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**(71) Applicant: SUN MOBILITY PTE LTD** [SG/SG]; 77 High Street, #09-14 High Street Plaza, Singapore 179433 (SG).

**(72) Inventors: RAJU, Suraj**; c/o, Sun Mobility Technology Centre, No. 25, 1st cross, 2nd Main road, Behind Graphite Mahadevpura Post, Doddanakundi Industrial Area 2, Phase 1, Doddanekkundi, Bengaluru, Karnataka 560048 (IN). **GUNJAN, Kumar**; c/o, Sun Mobility Technology Centre, No. 25, 1st cross, 2nd Main road, Behind Graphite Mahadevpura Post, Doddanakundi Industrial Area 2, Phase 1, Doddanekkundi, Bengaluru, Karnataka 560048 (IN). **S, Karthikeyan**; c/o, Sun Mobility Technology Centre, No. 25, 1st cross, 2nd Main road, Behind Graphite Mahadevpura Post, Doddanakundi Industrial Area 2, Phase 1, Doddanekkundi, Bengaluru, Karnataka 560048 (IN). **GOPALAKRISHNAN, Arvind**; c/o, Sun Mobility Technology Centre, No. 25, 1st cross, 2nd Main road, Behind Graphite Mahadevpura Post, Doddanakundi Industrial Area 2, Phase 1, Doddanekkundi, Bengaluru, Karnataka 560048 (IN).

**(74) Agent: SPRUSON & FERGUSON (ASIA) PTE LTD**; P.O. Box 1531, Robinson Road Post Office, Singapore 903031 (SG).

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**(54) Title:** A BATTERY CHARGING AND SWAPPING STATION AND METHODS FOR MANAGING OPERATING MODES OF THE SAME

**(57) Abstract:** A battery charging and swapping station and methods for managing operating modes of the same Embodiments herein disclose methods and systems for managing the operating modes of a battery charging and swapping station, wherein the station can be put into a non-operational mode without compromising other factors including the life of the battery pack and power consumption at the battery charging and swapping station

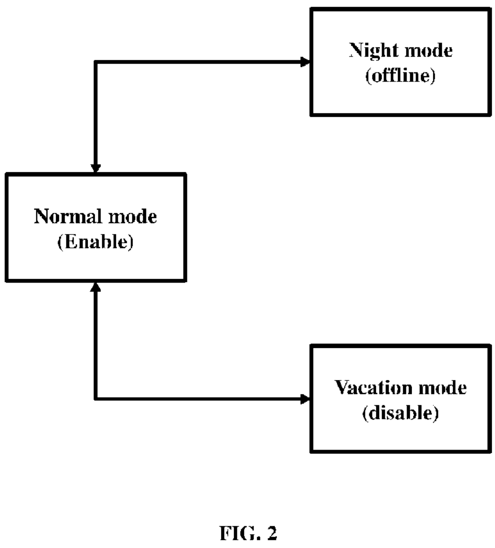


FIG. 2

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# TITLE OF THE INVENTION

**"A battery charging and swapping station and methods for managing operating modes of the same"**

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

## CROSS REFERENCE TO RELATED APPLICATION

This application is based on and derives the benefit of Indian Provisional Application IN202341002409, the contents of which are incorporated herein by reference.

## TECHNICAL FIELD

[001] Embodiments disclosed herein relate to battery charging and swapping stations, and more particularly to managing one or more modes of operation of a battery charging and swapping station.

## BACKGROUND

[002] Depleted battery packs from a vehicle can be swapped with charged battery packs at battery charging and swapping stations. The battery charging and swapping stations are operated continuously 24/7, ensuring the availability of charged battery packs to the users at all times. However, there are certain times where the station operator may have to close the battery charging and swapping station at some point (such as maintenance, reduced traffic (for example, a swapping station for school vans/buses may be closed during school holidays)). At that point in time, the battery charging and swapping station cannot be switched off just like that as the battery packs inside the battery charging and swapping station may go into deep discharge mode, if the battery charging and swapping stations is not operated for a longer period. The other option to avoid the deep discharge of battery packs in non-operational mode of the battery charging and swapping station is to have the station running at all times. This will increase the power consumption by the battery charging and swapping station as the battery charges without being utilized by the user.

[003] Hence, there is a need in the art for solutions which will overcome the above mentioned drawback(s), among others.

