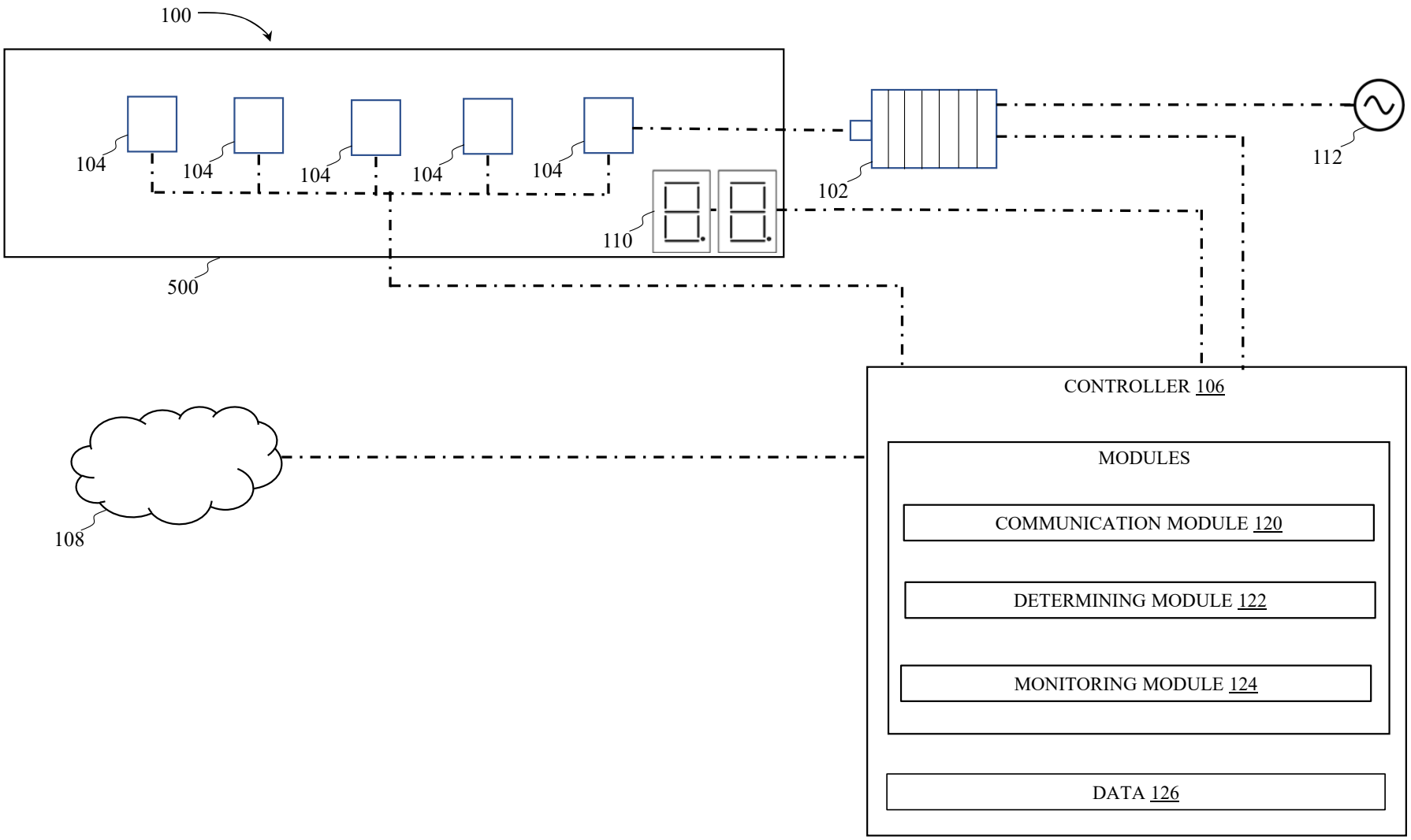

FIGURE 1

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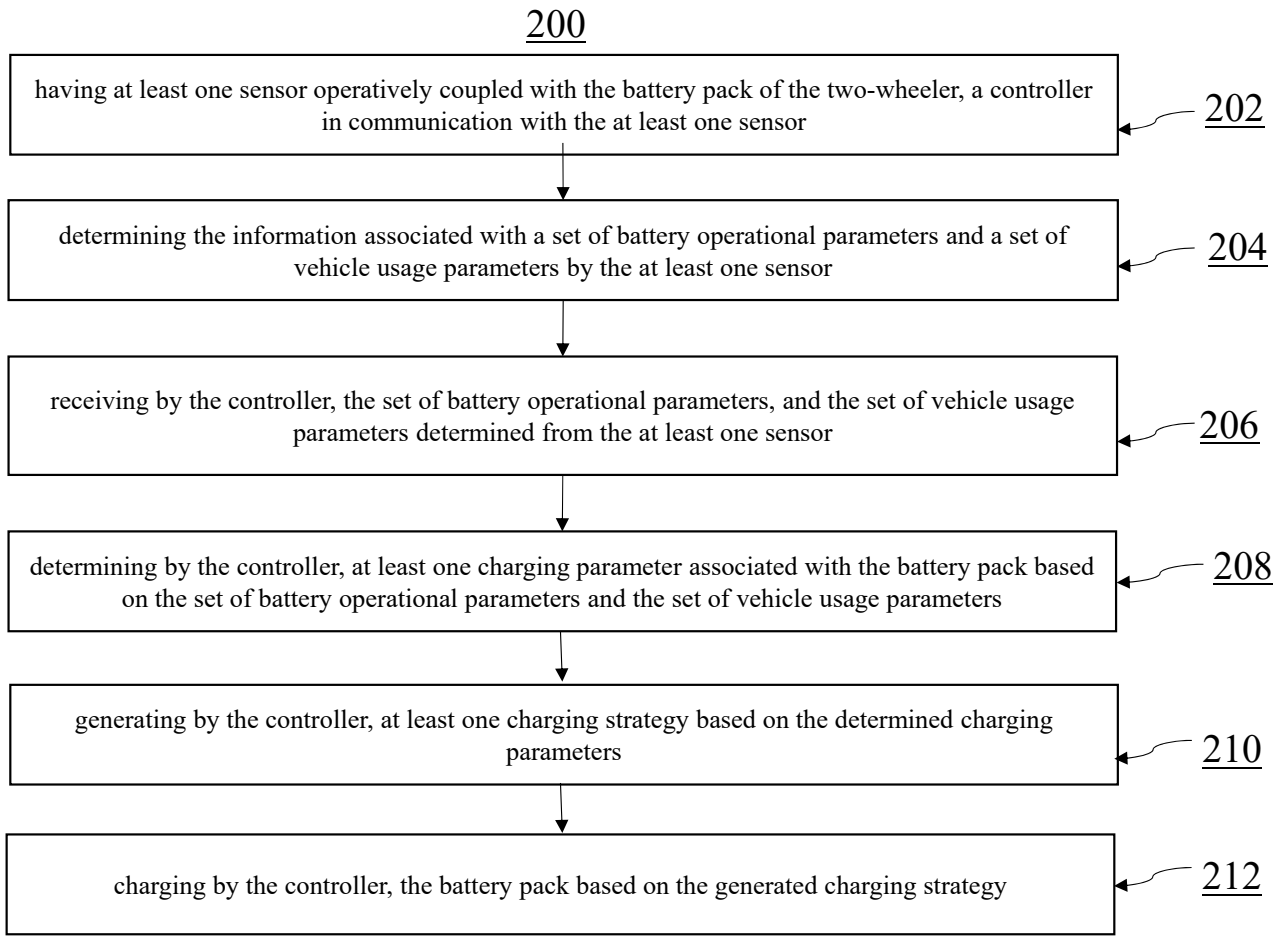

