 may newly store the image file of the driver in the memory 130, to update the image file of the driver.

15 In some embodiments, the sensor 140 may obtain an audio input of the driver. The controller 120 may identify the driver based on the obtained audio input of the driver using the one or more voice recognition algorithms, and create or extract a profile of the driver. For example, the microphone 142 may obtain the audio input of the driver. The controller 120 may process the audio input of the driver to detect a voice
20 of the driver. The controller 120 may then compare the detected voice of the driver of the obtained audio input with a plurality of voices of drivers stored in the memory 130, to determine if the driver is a new driver or a previously recorded driver.

In some embodiments, the controller 120 may determine to use one of the camera
25 141 and the microphone 142 to save resources in identifying the driver. In some other embodiments, the controller 12 may determine to use both the camera 141 and the microphone 142 to improve accuracy in identifying the driver.

In some embodiments, the sensor 140 may capture an image of the occupant. The controller 120 may identify the occupant based on the captured image of the
30 occupant using the one or more image processing algorithms, and create or extract a profile of the occupant. For example, the camera 141 may capture the image of the occupant. The controller 120 may process the image of the occupant to detect a face of the occupant. The controller 120 may then compare the detected face of the

occupant of the captured image with a plurality of faces of occupants stored in the memory 130, to determine if the occupant is a new occupant or a previously recorded occupant. If it is determined that the occupant is the new occupant, the controller 120 may create the profile of the new occupant. The controller 120 may store the image file of the occupant in the memory 130, to create the profile of the new occupant. If it is determined that the occupant is the previously recorded occupant, the controller 120 may extract a profile of the occupant from the memory 130. The controller 120 may newly store the image file of the occupant in the memory 130, to update the image file of the occupant.

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In some embodiments, the sensor 140 may obtain an audio input of the occupant. The controller 120 may identify the occupant based on the obtained audio input of the occupant using the one or more voice recognition algorithms, and create or extract a profile of the occupant. For example, the microphone 142 may obtain the audio input of the occupant. The controller 120 may process the audio input of the occupant to detect a voice of the occupant. The controller 120 may then compare the detected voice of the occupant of the obtained audio input with a plurality of voices of occupants stored in the memory 130, to determine if the occupant is a new occupant or a previously recorded occupant.

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In some embodiments, the controller 120 may determine to use one of the camera 141 and the microphone 142 to save resources in identifying the occupant. In some other embodiments, the controller 12 may determine to use both the camera 141 and the microphone 142 to improve accuracy in identifying the occupant.

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In some embodiments, the controller 120 may determine a profile of the user based on the analysis of the obtained driving parameter, for example, the vehicle data, relating to the user.

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In some embodiments, the controller 120 may determine the profile of the driver based on the analysis of the obtained data relating to the driver and the obtained driving parameter, for example, the vehicle data. For example, the controller 120 may determine whether to update the profile of the driver, and if it is determined to

update the profile of the driver, update the profile of the driver based on the analysis of the obtained data relating to the driver and the obtained driving parameter, for example, the vehicle data.

5 In some embodiments, the profile of the driver may include an identity of the driver, for example, name and image of the driver. In some embodiments, the controller 120 may (repeatedly) use the profile of the driver to map a behaviour of the driver when an event occurs. For example, the event may include an event of changes of the vehicle data, for example, changes of HVAC and changes of ambient lighting by
10 the driver's control, and the behaviour of the driver is captured by the cameras and classified accordingly by the controller 120, as specific types of behaviour in response to certain events. In some embodiments, the profile of the driver may further include information about the driver's preference, for example, the HVAC, infotainment, and average rest time. In some other embodiments, the profile of the
15 driver may provide a link to the information about the driver's preference stored in the memory 130. In some embodiments, the profile of the driver may further include information about at least one of a driving style and a driving capability of the driver. In some embodiments, the controller 120 may classify the driving style of the driver as one of economic driving style, aggressive driving style, etc. In some
20 embodiments, the controller 120 may classify the driver as one of a regular driver and an occasional driver based on the analysis of the obtained driving parameter, for example, the vehicle data, to determine the driving capability of the driver.

The various embodiments may help in maintaining the vehicle's health, as the
25 controller 120 may potentially classify the driver as the regular driver or the occasional driver. The regular drivers may be used to driving for long hours at a stretch without the need for frequent rest stops, whereas the occasional drivers may tend to take frequent stops to enjoy the long drive. Thereby, the vehicle's health may be affected. For example, the vehicle's health may also be affected due to the
30 following factors:

- Driving style (economic/aggressive);
- Driving capability (occasional/regular);
- Range anxiety; and

- Terrain (plains/ mountainous)

Advantageously, the user, for example, the driver, may be able to enjoy the road travel while the system 100 ensures vehicle health.