## OBJECTS

[004] The principal object of embodiments herein is to disclose methods and systems for managing the operating modes of a battery charging and swapping station, wherein the station can be put into a non-operational mode without compromising other factors including the life of the battery pack and power consumption at the battery charging and swapping station.

[005] These and other aspects of the embodiments herein will be better appreciated and understood when considered in conjunction with the following description and the accompanying drawings. It should be understood, however, that the following descriptions, while indicating at least one embodiment and numerous specific details thereof, are given by way of illustration and not of limitation. Many changes and modifications may be made within the scope of the embodiments herein without departing from the spirit thereof, and the embodiments herein include all such modifications.

## BRIEF DESCRIPTION OF FIGURES

[006] Embodiments herein are illustrated in the accompanying drawings, throughout which like reference letters indicate corresponding parts in the various figures. The embodiments herein will be better understood from the following description with reference to the following illustratory drawings. Embodiments herein are illustrated by way of examples in the accompanying drawings, and in which:

[007] FIG. 1 depicts the battery swapping network, according to embodiments as disclosed herein;

[008] FIG. 2 depicts the station switching between the operating modes, according to embodiments as disclosed herein;

[009] FIG. 3 depicts a process for managing the operation of the battery charging and swapping station, according to embodiments as disclosed herein;

[0010] FIG. 4 is a flowchart depicting the process of the battery charging and swapping station operating in vacation mode, according to embodiments as disclosed herein;

[0011] FIG. 5 is a flowchart depicting the process of the battery charging and swapping station operating in night mode, according to embodiments as disclosed herein;

[0012] FIG. 6 is a flowchart depicting the process of the battery charging and swapping station operating in power mode, according to embodiments as disclosed herein;

[0013] FIG. 7 is a flowchart depicting the process of the battery charging and swapping station operating in backup mode, according to embodiments as disclosed herein; and

[0014] FIG. 8 is a flowchart depicting the process of the battery charging and swapping station operating in optimize mode, according to embodiments as disclosed herein.

## DETAILED DESCRIPTION

[0015] The embodiments herein and the various features and advantageous details thereof are explained more fully with reference to the non-limiting embodiments that are illustrated in the accompanying drawings and detailed in the following description. Descriptions of well-known components and processing techniques are omitted so as to not unnecessarily obscure the embodiments herein. The examples used herein are intended merely to facilitate an understanding of ways in which the embodiments herein may be practiced and to further enable those of skill in the art to practice the embodiments herein. Accordingly, the examples should not be construed as limiting the scope of the embodiments herein.

[0016] For the purposes of interpreting this specification, the definitions (as defined herein) will apply and whenever appropriate the terms used in singular will also include the plural and vice versa. It is to be understood that the terminology used herein is for the purposes of describing particular embodiments only and is not intended to be limiting. The terms “comprising”, “having” and “including” are to be construed as open-ended terms unless otherwise noted.

[0017] The words/phrases "exemplary", “example”, “illustration”, “in an instance”, “and the like”, “and so on”, “etc.”, “etcetera”, “e.g.,” , “i.e.,” are merely used herein to mean "serving as an example, instance, or illustration." Any embodiment or implementation of the present subject matter described herein using the words/phrases "exemplary", “example”, “illustration”, “in an instance”, “and the like”, “and so on”, “etc.”, “etcetera”, “e.g.,” , “i.e.,” is not necessarily to be construed as preferred or advantageous over other embodiments.

[0018] Embodiments herein may be described and illustrated in terms of blocks which carry out a described function or functions. These blocks, which may be referred to herein as managers, units, modules, hardware components or the like, are physically implemented by analog and/or digital circuits such as logic gates, integrated circuits, microprocessors, microcontrollers, memory circuits, passive electronic components, active electronic components, optical components, hardwired circuits and the like, and may optionally be driven by a firmware. The circuits may, for example, be embodied in one or more semiconductor chips, or on substrate supports such as printed circuit boards and the like. The circuits constituting a block may be implemented by dedicated hardware, or by a processor (e.g., one or more programmed microprocessors and associated circuitry), or by a combination of dedicated hardware to perform some functions of the block and a processor to perform other functions of the block. Each block of the embodiments may be physically separated into two or more interacting and discrete blocks without departing from the scope of the disclosure. Likewise, the blocks of the embodiments may be physically combined into more complex blocks without departing from the scope of the disclosure.