FIGURE 2

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300

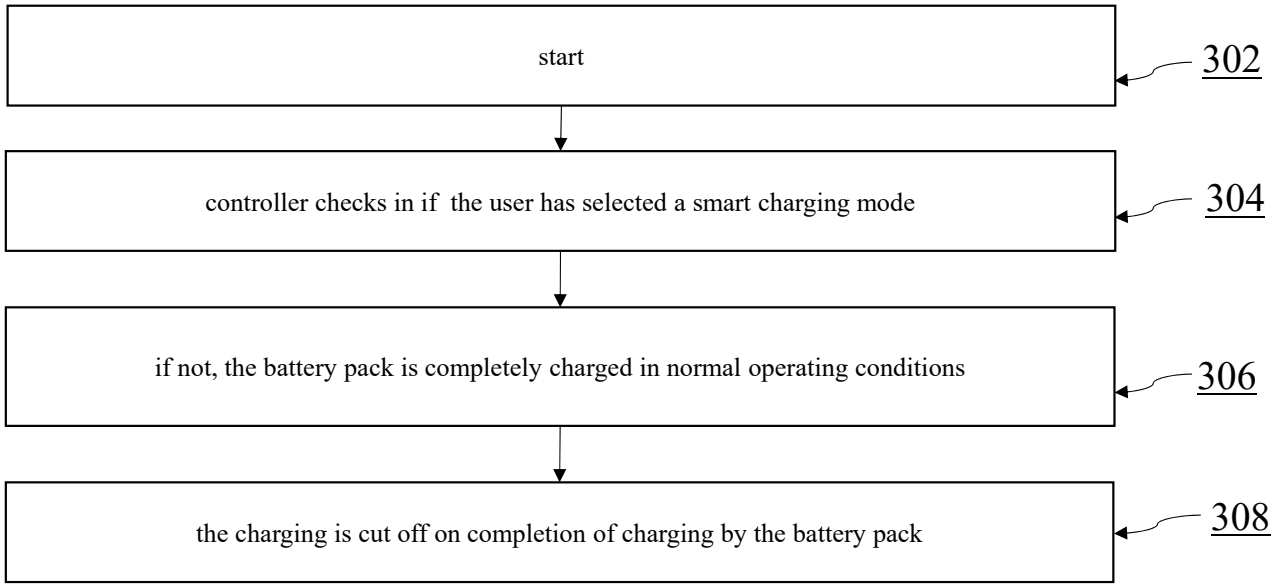

FIGURE 3

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400

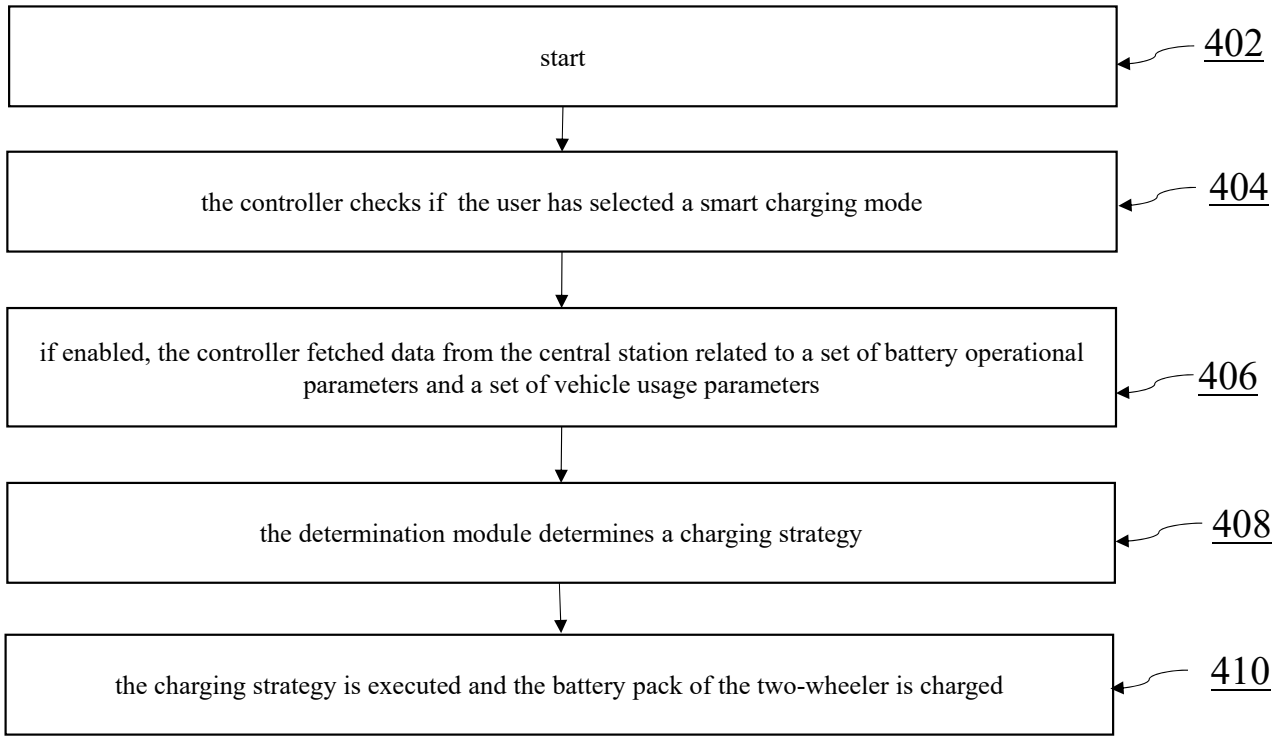

FIGURE 4

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FORM 2
THE PATENTS ACT 1970
(39 of 1970)
&
The Patents [Amendment] Rules, 2006
COMPLETE SPECIFICATION

(See section 10 and rule 13)

1. TITLE OF THE INVENTION

A CHARGING SYSTEM FOR A TWO-WHEELER AND A METHOD FOR OPERATION THEREOF

2. APPLICANT

NAME : Ather Energy Private Limited

NATIONALITY : IN

ADDRESS : 3rd Floor, Tower D, IBC Knowledge Park, #4/1, Bannerghatta Main Road, Bengaluru - 560029, Karnataka, India

3. PREAMBLE TO THE DESCRIPTION

COMPLETE

The following specification particularly describes the invention and the manner in which it is to be performed.

FIELD OF THE INVENTION

The present disclosure relates to electric vehicles. More particularly, the present disclosure relates to a system and a method for charging a battery pack of an electric two-wheeler.

BACKGROUND

Electric vehicles have gained widespread popularity in the last few years and significant growth and development are still being witnessed in their realm. As is already known, such EVs are required to be frequently charged, for example, at charging terminals for continuous operation. Currently, charging systems employed in an electric vehicle often rely on charging batteries end to end. This might not be optimal for different users and might also result in higher rate of battery degradation.

In particular, the battery usage or vehicle usage pattern of each user might be different and therefore, it might not be optimal to charge the battery end to end for each user. In addition, each user may have a unique way of handling their electric vehicle. As an example, some users might extensively use the electric vehicle and therefore, the battery of such vehicle might require to be charged end to end. However, some users might not extensively use their electric vehicle and therefore, it might not be optimal to fully charge the battery of such vehicle.

In addition, charging the battery seems to be an additional responsibility of the user. The user needs to follow optimal charging practices to maintain a prolonged life and optimum performance of the battery. If the charging is not

practiced properly, it may lead to reduced performance and degradation of the battery over a period of time.

So, it is desirable to implement a system and a method to provide a smart charging solution for a two-wheeler.

SUMMARY

This summary is provided to introduce a selection of concepts, in a simplified format, that are further described in the detailed description of the invention. This summary is neither intended to identify key or essential inventive concepts of the invention and nor is it intended for determining the scope of the invention.

The present disclosure is related to a charging system for a two-wheeler. The system includes at least one sensor operatively coupled with a battery pack of the two-wheeler to determine information associated with a set of battery operational parameters and a set of vehicle usage parameters and a controller in communication with the at least one sensor. The controller is configured to receive the set of battery operational parameters and the set of vehicle usage parameters from the at least one sensor and determine at least one charging parameter associated with the battery pack based on the set of battery operational parameters received by the controller and the set of vehicle usage parameters received by the controller. In addition, the controller is configured to generate at least one charging strategy based on the determined charging parameters and charge the battery pack based on the generated charging strategy.

The present disclosure is further related to a method for charging a battery pack of a two-wheeler. The method includes having at least one sensor operatively coupled with the battery pack of the two-wheeler and a controller in communication with the at least one sensor. In addition, the method includes determining information associated with a set of battery operational parameters and a set of vehicle usage parameters by the at least one sensor and receiving by the controller,

the set of battery operational parameters and the set of vehicle usage parameters determined from the at least one sensor. Further, the method includes determining by the controller, at least one charging parameter associated with the battery pack based on the set of battery operational parameters and the set of vehicle usage parameters. Additionally, generating by the controller, at least one charging strategy based on the determined charging parameters and charging by the controller, the battery pack based on the generated charging strategy.