- 5 In some embodiments, the controller 120 may determine the profile of the occupant based on the analysis of the obtained data relating to the occupant and the obtained driving parameter, for example, the vehicle data. In some embodiments, the profile of the occupant may include an identity of the occupant, for example, name and image of the occupant. In some embodiments, the controller 120 may (repeatedly)
- 10 use the profile of the occupant to map a behaviour of the occupant when an event occurs. For example, the event may include an event of changes of the vehicle data, for example, changes of HVAC and changes of ambient lighting by the occupant's control. In some embodiments, the profile of the occupant may further include information about the occupant's preference, for example, the HVAC, infotainment,
- 15 and average rest time. In some other embodiments, the profile of the occupant may provide a link to the information about the occupant's preference stored in the memory 130.

- In some embodiments, the controller 120 may determine the route plan information
- 20 for the vehicle based on the profile of the user and the driving parameter. For example, the route plan information may include a route map from the start point to the end point that the user selected. The controller 120 may derive the route map with at least one charging schedule information and/or at least one rest stop, for example, based on the following input data:

- 25
- Start and end point;
 - The profile of the driver;
 - The profile of the occupant;
 - Charging stations and capabilities; and
 - Facilities across the route.

- 30 In some embodiments, the controller 120 may determine the route plan information for the vehicle based on the profile of the driver, the profile of the occupant (if the occupant is in the vehicle), and the driving parameter, for example, the vehicle data, the environmental data, the route information, and the charging stations data. In

some embodiments, the route plan information includes a suggestion for a charging schedule information for the vehicle. In some embodiments, the charging schedule information may refer to a suggestion of a timing and a location for fuelling-up with electricity or petrol/gas.

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In some embodiments, the controller 120 may estimate a driving range of the vehicle based on the profile of the user and the driving parameter. For example, the controller 120 may estimate a driving range of the vehicle based on the profile of the driver and the driving parameter. In some embodiments, the controller 120 may estimate a charging requirement of the vehicle based on the profile of the user, the driving parameter, and the estimated driving range. For example, the controller 120 may estimate the charging requirement of the vehicle based on the profile of the driver, the driving parameter, and the estimated driving range. In some embodiments, the controller 120 may determine the route plan information including the charging schedule information, based on the estimated charging requirement. The estimated charging requirement may be calculated using mathematical correlation between amount of electricity stored in a battery of the vehicle, distance between origin location and the target location, in consideration of other parameters as disclosed herein.

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In some embodiments, the route plan information may further include a suggestion for a rest stop for the vehicle. In some embodiments, the suggestion for the rest stop may refer to a suggestion of a timing and a location for rest stop. In some embodiments, the controller 120 may determine the route plan information including the suggestion for the rest stop, based on the profile of the user and the driving parameter. For example, the controller 120 may determine the route plan information including the suggestion for the rest stop, based on the profile of the driver, the profile of the occupant, and the driving parameter, for example, the route information.

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In some embodiments, the controller 120 may generate a list of locations of rest stops from an origin location to a target location with each of the location of rest stops ranked according to a ranking score and provide the suggestion for the rest

stop having the highest ranking to the user. This information on location of rest stop may be displayed to the user via an in-vehicle display, although not limited thereto. If the user, for example, the driver, does not accept the suggestion for the rest stop, the controller 120 may provide another suggestion for the rest stop based on the ranking score, where a first location of rest stop may be one of a highest ranking score on the list of locations of rest stops from an origin location to a target location generated, and the other suggestion, namely a second location of rest stop may be one of a lower ranking score on the list of location of rest stops generated compared to the first location of rest stop. In some embodiments, the controller 120 may record the user's, for example, the driver's selection for the acceptance of the suggestion in the memory 130, to learn from the driver's selection and make an improved suggestion next time. A rejection input received by the controller 102 may be a signal sent to the controller 102 through a user interface input by the user to confirm rejection or acceptance.

Advantageously, the various embodiments may learn from the user's preferences and provide better personalised and optimised vehicle rest stop suggestions. Since the system 100 saves preferred rest stops on a route, the system 100 may save time and computation power.