[0019] It should be noted that elements in the drawings are illustrated for the purposes of this description and ease of understanding and may not have necessarily been drawn to scale. For example, the flowcharts/sequence diagrams illustrate the method in terms of the steps required for understanding of aspects of the embodiments as disclosed herein. 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 present embodiments 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. Furthermore, in terms of the system, one or more components/modules which comprise the system 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 present embodiments 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.

[0020] The accompanying drawings are used to help easily understand various technical features and it should be understood that the embodiments presented herein are not limited by the accompanying drawings. As such, the present disclosure should be construed to extend to any modifications, equivalents, and substitutes in addition to those which are particularly set out in the accompanying drawings and the corresponding description. Usage of words such as first, second, third etc., to describe components/elements/steps is for the purposes of this description and should not be construed as sequential ordering/placement/occurrence unless specified otherwise.

[0021] The embodiments herein achieve methods and systems for managing the operating modes of a battery charging and swapping station, wherein the station can be put into a non-operational mode without compromising other factors including the life of the battery pack and power consumption at the battery charging and swapping station. Referring now to the drawings, and more particularly to FIGS. 1 through 8, where similar reference characters denote corresponding features consistently throughout the figures, there are shown embodiments.

[0022] FIG. 1 depicts the battery swapping network. The network 100, as depicted, comprises at least one battery charging and swapping station 101, and a Cloud Management Unit (CMU) 102. The battery charging and swapping station 101 can further comprise a Dock Control Unit (DCU) 101A, a Swap Management Unit (SMU) 101B, one or more battery docks 101C, a memory 101D, and a communication module 101E.

[0023] Embodiments herein disclose methods of functioning of the battery charging and swapping station 101, when the battery charging and swapping station 101 is not being used to ensure that the battery life cycle is not affected and in the meantime, not consuming too much power by the battery charging and swapping station 101 during this time. The battery charging and swapping station 101 can change the mode of operation. This command either can come from the cloud server, the CMU 102, or from the station operator.

[0024] When powered ON, the DCU 101A can boot up into a bootloader. The configurations can comprise configurations stored in the memory 101D, and configurations read from the CMU 102. Based on one or more configurations in the memory 101D, the DCU 101A can boot into firmware. There can be multiple firmware; e.g., Application firmware and upgrade firmware. During the normal process, the boot up happens into an application firmware. The DCU 101A can check communication with the SMU 101B and the CMU 102. In an embodiment herein, the DCU 101A can communicate with the SMU 101B using a UART (Universal Asynchronous Receiver Transmitter). If the DCU 101A is unable to communicate with the SMU 101B and/or the CMU 102, the DCU 101A can raise a fault. The DCU 101A shall then read the configurations.

[0025] On successfully reading the configurations and successfully communicating with the SMU 101B and/or the CMU 102, the DCU 101A shall perform charger discovery; i.e., charger discovery involves establishing communication with the charger after successful authentication. The DCU 101A shall check communication with one or more sensors present in the battery charging and swapping station 101, such as, but not limited to, an Energy Meter (EM), a Lower Explosive Limit (LEL) sensor, and so on (not shown). On completing charger discovery and successfully checking communication with the one or more sensors, the DCU 101A can start normal functionalities of the battery charging and swapping station 101.

[0026] There is no specific scenario defined for the shutdown of the DCU 101A; i.e., the DCU 101A will continue to run as long as the battery charging and swapping station 101 is in operation.. If grid power is available to the battery charging and swapping station 101, the DCU 101A shall continue to run. If there is a loss in the grid power and State of Charge (SOC) of batteries present in the docks 101C, (which are serving as backup power) goes below a pre-defined threshold (for example, 20%, 15%, 10%), the DCU 101A can shut the battery charging and swapping station 101 down. The DCU 101A can send a station shutdown fault to the CMU 102 and the SMU 101B. The CMU 102 can inform the cloud (i.e., the server) (not shown) about the shutdown of the battery charging and swapping station 101, fault(s) that caused the shutdown, and so on. The CMU 102 can further send the shutdown battery pack command to the DCU 101A. After receiving this command, the DCU 101A can shut down the battery packs.

[0027] The battery charging and swapping station 101 can be provided with a plurality of operation modes. In an embodiment herein, the operating modes can be normal mode, vacation mode, night mode, and power mode. If the settings of the battery charging and swapping station 101 are set in normal mode, the functionality of charging and swapping of battery packs of the battery charging and swapping station 101 happens normally.