The charging system facilitates continuous monitoring of the battery pack parameters using the at least one sensor and adjusts the charging strategy as needed to ensure a safe and the effective charging of the battery pack. In addition, the charging from the charging system is safe and efficient as the at least one sensor is adapted to detect any potential hazard such as but not limited to the overheating and overcharging of the battery pack. In addition, the charging system stores the data in a central station, such as a remote server, thereby enabling the remote access to the data and enhancing the performance of the charging system. The remote server also provides additional computing resource to the charging system. Overall, the charging system provides a more efficient, effective, and a safe way to charge the battery pack, improves the life of the battery pack, and reduces the environmental impact caused due to the battery disposal.

To further clarify advantages and features of the present invention, a more particular description of the invention will be rendered by reference to specific embodiments thereof, which is illustrated in the appended drawings. It is appreciated that these drawings depict only typical embodiments of the invention and are therefore not to be considered limiting of its scope. The invention will be described and explained with additional specificity and detail with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects, and advantages of the present invention will become better understood when the following detailed description is read with reference to the accompanying drawings in which like characters represent like parts throughout the drawings, wherein:

Figure 1 illustrates a block diagram of a charging system for a two-wheeler, in accordance with an embodiment of the present disclosure;

Figure 2 illustrates a flow diagram of a method of execution of a charging of a battery pack, in accordance with an embodiment of the present disclosure;

Figure 3 illustrates a flow diagram of an embodiment of a method of charging the battery pack, in accordance with one embodiment of the present disclosure; and

Figure 4 illustrates a flow diagram of an embodiment of a method of charging the battery pack, in accordance with another embodiment of the present disclosure.

Further, skilled artisans will appreciate that elements in the drawings are illustrated for simplicity and may not have necessarily been drawn to scale. Furthermore, in terms of the construction of the device, one or more components of the device may have been represented in the drawings by conventional symbols, and the drawings may show only those specific details that are pertinent to understanding the embodiments of the present invention so as not to obscure the drawings with details that will be readily apparent to those of ordinary skill in the art having the benefit of the description herein.

DETAILED DESCRIPTION OF FIGURES

For the purpose of promoting an understanding of the principles of the invention, reference will now be made to the embodiment illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in the illustrated system, and such further applications of the principles of the invention as illustrated therein being

contemplated as would normally occur to one skilled in the art to which the invention relates. Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skilled in the art to which this invention belongs. The system, methods, and examples provided herein are illustrative only and not intended to be limiting.

For example, the term "some" as used herein may be understood as "none" or "one" or "more than one" or "all." Therefore, the terms "none," "one," "more than one," "more than one, but not all" or "all" would fall under the definition of "some." It should be appreciated by a person skilled in the art that the terminology and structure employed herein is for describing, teaching, and illuminating some embodiments and their specific features and elements and therefore, should not be construed to limit, restrict or reduce the spirit and scope of the present disclosure in any way.

For example, any terms used herein such as, "includes," "comprises," "has," "consists," and similar grammatical variants do not specify an exact limitation or restriction, and certainly do not exclude the possible addition of one or more features or elements, unless otherwise stated. Further, such terms must not be taken to exclude the possible removal of one or more of the listed features and elements, unless otherwise stated, for example, by using the limiting language including, but not limited to, "must comprise" or "needs to include."

Whether or not a certain feature or element was limited to being used only once, it may still be referred to as "one or more features" or "one or more elements" or "at least one feature" or "at least one element." Furthermore, the use of the terms "one or more" or "at least one" feature or element do not preclude there being none of that feature or element, unless otherwise specified by limiting language including, but not limited to, "there needs to be one or more…" or "one or more elements is required."

Unless otherwise defined, all terms and especially any technical and/or scientific terms, used herein may be taken to have the same meaning as commonly understood by a person ordinarily skilled in the art.

Reference is made herein to some "embodiments." It should be understood that an embodiment is an example of a possible implementation of any features and/or elements of the present disclosure. Some embodiments have been described for the purpose of explaining one or more of the potential ways in which the specific features and/or elements of the proposed disclosure fulfil the requirements of uniqueness, utility, and non-obviousness.

Use of the phrases and/or terms including, but not limited to, "a first embodiment," "a further embodiment," "an alternate embodiment," "one embodiment," "an embodiment," "multiple embodiments," "some embodiments," "other embodiments," "further embodiment", "furthermore embodiment", "additional embodiment" or other variants thereof do not necessarily refer to the same embodiments. Unless otherwise specified, one or more particular features and/or elements described in connection with one or more embodiments may be found in one embodiment, or may be found in more than one embodiment, or may be found in all embodiments, or may be found in no embodiments. Although one or more features and/or elements may be described herein in the context of only a single embodiment, or in the context of more than one embodiment, or in the context of all embodiments, the features and/or elements may instead be provided separately or in any appropriate combination or not at all. Conversely, any features and/or elements described in the context of separate embodiments may alternatively be realized as existing together in the context of a single embodiment.

Any particular and all details set forth herein are used in the context of some embodiments and therefore should not necessarily be taken as limiting factors to the proposed disclosure.

Embodiments of the present invention will be described below in detail with reference to the accompanying drawings.

A charging system 100 for a two-wheeler 500 is shown in **Figure 1** to **Figure 4**. Specifically, **Figure 1** illustrates a schematic diagram of the charging system 100 of a two-wheeler 500. The charging system 100 may interchangeably be referred to as the system 100, without departing from the scope of the present disclosure. The system 100 may be employed to charge a battery pack 102 of the two-wheeler 500.

Referring to **Figure 1**, the system 100 includes at least one sensor 104 operatively coupled with the battery pack 102, and a controller 106. In the illustrated embodiment, the controller 106 may be in communication with the at least one sensor 104, the battery pack 102, a central station 108 to facilitate the storage of the data from the at least one sensor 104, and a display unit 110 to facilitate the information to the user about the charging of the two-wheeler 500.

In addition, the system 100 includes a battery charger (not shown) adapted to selectively couple with the battery pack 102 and an AC supply 112 to facilitate the charging of the battery pack 102 of the two-wheeler 500. In an example, the battery pack 102 of the two-wheeler 500 may be a Li-ion battery, or a plurality of Li-ion batteries coupled together to facilitate the operation of the two-wheeler 500.

The at least one sensor 104 may be operatively coupled with the battery pack 102 of the two-wheeler 500 to determine information associated with a set of battery operational parameters and a set of vehicle usage parameters. The at least one sensor 104 is adapted to continuously acquire data associated with the set of battery operational parameters and the set of vehicle usage parameters for the two-wheeler 500. In an example, the at least one sensor 104 may include a one or more current sensors, a one or more voltage sensors, a one or more temperature sensors, a one or more humidity sensors. In addition, the at least one sensor 104 may be configured with a developmental board such as but not limited to a N1 board adapted to run on

an android platform. The configuration of the one or more sensors 104 with the developmental board facilitates the connection of the at least one sensor with the controller 106 and the central station 108 for transferring data.

In an embodiment, the set of battery operational parameters may include, but is not limited to, at least a temperature of the battery pack, a battery degradation rate, a voltage of the battery, a depth of discharge of the battery pack, a charge-discharge cycle, a charging current, a health status of the battery, a state of charge (SOC) consumed per day, a current SOC, a number of charge-discharge cycles performed per day, a conventional charging time of the user, or any other charging habits of the user. In addition, the set of battery operational parameters may be recorded for determining a charging behaviour of the user. In an example battery operational parameters pattern may include the behavioural patterns of the user. Further, the set of vehicle usage parameters may include, but is not limited, to a vehicle riding time, a vehicle start time, a vehicle trip end time, an average distance travelled per day, a vehicle standby time, historical patterns of charging of the battery pack 102, and historical patterns of discharging of the battery pack 102. In addition, the set of vehicle usage parameters may be recorded for determining a vehicle usage pattern of the user. In an example, the vehicle usage pattern may include the behavioural patterns of the user.