In some embodiments, the controller 120 may generate a list of locations of one or more charging stations from an origin location to a target location with each of the location of charging station ranked according to a ranking score. In some embodiments, the controller 120 may provide the suggestion for the charging station having the highest ranking score. If the user, for example, the driver, does not accept the suggestion for the charging station, the controller 120 may provide another suggestion for the charging station based on the ranking score, where a first location of charging station may be one of a highest ranking score on the list of locations of charging station from an origin location to a target location generated, and the other suggestion, namely a second location of charging station may be one of a lower ranking score on the list of location of charging station generated compared to the first location of rest stop. A rejection input received by the controller 102 may be a signal sent to the controller 102 through a user interface input by the

user to confirm rejection or acceptance. In some embodiments, the controller 120 may record the user's, for example, the driver's selection for the acceptance of the suggestion in the memory 130, to learn from the driver's selection and make an improved suggestion next time.

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Advantageously, the various embodiments may learn from the user's preferences and provide better personalised and optimised charging station suggestions. Since the system 100 saves preferred charging stations on a route, the system 100 may save time and computation power.

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In some embodiments, the controller 120 may collect the driving parameter, for example, vehicle data, in relation to the driver. The controller 120 may learn a behaviour of the driver through model drifting algorithm based on the collected driving parameter, and update the profile of the driver.

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FIG. 2 illustrates a flowchart of a method 200 for providing a route plan information for a vehicle according to various embodiments. According to various embodiments, the method 200 for providing the route plan information for the vehicle is provided.

20 In some embodiments, the method 200 may include a step 210 of obtaining data relating to a user. For example, the user may include at least one of a driver and at least one occupant of the vehicle.

In some embodiments, the method 200 may include a step 220 of obtaining at least
25 one driving parameter.

In some embodiments, the method 200 may include a step 230 of analysing the obtained data relating to the user and the obtained driving parameter.

30 In some embodiments, the method 200 may include a step 240 of identifying the user based on the analysis of the obtained data relating to the user.

In some embodiments, the method 200 may include a step 250 of determining a profile of the user based on the analysis of the obtained driving parameter.

In some embodiments, the method 200 may include a step 260 of determining the route plan information for the vehicle based on the profile of the user and the driving parameter. The route plan information may include a suggestion for a charging schedule for the vehicle.

Although not shown, the route plan information may include a suggestion for a rest stop for the vehicle. Although not shown, the route plan information may include a suggestion for the charging schedule and the rest stop for the vehicle.

FIG. 3 illustrates a data flow diagram showing an architecture of Artificial Intelligence (AI) model of a system 100 for providing a route plan information for a vehicle according to various embodiments.

As shown in FIG. 3, in some embodiments, the system 100 may use the following input data to provide the route plan information for the vehicle, while maintaining a vehicle health:

- (In-cabin) Camera(s) 141 (as described with reference to FIG. 1);
- Microphone(s) 142 (as described with reference to FIG. 1);
- Vehicle data, including, but not limited to, HVAC data (Heating, Ventilation, and Air Conditioning), ambient lighting data, infotainment data, CAN (Controller Area Network) data, BMS (Battery Management System) data, and fuel gauge data;
- Environmental data, including, but not limited to, ambient lighting outside vehicle data, weather data, time data, and location data;
- Route information, including, but not limited to, a start and end location data, terrain data (plains/mountainous), facilities data across the route; and
- Charging stations data, including, but not limited to, charging stations location data, fast/slow charging data, charging slots numbers data, and charging time slots data.

As shown in FIG. 3, in some embodiments, a user identification may be performed based on the input data obtained from the camera(s) 141 and the microphone(s) 142 as input data. A user's preference may be obtained in relation to the identified

user, for example, from a memory 130 (as described with reference to FIG. 1). A profile of a driver (also referred to as a “driver profiling”) may be determined based on the user identification and the vehicle data (i.e. the vehicle data relating to the identified user) as input data. In some embodiments, the profile of the driver may be a combination of a driving style (economic/aggressive) and a driving capability (occasional/regular) (as described with reference to FIG. 1). In some embodiments, the system 100 may collect such data in regular intervals, and learn new patterns and behaviours of the driver through model drifting algorithm. Advantageously, the profile of the driver may also be updated and provide better recommendations over time. For clarity and brevity, model drift or model drifting is a machine learning methodology.

A driving range estimation may be performed based on the profile of the driver, the vehicle data, the environmental data, and the route information as input data.

As shown in FIG. 3, in some embodiments, a charging requirement estimation may be performed based on the profile of the driver, the estimated driving range (for example, driveable kilometres), and the charging stations data (for example, location, charge capacity, etc.) as input data. In some embodiments, neural networks (NN) trained over such data may estimate whether or not charging is needed and/or the required amount of charge. In some embodiments, a location of a rest stop, a duration of the rest stop and the charging requirement estimation may be output. In some embodiments, the user’s preference may be used as additional input data, to obtain (or adjust) the location of the rest stop, the duration of the rest stop and the charging requirement estimation. In some embodiments, the amount of charge/fuel needed, and the user preferences are fed into a regression model which may determine the minimum duration of the rest stop.