[0028] In an embodiment herein, vacation mode can be set manually by the station operator. In an embodiment herein, vacation mode can be pre-configured into the battery charging and swapping station 101, which will automatically go in vacation mode during the configured time. In the vacation mode, the DCU 101A can disable the swapping operation at the battery charging and swapping station 101. However, in the vacation mode, the battery charging and swapping station 101 can still draw power from the grid (if available) for the thermal management of the battery packs present in the docks 101C. The DCU 101A can keep charging management active, thereby ensuring that the SOC of the battery packs are maintained at an optimal SOC range (for example, 90-100%). This can involve the DCU 101A can keep monitoring if the SoC of the battery packs is within the optimal SOC range. If the SoC of a battery pack falls outside the optimal SOC range, the DCU 101A can initiate the charging of the battery packs using the grid power, thereby ensuring that the battery packs are not going into deep discharge mode.

[0029] If the power from grid is not available, all the electronic accessories and components initiate shutdown and the DCU 101A can send a station shutdown fault to the SMU 101B and the CMU 102. Subsequently, the battery charging and swapping station 101 shall proceed to shut down.

[0030] An authorized person (such as, but not limited to, a station operator, a network administrator, and so on) can initiate the night mode, using a mobile device, a wearable device, a web application, or through an interface provided at the swapping station. The authorized person can pre-configure a time that the battery charging and swapping station 101 should operate in night mode in the form of a first timestamp, and a second timestamp respectively; for example, from 10PM - 6AM on weekdays, 12 midnight – 5AM on weekends, and so on. When the battery charging and swapping station 101 is in night mode, the battery charging and swapping station 101 can be made offline for users (wherein users as referred to herein can be a person who wants to swap batteries). In an embodiment herein, the station follows the set time for night mode only for the upcoming/current night. In an embodiment herein, the battery charging and swapping station 101 can follow the set time for night mode, until a new time is for night mode is assigned to the battery charging and swapping station 101. At the configured first timestamp, the battery charging and swapping station 101 can switch from normal mode to night mode. At the configured second timestamp, the battery charging and swapping station 101 can change back to normal mode from night mode. In an embodiment herein, all the configuration and firmware updates for the battery charging and swapping station 101 is set to happen in the night mode.

[0031] In an embodiment herein, the DCU 101A cannot change from the vacation mode to the night mode or vice versa. FIG. 2 depicts the station switching between the operating modes. The battery charging and swapping station 101 can switch from normal mode to night mode and vice versa. The battery charging and swapping station 101 can switch from normal mode to vacation mode and vice versa.

[0032] In the power mode, the DCU 101A can charge the batteries present in the docks 101C at a higher energy level, based on input power to the battery charging and swapping station 101. For example, in the power mode, the DCU 101A can charge the vehicle at 32A, instead of the normal charging rate of 16A. In an embodiment herein, the power mode can be activated/de-activated automatically, based on the input power. In an embodiment herein, the power mode can be activated/de-activated by the authorized person.

[0033] In an embodiment herein, the battery charging and swapping station 101 can operate in a backup mode. In the backup mode, the battery charging and swapping station 101 can operate according to the power availability of the battery charging and swapping station 101 from the grid and other power sources (which can comprise one or more energy sources, such as, but not limited to, renewable energy sources (such as, but not limited to, solar energy, wind energy, and so on), an inverter, a Uninterrupted Power Supply (UPS), battery packs present in the docks 101C, and so on.). The DCU 101A can automatically switch the battery charging and swapping station 101 to the backup mode, if the power from the grid is cut off. In the backup mode, the battery charging and swapping station 101 can be powered through one or more the battery packs present in the docks 101C, according to the station utilization; thereby ensuring the swapping operation. In case, the battery packs in the battery charging and swapping station 101 do not have sufficient power for enabling the functioning of the battery charging and swapping station 101, the DCU 101A can shut down the battery charging and swapping station 101. The DCU 101A can continuously monitor the power from the other sources and on detecting that the power is available from grid, the DCU 101A can automatically turn the battery charging and swapping station 101 on and restart operation (normal mode).

[0034] In an embodiment herein, the battery charging and swapping station 101 can operate in an optimize mode. In the optimize mode, the battery charging and swapping station 101 can get inputs from various sensors including, but not limited to, an ambient temperature sensor (not shown), a light sensor (not shown), and a temperature sensor for the battery packs present in the docks 101C (not shown). The battery charging and swapping station 101 can optimize the battery temperature management based on the ambient temperature (as provided by the ambient temperature sensor).