As shown in the **Figure 1**, the at least one sensor 104 is coupled with the controller 106 to facilitate the transfer of the data acquired from the at least one sensor 104 and facilitate in generating a charging strategy for the two-wheeler 500. In addition, the controller 106 is shown externally for illustration purpose only and the controller 106 may be an integrated part of the two-wheeler 500.

The controller 106 includes a plurality of modules to facilitate the execution of the charging strategy for the two-wheeler 500. The controller may include, but is not limited to, a processor, memory, module(s), and data 126. The module(s) and the memory may be coupled to the processor. The processor may be a single

processing unit or a number of units, all of which could include multiple computing units. The processor may be implemented as one or more microprocessors, microcomputers, microcontrollers, digital signal processors, central processing units, state machines, logic circuitries, and/or any devices that manipulate signals based on operational instructions. Among other capabilities, the processor is configured to fetch and execute computer-readable instructions and data stored in the memory. Further, the controller may include, but is not limited to, a vehicle controlling unit (VCU) or a motor controlling unit (MCU).

The memory may include any non-transitory computer-readable medium known in the art including, for example, volatile memory, such as static random-access memory (SRAM) and dynamic random access memory (DRAM), and/or non-volatile memory, such as read-only memory (ROM), erasable programmable ROM, flash memories, hard disks, optical disks, and magnetic tapes.

The module(s), amongst other things, include routines, programs, objects, components, data structures, etc., which perform particular tasks or implement data types. The module(s) may also be implemented as, signal processor(s), state machine(s), logic circuitries, and/or any other device or component that manipulate signals based on operational instructions.

Further, the module(s) may be implemented in hardware, instructions executed by at least one processing unit, for e.g., the processor, or by a combination thereof. The processing unit may comprise a computer, a processor, a state machine, a logic array and/or any other suitable devices capable of processing instructions. The processing unit may be a general-purpose processor which executes instructions to cause the general-purpose processor to perform operations or, the processing unit may be dedicated to performing the required functions. In some example embodiments, the module(s) may be machine-readable instructions (software, such as web-application, mobile application, program, etc.) which, when

executed by a processor/processing unit, perform any of the described functionalities.

In an implementation, the module(s) may include a communication module 120, a determination module 122, and a monitoring module 124. In addition, the controller 106 includes the data 126 for serving amongst other things, such as a repository for storing data processed, received, and generated by one or more of the modules of the controller 106. In an embodiment, the data 126 may include a predefined data set, or a set of predefined instructions for the execution of the charging strategy for the two-wheeler 500. In addition, the data 126 may include one or more modes having one or more strategies for executing the charging strategy for a two-wheeler 500. As an example, the data 126 may include data 126 related to one or more modes of charging the battery pack 102. One or more modes may include, but are not limited to, a smart charging mode, a default charging mode, and a customized charging mode having a plurality of pre-defined instructions related to the battery operational parameters to be executed in respective modes.

The controller 106 may be configured to receive the set of battery operational parameters and the set of vehicle usage parameters from the at least one sensor 104The determination module 122 of the controller 106 is configured to receive and determine the information/data related to the information associated with the set of battery operational parameters and the set of vehicle usage parameters by the at least one sensor 104.

Further, the controller 106 may be configured determine at least one charging parameter associated with the battery pack 102 based on the set of battery operational parameters received by the controller 106 and the set of vehicle usage parameters received by the controller 106. In an embodiment, the determination module 122 is configured to determine at least one charging parameter associated with the battery pack 102 based on the set of battery operational parameters

received by the controller 106 and the set of vehicle usage parameters received by the controller 106.

In addition, the determination module 122 may use the machine-learning algorithms for analyzing the data related to the set of battery operational parameters and the set of vehicle usage parameters. In an embodiment, the at least one charging parameter determined by the determination module 122 for charging the battery pack 102 includes a maximum SOC level, a charging rate, a total time range, a start time range, an end time range, an intermediate time range, and a charging pattern.

Further, the controller 106 may be configured to generate at least one charging strategy based on the determined charging parameters. In an embodiment, the determining module 122 may be configured to generate the at least one charging strategy based on the determined charging parameters. In an embodiment, the at least one charging strategy may be indicative of a charging cycle with the determined charging parameters for the battery pack. In an embodiment, the charging pattern may be indicative of a pattern in which the battery pack is charged at varied charging rates in varied time ranges.

Further, the controller may be configured to charge the battery pack 102 based on the generated charging strategy. In an embodiment, the controller may control a charging cycle of the battery based on the generated charging strategy.

In an embodiment, the controller 106 may be configured to generate a plurality of charging strategies based on the determined charging parameters. Further, the controller 106 may be configured to display a notification indicative of the plurality of charging strategies. The controller 106 may be configured to receive an input indicative of a selection of one of the plurality of charging strategies. Further, the controller 106 may be configured to charge the battery pack 102 based on the selected charging strategy.

Further, in an embodiment, the controller 106 may be configured to receive an input indicative of one of enabling and disabling the at least one charging strategy. The controller 106 may be configured to charge the battery pack 102 based on the at least one charging strategy, if the input is indicative of enabling the at least one charging strategy. Further, the controller 106 may be configured to charge the battery pack 102 without the at least one charging strategy if the input is indicative of disabling the at least one charging strategy.

The controller 106 may be configured to monitor at least one abnormality associated with the set of battery operational parameters while charging the battery pack 102 in the at least one of the plurality of charging strategy. Further, the controller 106 may be configured to generate a notification indicative of an alert associated with the at least one abnormality.

The monitoring module 124 of the controller 106 is configured to continuously monitor the battery parameters generated from the at least one sensor 104. In addition, the monitoring module 124 facilitates any adjustment of the charging strategy based on any abnormality detected by the monitoring module 124. The monitoring module 124 is configured to detect any abnormalities associated with the battery's operation, such as but not limited to irregular charging patterns or decreased battery capacity, and alert the determination module 122 of the controller 106 to take corrective actions and change or optimize the charging strategy accordingly.

The communication module 120 of the controller 106 facilitates the communication of the data to the controller 106 and further facilitates the transmission of the data from the controller 106. In addition, the communication module 120 is configured to send the data from the at least one sensor 104 to the central station 108 to facilitate the storage of the data in the central station 108, such as a remote server. Additionally, the communication module 120 facilitates the

communication of the plug condition of the charger with the two-wheeler 500 via the battery pack 102.

Referring to Figure 2, a method 200 of charging the battery pack 102 of the two-wheeler 500 is shown. The method 200 includes a plurality of steps for executing the charging of the battery pack 104 of the two-wheeler 500. In the step 202, having at least one sensor 104 operatively coupled with the battery pack 104 of the two-wheeler 500, and the controller 106 in communication with the at least one sensor 104. The at least one sensor 104 is adapted to generate the data related to the set of battery operational parameters and the set of vehicle usage parameters. The controller 106 is configured to facilitate the transfer of the data acquired from the at least one sensor 104 and facilitate in determining a charging strategy for the two-wheeler 500.

In the step 204, the method 200 includes determining the information associated with the set of battery operational parameters and the set of vehicle usage parameters by the at least one sensor 104. In the step 204, the battery operational parameters include at least the temperature, the battery degradation rate, the voltage, the depth of discharge, the charge-discharge cycle, the charging current, the health status, the state of charge (SOC) consumed per day, the current SOC, and the number of charge-discharge cycle per day. In addition, the set of vehicle usage parameters includes the vehicle riding time, the vehicle start time, the vehicle trip end time, the average distance travelled per day, the vehicle standby time.

Further, the method 200 moves to step 206. In the step 206, the method 200 includes, receiving by the controller 106, the set of battery operational parameters, and the set of vehicle usage parameters determined from the at least one sensor 104. For so doing, the communication module 120 of the controller 106 is configured to communicate with the at least one sensor 104 and receive the data related to the set of battery operational parameters, and the set of vehicle usage parameters. In addition, the data related to the set of battery operational parameters, and the set of

vehicle usage parameters is sent to the central station 108 for facilitating the storage of the data within the central station 108.