In some embodiments, an Artificial Intelligence (AI) based neural network models, including, but not limited to, support vector machines, decision trees, ensemble models, k-nearest neighbour models, Bayesian networks, or other types of models including linear models and/or non-linear models may be used in the system 100, for example, in the controller 120. In some embodiments, the neural networks may

include, but are not limited to, feed-forward neural networks, convolutional neural networks (CNN), and recurrent neural networks (RNN). The neural networks may use the following input data to compute the following attributes:

- 5 • Occupant profiling based on the user identification, for example, an occupant identification

 - Description: identifying the occupant(s) and creating a unique profile for each occupant(s)
 - Input: image captured from the in-cabin camera 141
 - Output: the identity of the occupant and unique identity
- 10 • Technique: face recognition based on the NN – the NN may be trained on data collected by an operator of the system 100 (real or simulated)

 - Dataset: the dataset may have images containing clearly visible faces
 - Architecture: CNN-based architecture may be used (for example, ResNet, InceptionV3, etc.)
- 15 • Driver profiling based on the user identification, for example, a driver identification

 - Description: identifying a pattern of the driver's driving style
 - Input: the user identification and the vehicle data
 - Output: the profile of the driver including a learnt pattern of the driver's driving style
- 20 • Technique: The NN may be trained on data collected by the operator of the system 100 (real or simulated)

 - Dataset: the dataset may have driver behaviour data
 - Architecture: Machine Learning (ML) techniques (for example, Random Forest, gradient boosting, personalised regression, etc.)
- 25 • Driving Range Estimation

 - Description: identifying the distance the vehicle can travel based on current fuel/charge
 - Input: the vehicle data, the environment data, the route information, and the driver profile
- 30 • Output: estimation of the driving range of the vehicle

 - Technique: The NN may be trained on data collected by the operator of the system 100 (real or simulated)

- Dataset: the dataset may have driver behaviour data
- Architecture: ML techniques (for example, Random Forest, gradient boosting, Multilayer Perceptron (MLP), AdaBoost, etc.)

5 In some embodiments, based on the user's preference, the duration of the rest stop and the location of the rest stop may be suggested. The system 100 may provide a list of suitable rest stops along with a ranking score. The ranking order may represent the probability of a suitable rest stop based on the remaining range, charge requirements, rest stop ratings from the internet, historical user's
10 preferences about the facilities, etc.

In some embodiments, if the user is not satisfied with the suggested rest stop (top-ranked), another suggestion may also be provided based on the ranking. If the user does not like any of the suggested rest stops, the user may manually choose a
15 new rest stop as per their preference. In such cases, the system 100 may take the new rest stop as feedback to provide better suggestions in the future.

It may be appreciated that the system 100 may be used for efficient planning of cargo fleets. The system 100 may also be advanced by considering the vehicle
20 service stations information and/or vehicle service options, based on a manual request and/or a vehicle health monitoring system while ranking the rest stops.

As described above, the various embodiments may solve the uncertainty that exists over the driving range of the vehicle as well as an overlook of the vehicle's health.
25 By providing the personalised route plan information based on the various driving parameters, the system 100 may provide a carefree and enjoyable ride experience.

In addition, the system 100 may also be used for not only EV but also Internal Combustion Engines (ICEs) and Hybrid engines. Given that gas stations may be
30 available aplenty/scarce, the system 100 may be extended/altered to personalise the vehicle rest stops while maintaining/maximising vehicle health/life. Also, the system 100 may ensure that the vehicle may not run out of fuel across the ride.

Ultimately, the user may stay comfortable, save time and have a better travel experience.

5 While the disclosure has been particularly shown and described with reference to specific embodiments, it should be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the scope of the invention as defined by the appended claims. The scope of the invention is thus indicated by the appended claims.