[0035] In an embodiment herein, the battery charging and swapping station 101 can be operated in quick swap mode. In the quick swap mode, the battery charging and swapping station 101 can allow for partial swapping of the battery packs from the battery charging and swapping station 101. Partial swapping means swapping of any number of batteries which are less than the specified set of packs; for example, in case of a vehicle equipped with three battery packs, the user can just swap one of the 3 battery packs.

[0036] The DCU 101A can be implemented by analog and/or digital circuits such as logic gates, integrated circuits, microprocessors, microcontrollers, memory circuits, passive electronic components, active electronic components, optical components, hardwired circuits, and the like, and may optionally be driven by firmware.

[0037] The SMU 101B can be implemented by analog and/or digital circuits such as logic gates, integrated circuits, microprocessors, microcontrollers, memory circuits, passive electronic components, active electronic components, optical components, hardwired circuits, and the like, and may optionally be driven by firmware.

[0038] The DCU 101A may include one or a plurality of processors. The one or the plurality of processors may be a general-purpose processor, such as a central processing unit (CPU), an application processor (AP), or the like, a graphics-only processing unit such as a graphics processing unit (GPU), a visual processing unit (VPU), and/or an AI-dedicated processor such as a neural processing unit (NPU). The DCU 101A may include multiple cores and is configured to execute the instructions stored in the memory 101D.

[0039] Further, the DCU 101A is configured to execute instructions stored in the memory 101D and to perform various processes. The communication module 101E is configured for communicating internally between internal hardware components and with external devices via one or more networks. The memory 101D also stores instructions to be executed by the DCU 101A. The memory 101D may include non-volatile storage elements. Examples of such non-volatile storage elements may include magnetic hard discs, optical discs, floppy discs, flash memories, or forms of electrically programmable memories (EPROM) or electrically erasable and programmable (EEPROM) memories. In addition, the memory 101D may, in some examples, be considered a non-transitory storage medium. The term “non-transitory” may indicate that the storage medium is not embodied in a carrier wave or a propagated signal. However, the term “non-transitory” should not be interpreted that the memory 101D is non-movable. In certain examples, a non-transitory storage medium may store data that can, over time, change (e.g., in Random Access Memory (RAM) or cache).

[0040] In an embodiment, the communication module 101E includes an electronic circuit specific to a standard that enables wired or wireless communication. The communication module 101E is configured to communicate internally between internal hardware components of the battery charging and swapping station 100 and with external devices via one or more networks.

[0041] Although the FIG. 1 shows various hardware components of the battery charging and swapping station 100, but it is to be understood that other embodiments are not limited thereon. In other embodiments, the battery charging and swapping station 100 may include less or more number of components. Further, the labels or names of the components are used only for illustrative purpose and does not limit the scope of the embodiments as disclosed herein. One or more components can be combined together to perform same or substantially similar function in the battery charging and swapping station 100.

[0042] FIG. 3 depicts a process for managing the operation of the battery charging and swapping station. In step 301, the battery charging and swapping station 101 checks if grid power is available to the battery charging and swapping station 101. If the grid power is available, in step 302, the battery charging and swapping station 101 continues normal operations; i.e., the battery charging and swapping station 101 continues to operate in normal mode. If the grid power is not available, in step 303, the battery charging and swapping station 101 checks if at least one battery pack is available in a dock 101C at the battery charging and swapping station 101. If there are no battery packs available in at least one dock 101C at the battery charging and swapping station 101, in step 304, the battery charging and swapping station 101 shuts down. If there is at least one battery pack is available in a dock 101C at the battery charging and swapping station 101, in step 305, the battery charging and swapping station 101 monitors the SOC of the batteries; i.e., the battery charging and swapping station 101 checks if the SOC of the batteries is within the optimal SOC range. If the SOC of all the batteries in the dock 101C is not within the optimal SOC range (for example, >20%), in step 304, the battery charging and swapping station 101 shuts down the battery charging and swapping station 101. If the SOC of at least one of the batteries in the dock 101C is within the optimal SOC range (for example, >20%), in step 306, the battery charging and swapping station 101 continues normal operation, wherein the at least one of the batteries in the dock 101C serves as a power source. The various actions in method 300 may be performed in the order presented, in a different order or simultaneously. Further, in some embodiments, some actions listed in FIG. 3 may be omitted.