In the step 208, the method 200 includes determining by the controller 106, at least one charging parameter associated with the battery pack 102 based on the set of battery operational parameters and the set of vehicle usage parameters. For so doing, the determination module 122 of the controller 106 is actuated. The determination module 122 facilitates the determination of one or more parameters of charging the battery pack 104 such as, but not limited to, the maximum SOC level, the charging rate, the total time range, the start time range, the end time range, the intermediate time range, and the charging pattern while charging the battery.

In the step 210, the method 200 includes generating by the controller 106, the at least one charging strategy based on the determined charging parameters. The generation of the charging strategy is performed by the determination module 122 of the controller 106. In addition, the at least one charging strategy includes a charging pattern indicative of a pattern in which the battery pack 102 is to be charged. The at least one charging strategy may include varied charging rates in varied time ranges determined by the determination module 122 of the controller 106. For example, the at least one charging strategy may include a charging rate of 2 amps for a time range 0-30 min and a charging rate of 10 amps for a time range 30-60 min.

In addition, the at least one charging strategy is indicative of a charging cycle with the determined charging parameters for the battery pack 102. In addition, the controller 106 is configured to receive an input indicative of one of enabling and disabling the at least one charging strategy from the user to facilitate the selection of a charging strategy by the user.

In the step 212, the method 200 includes charging, by the controller 106, the battery pack 102 based on the generated charging strategy. The charging strategies

may be at least one charging strategy or a plurality of charging strategies adapted to be executed linearly or parallelly or including a plurality of intervals in-between the charging strategies. In addition, the charging of the battery pack 102 is based on the at least one charging strategy, if the input is indicative of enabling the at least one charging strategy. In addition, the charging of the battery pack 102 by the controller 106 may be performed without the at least one charging strategy if the input is indicative of disabling the at least one charging strategy.

Further, in an embodiment, the method 200 includes monitoring, at least one abnormality associated with the set of battery operational parameters. The monitoring module 124 of the controller 106 is adapted to continuously monitor the battery parameters generated from the at least one sensor 104. In addition, the monitoring module 124 facilitates any adjustment of the charging strategy based on any abnormality deducted by the monitoring module 124. The monitoring module 124 is adapted to detect any abnormalities associated with the battery's operation, such as but not limited to irregular charging patterns or decreased battery capacity and alerts the determination module 122 of the controller 106 to take corrective actions and change or optimize the charging strategy accordingly.

Further, in an embodiment, the method 200 includes notifying the user of any abnormality associated with the battery operational parameters and the set of vehicle usage parameters. Further, the communication module 120 sends a signal to the display unit 110 about the determined charging strategy by the determination module 122 of the controller 106. This facilitates the displaying of the notification to the user about the determined charging strategy.

Referring to Figure 3, a flow diagram of the method 300 of execution of a charging of the two-wheeler 500 is shown. The method 300 includes a step 302, in which the user plugs the charger in the two-wheeler 500. The charger of the two-wheeler 500 is connected to the source of AC supply 112.

The method 300 moves to step 304, the controller 106 checks if the user has selected a smart charging mode. There may be different charging modes available to the user such as, but not limited to, a smart charging mode, a normal charging mode, and a user-defined charging mode. In an example, the smart charging mode is a default setting for charging the battery pack 102 of the two-wheeler 500. However, if the user has selected a normal charging mode, the method 300 moves to the next step.

In the step 306, charging of the battery pack 102 of the two-wheeler 500 is executed. As an example, the normal mode of charging is operated in this case. The charging parameters determined by the determination module 122 of the controller 106 are constant throughout the charging. In addition, the battery pack 102 of the two-wheeler 500 is charged end to end starting from the initial point of SOC to 100 percent of the SOC. The charging normal mode is continuous and does not have any pauses or the charging is not interrupted. However, the monitoring module 124 of the controller 106 monitors the set of battery operational parameters at all times of the charging and generates an alert in case of any malfunctioning in the battery operational parameters.

In the step 308, the charging is complete. In this step 308, the SOC of the battery is reached 100 and the charging is complete. The charger from the AC supply 112 is switched off and no more charging of the battery pack 102 takes place.

Referring to Figure 4, a flow diagram of the method 400 of execution of the charging of the two-wheeler 500 is shown. The method 400 includes a step 402, in which the user plugs the charger in the two-wheeler 500. The charger of the two-wheeler 500 is connected to the source of AC supply 112.

The method 400 moves to step 404, in the step 404, the controller 106 checks if the user has selected the smart charging mode. The smart charging mode is also a default setting of the system 100 for the two-wheeler 500. In addition, if the user

has not selected the normal charging mode, the smart charging is actuated while charging the battery pack 102 of the two-wheeler 500. The detection of the smart charging mode by the controller 106 moves the method 400 to a step 406.

In the step 406, the controller 106 is adapted to fetch data from the central station 108. The central station 108 may be embodied as a remote server for facilitating the storage of the data and adding computation to the controller 106. The data fetched from the central station 108 includes the data related to the set of battery operational parameters and the set of vehicle usage parameters. In an example, the data related to the battery operational parameters include at least the temperature, the battery degradation rate, the voltage, the depth of discharge, the charge-discharge cycle, the charging current, the health status, the state of charge (SOC) consumed per day, the current SOC, and the number of charge-discharge cycle per day. In addition, the data related to the set of vehicle usage parameters include the vehicle riding time, the vehicle start time, the vehicle trip end time, the average distance travelled per day, and the vehicle standby time.

Further, the method 400 moves to a step 408. In the step 408, the determination module 122 of the controller 106 determines a charging strategy for the battery pack 102 of the two-wheeler 500 based on the received data related to the set of battery operational parameters and the set of vehicle usage parameters. In addition, the charging strategy determined by the determination module 122 includes the one or more parameters of charging including, but not limited to, the maximum SOC level, the charging rate, the total time range, the start time range, the end time range, the intermediate time range, and the charging pattern for the battery pack 102. In addition, the charging strategy determined by the determination module 122 may include varied charging rates in varied time ranges.

In the step 410, charging by the controller 106 of the battery pack 102 is performed. The charging of the battery pack 102 is based on the generated charging strategy. The charging strategies may be at least one charging strategy or a plurality

of charging strategies adapted to be executed linearly or parallelly or including a plurality of pauses in between the charging strategies. In addition, the charging of the battery pack 102 is based on the at least one charging strategy, if the input is indicative of enabling the at least one charging strategy.

Now, various exemplary implementations of different charging strategies are explained hereinafter. It should be noted that the below-mentioned implementations are exemplary in nature and the system 100 can also generate different charging strategies, without departing from the scope of the present disclosure.

In one example, based on the set of battery operational parameters and the set of vehicle usage parameters, the determining module 122 of the controller 106 may generate a charging strategy, such as an optimized charging strategy. The optimized charging strategy may be generated based on the data fetched from the central station 108. The data may indicate that 67 percent of the SOC of the battery pack 102 depletes on daily basis for the two-wheeler 500. Further, the data indicate that the two-wheeler 500 start time is 7:00 AM, and the user charges the battery pack 102 from 9:00 PM to 6:00 AM. The determination module 122 of the controller 106 determines that almost 80 percent SOC will be desirable for the user and will help in prolonging the life of the battery pack 102. So, the charging strategy generated by the determination module 122 may ensure that the battery pack 102 will be charged upto 80 percent SOC. In the optimized charging strategy, the charging of the battery pack 102 may be cut-off after 80 percent SOC.

In another example, the controller 106 fetches data from the central station 108 related to the set of battery operational parameters and the set of vehicle usage parameters. The data fetched from the central station 108 includes a user's data that uses almost 87 percent of the SOC of the battery pack 102. The ride starts at 9:00 AM, and the user charges the battery pack 102 from 10:00 PM to 8:00 AM. In this case, charging the battery pack 102 to 80 percent may not be a desirable solution. The determination module 122 of the controller 106 determines a charging strategy

for the charging of the battery pack 102, the determined charging strategy includes charging the battery pack 102 upto 80 percent SOC having a set of predetermined current and voltage parameters. The predetermined current and voltage parameters of the battery pack 102 may facilitate a normal charging. In addition, the determination module 122 of the controller 106 determines a charging strategy beyond 80 percent SOC and upto 100 percent SOC.

The charging strategy determined for this range may include having a set of predetermined current and voltage parameters for charging the battery pack. The predetermined current and voltage parameters for charging the battery pack 102 may facilitate slow charging for optimizing and prolonging the battery life of the battery pack 102.