10

REFERENCE SIGNS

100: System

110: Communication Interface

15 120: Controller

130: Memory

140: Sensor

141: Camera

142: Microphone

Patent claims

1. A system (100) for providing a route plan information for a vehicle from an origin location to a target location, the system (100) comprising:
 - at least one sensor (140) operable to obtain data relating to a user; and
 - 5 a controller (120) operable to:
 - obtain at least one driving parameter;
 - analyse the obtained data relating to the user and the obtained driving parameter;
 - identify the user based on the analysis of the obtained data relating to
 - 10 the user; and
 - determine a profile of the user based on the analysis of the obtained driving parameter,
 - characterised in that:
 - the controller (120) is further operable to determine a route plan information
 - 15 for the vehicle based on the profile of the user and the driving parameter, wherein the route plan information includes a charging schedule for the vehicle.
2. The system (100) according to claim 1, characterised in that the controller (120) is further operable to:
 - 20 estimate a driving range of the vehicle based on the profile of the user and the driving parameter;
 - estimate a charging requirement of the vehicle based on the profile of the user, the driving parameter, and the estimated driving range; and
 - generate the route plan information including the charging schedule
 - 25 information, based on the estimated charging requirement.
3. The system (100) according to claim 1 or claim 2, characterised in that the route plan information further includes a location of a rest stop along the origin location to the target location for the vehicle, and
- 30 the controller (120) is further operable to generate the route plan information including location of the rest stop along the origin location to the target location, based on the profile of the user and the driving parameter.

4. The system (100) according to claim 3, characterised in that the controller (120) is further operable to:

generate a list containing one or more location of rest stops along the origin location to the target location ranked according to a ranking score for each of the one or more location of the rest stops; and

in response to a rejection input received by the controller (120) with respect to a first location of the rest stop generated on the list,

generate a second location of the rest stop based on a ranking score lower than a ranking score the first location of the rest stop generated.

10 g.

5. The system (100) according to any one of claims 1 to 4, characterised in that the user includes a driver of the vehicle, and

the sensor (140) is operable to obtain data relating to the driver; and

15 the controller (120) is operable to identify the driver based on the analysis of the obtained data relating to the driver, and determine a profile of the driver based on the analysis of the obtained driving parameter.

6. The system (100) according to claim 5, characterised in that the profile of the driver includes information about at least one of a driving style and a driving capability of the driver.

7. The system (100) according to claim 6, characterised in that the controller (120) is further operable to classify the driver as one of a regular driver and an occasional driver based on the analysis of the obtained data relating to the driver and the obtained driving parameter, to determine the driving capability of the driver.

8. The system (100) according to any one of claims 5 to 7, characterised in that the controller (120) is further operable to:

30 collect the driving parameter in relation to the driver; and

learn a behaviour of the driver through model drifting algorithm based on the collected driving parameter; and

update the profile of the driver.

9. The system (100) according to any one of claims 5 to 8, characterised in that the user further includes at least one of an occupant of the vehicle, and

the sensor (140) is further operable to capture an image of the occupant; and

5 the controller (120) is further operable to analyse the captured image of the occupant, identify the occupant based on the analysis of the captured image of the occupant, and create a profile of the occupant.

10. The system (100) according to claim 9, characterised in that the controller
10 (120) is further operable to use the profile of the occupant to map a behaviour of the occupant when an event occurs.

11. The system (100) according to any one of claims 1 to 10, characterised in that the driving parameter comprises at least one of vehicle data, environmental data,
15 route information, and charging stations data.

12. A computer-implemented method (200) for providing a route plan information for a vehicle from an origin location to a target location, the method (200) comprising:

20 obtaining (210) data relating to a user;

obtaining (220) at least one driving parameter;

analysing (230) the obtained data relating to the user and the obtained driving parameter;

25 identifying (240) the user based on the analysis of the obtained data relating to the user; and

determining (250) a profile of the user based on the analysis of the obtained driving parameter,

characterised in that the method (200) further comprises generating (260) the route plan information for the vehicle based on the profile of the user and
30 the driving parameter, wherein the route plan information includes a suggestion for a charging schedule for the vehicle.

13. The method (200) according to claim 12, further comprising:

estimating a driving range of the vehicle based on the profile of the user and the driving parameter;

estimating a charging requirement of the vehicle based on the profile of the user, the driving parameter, and the estimated driving range; and

5 generating the route plan information including the charging schedule information, based on the estimated charging requirement.

14. The method (200) according to claim 12 or claim 13, characterised in that the route plan information further includes a suggestion for a rest stop for the vehicle,
10 and

the method (200) further comprises generating the route plan information including the suggestion for the rest stop, based on the profile of the user and the driving parameter.

15 15. The method (200) according to claim 14, further comprising:
generating a list of one or more location of rest stops along the origin location to the target location ranked according to a ranking score for each of the one or more location of rest stops; and

20 in response to receiving, by way of the controller (120), a rejection input with respect to a first location of the rest stop generated on the list,
generating a second location of the rest stop based on a ranking score lower than a ranking score of the first location of the rest stop generated.

16. A computer program product comprising instructions to cause the system (100)
25 of claims 1 to 11 to execute the steps of the method (200) claims 12 – 15.

17. A computer-readable medium having stored thereon the computer program of claims 12 to 15.