In yet another example, based on the set of battery operational parameters and the set of vehicle usage parameters, the determining module 122 of the controller 106 may generate a charging strategy, such as an overnight charging strategy. The overnight charging strategy may be implemented to charge the two-wheeler 500 during a time duration, such as night, when such two-wheeler 500 is not operated for prolonged time period. The overnight charging strategy may include pausing the charging for a duration of time and reinitiating the charging an hour before the vehicle start time for the user. For example, in the overnight charging strategy, the battery pack 102 of the two-wheeler 500 may be charged to 80 percent SOC for a first-time duration, such as 10 PM-5AM. Further, the overnight charging strategy may pause the charging after charging the battery to 80 percent SOC. Subsequently, the overnight charging strategy may include a second-time duration, such as 7 AM – 8 AM which is determined based on the vehicle start time, such as 8AM. Accordingly, in the overnight charging strategy, the charging of the battery pack 102 may be reinitiated to charge such battery pack 102 upto 100 percent SOC. This ensures that the battery pack 102 may not be overcharged and the overall temperature of the battery pack 102 remain optimal.

In yet another example, based on the set of battery operational parameters and the set of vehicle usage parameters, the determining module 122 of the controller 106 may generate a charging strategy, such as a paced charging strategy. In the paced charging strategy, the battery pack may be charged at varied charging rates in varied time ranges. For example, the battery pack 102 of the two-wheeler 500 may be charged to 80 percent SOC for a first-time duration, such as 10 PM-5AM at a first charging rate. Further, the battery pack 102 may be charged upto 100 percent SOC at a second charging rate for a second time duration, such as 5AM-7AM. The second charging rate may be less than the first charging rate. This ensures that the battery pack 102 may not be overcharged and the overall temperature of the battery pack 102 remains optimal.

The advantages of the charging system 100 and the method 200, 300, 400 of charging the battery pack 102 for the two-wheeler 500 are now explained. The charging system 100 facilitates continuous monitoring of the battery pack 102 parameters using the at least one sensor 104 and adjusts the charging strategy as needed to ensure a safe and the effective charging of the battery pack 102. In addition, the charging from the charging system 100 is safe and efficient as the at least one sensor 104 is adapted to detect any potential hazard such as but not limited to the overheating and overcharging of the battery pack 102. In addition, the charging system 100 stores the data in the central station 108 or the cloud thereby enabling the remote access to the charging data and enhancing the performance of the charging system 100. The central station 108 also provide additional computing resource to the charging system 100. Overall, the charging system 100 provides a more efficient, effective, and a safe way to charge the battery pack 108, improves the life of the battery pack 108, and reduces the environmental impact caused due to the battery disposal. Further, the recorded set of battery operational parameters and the recorded set of the vehicle usage parameters facilitates in determining a charging strategy thereby enabling a personalized charging experience for every user.

While specific language has been used to describe the present disclosure, any limitations arising on account thereto, are not intended. As would be apparent to a person in the art, various working modifications may be made to the method in order to implement the inventive concept as taught herein. The drawings and the foregoing description give examples of embodiments. Those skilled in the art will appreciate that one or more of the described elements may well be combined into a single functional element. Alternatively, certain elements may be split into multiple functional elements. Elements from one embodiment may be added to another embodiment.

We Claim:

1. A charging system (100) for a two-wheeler (500), the charging system (100) comprising:

at least one sensor (104) operatively coupled with a battery pack (102) of the two-wheeler (500) to determine information associated with a set of battery operational parameters and a set of vehicle usage parameters;

a controller (106) in communication with the at least one sensor (102), and configured to:

receive the set of battery operational parameters and the set of vehicle usage parameters from the at least one sensor;

determine at least one charging parameter associated with the battery pack (102) based on the set of battery operational parameters received by the controller (106) and the set of vehicle usage parameters received by the controller (106);

generate at least one charging strategy based on the determined charging parameters; and

charge the battery pack (102) based on the generated charging strategy.

2. The system (100) as claimed in claim 1, wherein the set of battery operational parameters includes at least a temperature, a battery degradation rate, a voltage, a depth of discharge, a charge-discharge cycle, a charging current, a health status, a state of charge (SOC) consumed per day, a current SOC, and a number of charge-discharge cycle per day.

3. The system (100) as claimed in claim 1, wherein the set of vehicle usage parameters includes a vehicle riding time, a vehicle start time, a vehicle trip end time, an average distance travelled per day, a vehicle standby time.

4. The system (100) as claimed in claim 1, wherein the at least one charging parameter includes a maximum SOC level, a charging rate, a total time range, a start time range, an end time range, an intermediate time range, and a charging pattern.

5. The system (100) as claimed in claim 4, wherein the charging pattern is indicative of a pattern in which the battery pack is charged at varied charging rates in varied time ranges.

6. The system (100) as claimed in claim 1, wherein the at least one charging strategy is indicative of a charging cycle with the determined charging parameters for the battery pack.

7. The system (100) as claimed in claim 1, wherein the controller (106) is configured to:

receive an input indicative of one of enabling and disabling the at least one charging strategy;

charge the battery pack (102) based on the at least one charging strategy, if the input is indicative of enabling the at least one charging strategy; and

charge the battery pack (102) without the at least one charging strategy if the input is indicative of disabling the at least one charging strategy.

8. The system (100) as claimed in claim 1, wherein the controller (106) is configured to:

generate a plurality of charging strategies based on the determined charging parameters;

display a notification indicative of the plurality of charging strategies;

receive an input indicative of a selection of one of the plurality of charging strategies; and

charge the battery pack (102) based on the selected charging strategy.

9. The system (100) as claimed in claim 1, wherein the controller (106) is configured to:

monitor at least one abnormality associated with the set of battery operational parameters while charging the battery pack (102) in the at least one of the plurality of charging strategy; and

generate a notification indicative of an alert associated with the at least one abnormality.

10. A method (200) for charging a battery pack (102) of a two-wheeler (500), the method comprising:

having at least one sensor (104) operatively coupled with the battery pack (102) of the two-wheeler (500), and a controller in communication with the at least one sensor (104);

determining information associated with a set of battery operational parameters and a set of vehicle usage parameters by the at least one sensor;

receiving by the controller (106), the set of battery operational parameters and the set of vehicle usage parameters determined from the at least one sensor (102);

determining by the controller (106), at least one charging parameter associated with the battery pack (102) based on the set of battery operational parameters and the set of vehicle usage parameters;

generating by the controller (106), at least one charging strategy based on the determined charging parameters; and

charging by the controller (106), the battery pack (102) based on the generated charging strategy.

11. The method (200) as claimed in claim 10, wherein the set of battery operational parameters includes at least a temperature, a battery degradation rate, a voltage, a depth of discharge, a charge-discharge cycle, a charging

current, a health status, a state of charge (SOC) consumed per day, a current SOC, and a number of charge-discharge cycle per day.

12. The method (200) as claimed in claim 10, wherein the set of vehicle usage parameters includes a vehicle riding time, a vehicle start time, a vehicle trip end time, and an average distance travelled per day, a vehicle standby time.

13. The method as claimed in claim 10, wherein the at least one charging parameter includes a maximum SOC level, a charging rate, a total time range, a start time range, an end time range, an intermediate time range, and a charging pattern.

14. The method (200) as claimed in claim 13, wherein the charging pattern is indicative of a pattern in which the battery pack is charged at varied charging rates in varied time ranges.

15. The method (200) as claimed in claim 10, wherein the at least one charging strategy is indicative of a charging cycle with the determined charging parameters for the battery pack.

16. The method (200) as claimed in claim 10 further comprising:

receiving by the controller (106), an input indicative of one of enabling and disabling the at least one charging strategy;

charging by the controller (106), the battery pack (102) is based on the at least one charging strategy, if the input is indicative of enabling the at least one charging strategy; and

charging by the controller (106), the battery pack (102) without the at least one charging strategy if the input is indicative of disabling the at least one charging strategy.

17. The method (200) as claimed in claim 10 further comprising:

generating by the controller (106), a plurality of charging strategies based on the determined charging parameters;

displaying by the controller (106), a notification indicative of the plurality of charging strategies;

receiving by the controller (106), an input indicative of a selection of one of the plurality charging strategies; and

charging by the controller (106), the battery pack (102) based on the selected charging strategy.

18. The method as claimed in claim 10 further comprising:

monitoring by the controller (106), at least one abnormality associated with the set of battery operational parameters while charging the battery pack (102) in the at least one of the plurality of charging strategy; and

generating by the controller (106), a notification indicative of an alert associated with the at least one abnormality.

Dated this **09th** day of **May, 2023**

Manisha Singh

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Abstract Of The Invention

A CHARGING SYSTEM FOR A TWO-WHEELER AND A METHOD FOR OPERATION THEREOF

The present disclosure is related to a charging system (100) for a two-wheeler (500). The charging system (100) includes at least one sensor (104) operatively coupled with a battery pack (102) of the two-wheeler (500) to determine information associated with a set of battery operational parameters and a set of vehicle usage parameters and a controller (106) in communication with at least one sensor (104). The controller (106) is configured to receive the set of battery operational parameters and the set of vehicle usage parameters and determine at least one charging parameter associated with the battery pack (102) based on the set of battery operational parameters received by the controller (106) and the set of vehicle usage parameters received by the controller (106). In addition, the controller (106) is configured to charge the battery pack (102).

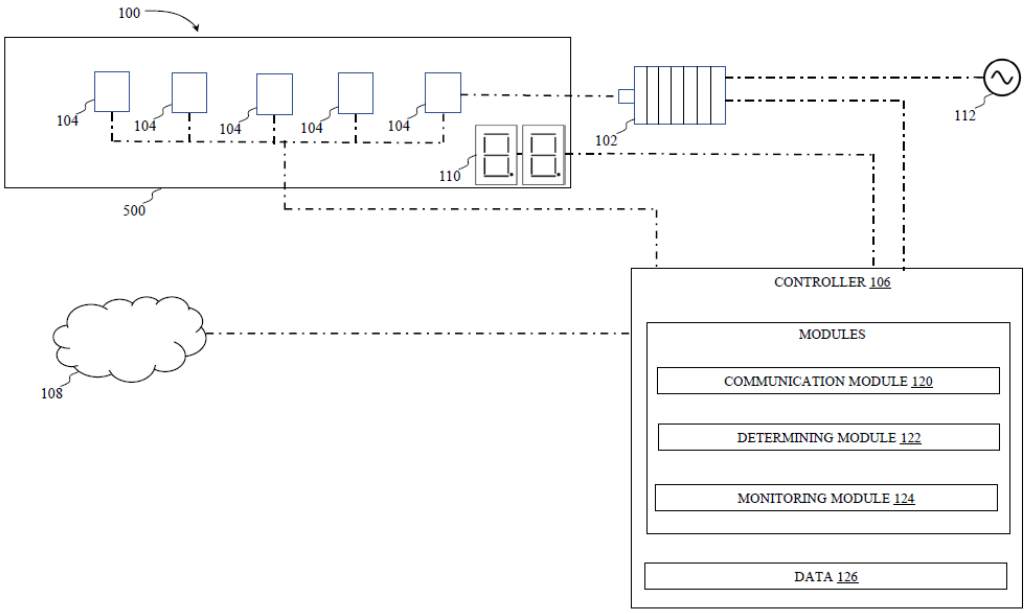

FIGURE 1

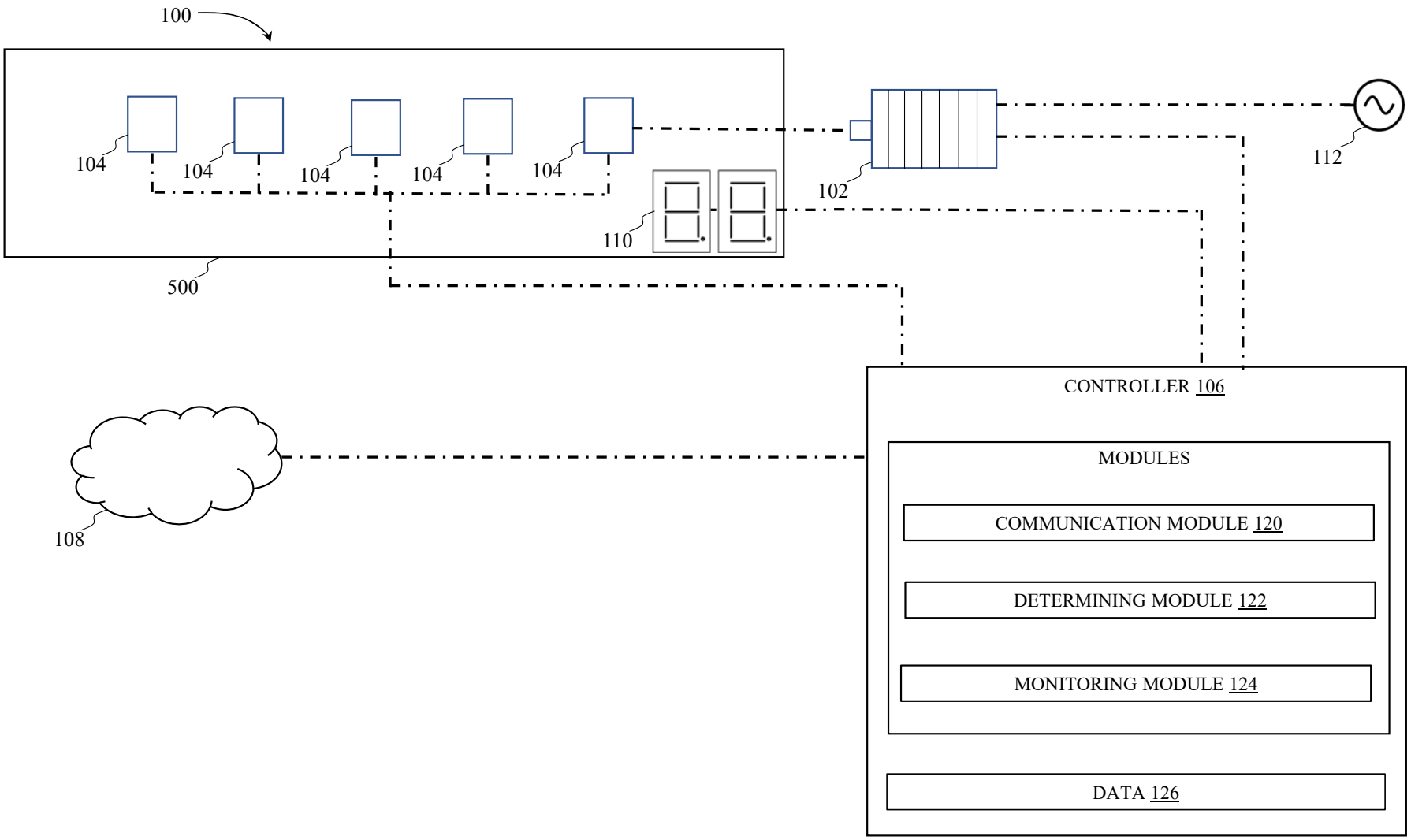

FIGURE 1

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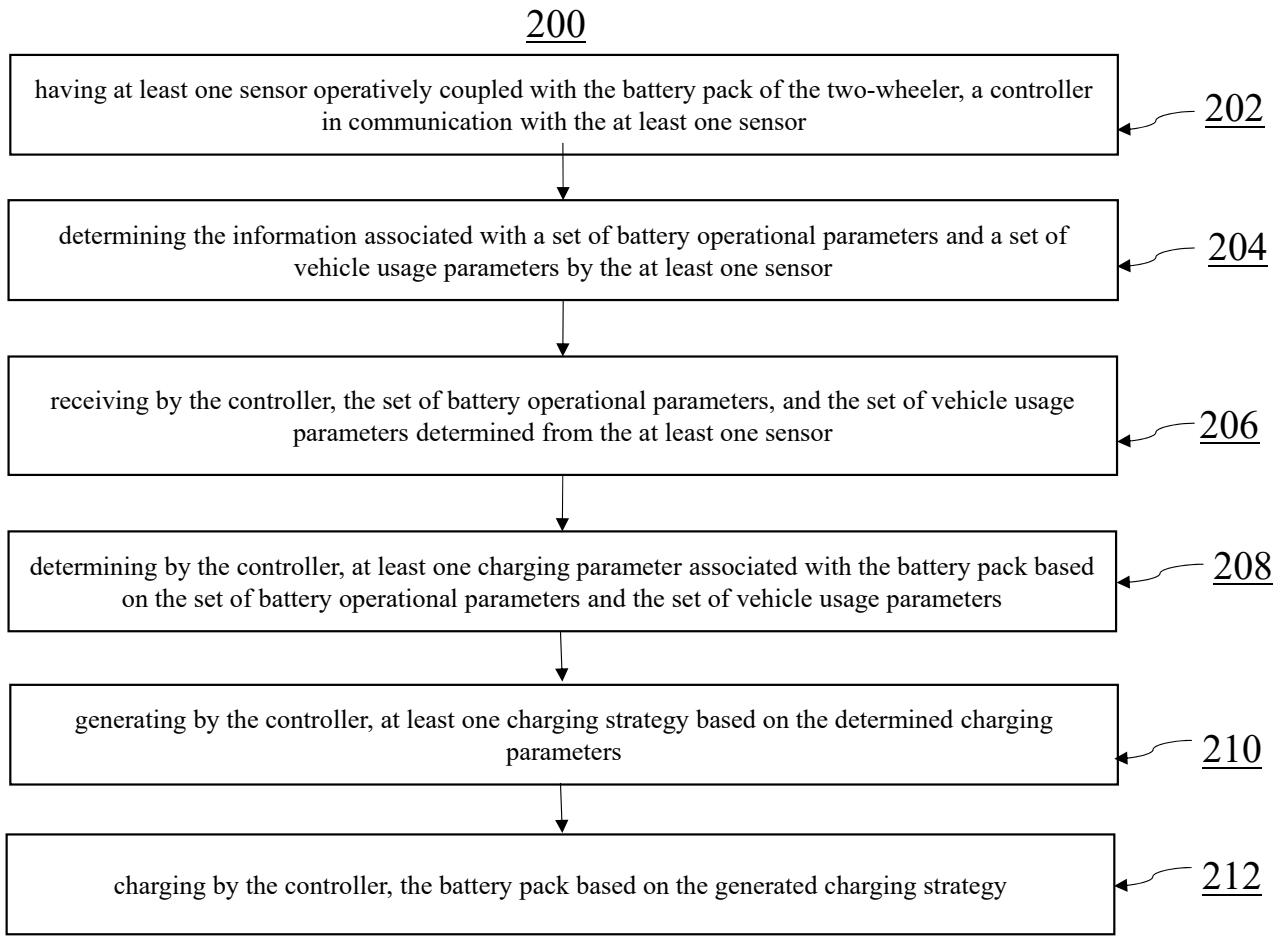

FIGURE 2

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300

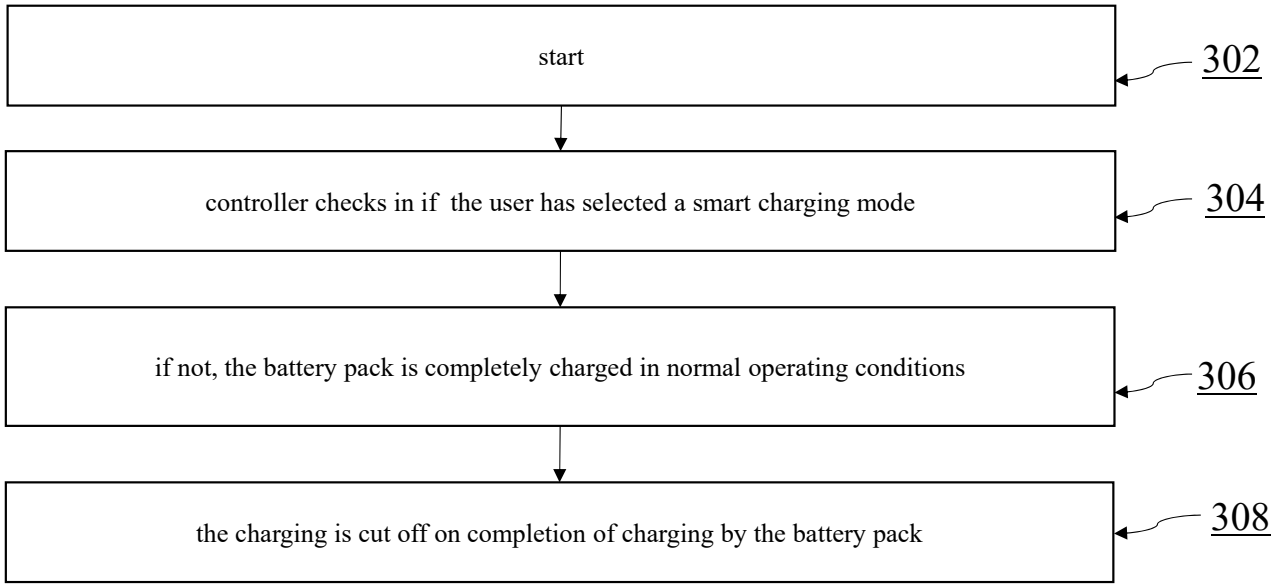

FIGURE 3

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400

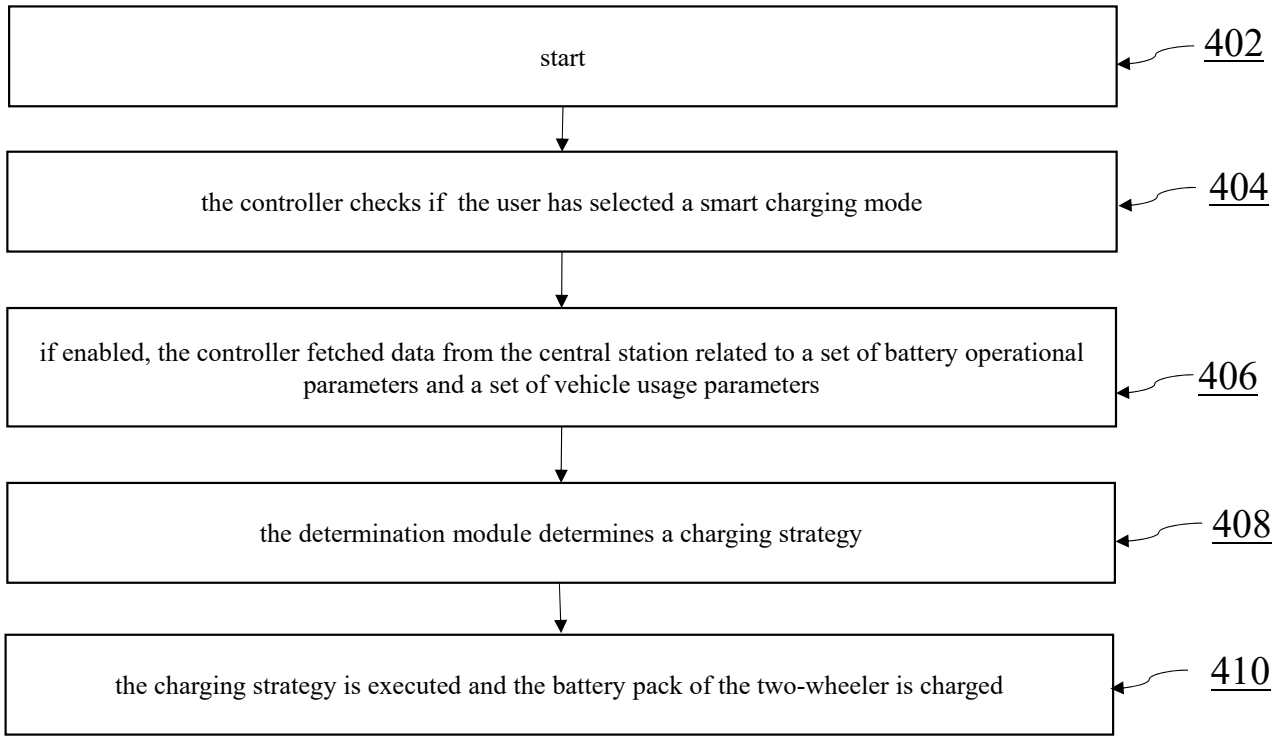

FIGURE 4

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