[0043] FIG. 4 is a flowchart depicting the process of the battery charging and swapping station operating in vacation mode. Consider that the battery charging and swapping station 101 is operating in vacation mode. In step 401, the battery charging and swapping station 101 disables the swapping operation at the battery charging and swapping station 101. In step 402, the battery charging and swapping station 101 still draws power from the grid (if available) for the thermal management of the battery packs present in the docks 101C. the battery charging and swapping station 101 keeps charging management active, thereby ensuring that the SOC of the battery packs are maintained at an optimal SOC range (for example,

>20%). In step 403, the battery charging and swapping station 101 keeps monitoring if the SoC of the battery packs is within the optimal SOC range. If the SoC of a battery pack falls outside the optimal SOC range and if the grid power is available (step 404), in step 405, the battery charging and swapping station 101 initiates the charging of the battery packs using the grid power, thereby ensuring that the battery packs are not going into deep discharge mode. If the power from grid is not available (step 404), in step 406, the battery charging and swapping station 101 initiates shutdown of all the electronic accessories and components, sends a station shutdown fault to the SMU 101B and the CMU 102, and proceeds to shut down the battery charging and swapping station 101. The various actions in method 400 may be performed in the order presented, in a different order or simultaneously. Further, in some embodiments, some actions listed in FIG. 4 may be omitted.

[0044] FIG. 5 is a flowchart depicting the process of the battery charging and swapping station operating in night mode. In step 501, the night mode is activated, wherein the battery charging and swapping station 101 was operating in normal mode. In an embodiment herein, the authorized person initiates the night mode, using a mobile device, a wearable device, a web application, or through an interface provided at the battery charging and swapping station. The authorized person can pre-configure a time that the battery charging and swapping station 101 should operate in night mode in the form of a first timestamp, and a second timestamp respectively. When the battery charging and swapping station 101 is in night mode, in step 502, the battery charging and swapping station 101 is made offline for users. The various actions in method 500 may be performed in the order presented, in a different order or simultaneously. Further, in some embodiments, some actions listed in FIG. 5 may be omitted.

[0045] FIG. 6 is a flowchart depicting the process of the battery charging and swapping station operating in power mode. In step 602, the battery charging and swapping station 101 activates the power mode. In an embodiment herein, the power mode can be activated automatically, based on the input power. In an embodiment herein, the power mode can be activated by the authorized person. In step 602, the battery charging and swapping station 101 charges the batteries present in the docks 101C at the higher energy level. The various actions in method

600 may be performed in the order presented, in a different order or simultaneously. Further, in some embodiments, some actions listed in FIG. 6 may be omitted.

[0046] FIG. 7 is a flowchart depicting the process of the battery charging and swapping station operating in backup mode. The battery charging and swapping station 101 enters backup mode, when the grid power is not available. In step 701, the battery charging and swapping station 101 checks if the grid power is available. If the grid power is not available, in step 702, the battery charging and swapping station 101 switches to backup mode. In step 703, the battery charging and swapping station 101 checks if one or more batteries present in the docks 101C have sufficient power to operate the battery charging and swapping station 101. If at least one battery present in the docks 101C does not have sufficient power to operate the battery charging and swapping station 101, in step 704, the battery charging and swapping station 101 shuts itself down. If at least one battery present in the docks 101C has sufficient power to operate the battery charging and swapping station 101, in step 705, the battery charging and swapping station 101 powers itself using the at least one battery present in the docks 101C. The various actions in method 700 may be performed in the order presented, in a different order or simultaneously. Further, in some embodiments, some actions listed in FIG. 7 may be omitted.

[0047] FIG. 8 is a flowchart depicting the process of the battery charging and swapping station operating in optimize mode. In step 801, the battery charging and swapping station 101 activates the optimize mode. In step 802, the battery charging and swapping station 101 can receive the ambient temperature from the ambient temperature sensor (not shown). In step 803, the battery charging and swapping station 101 optimizes the battery temperature management based on the ambient temperature. The various actions in method 800 may be performed in the order presented, in a different order or simultaneously. Further, in some embodiments, some actions listed in FIG. 8 may be omitted.

[0048] The disclosed embodiments encompass numerous advantages. Embodiments herein ensure the optimal and effective operation of the battery charging and swapping station during its unutilized state and enhancing the life cycle of the station accessories and battery packs.

[0049] The embodiments disclosed herein can be implemented through at least one software program running on at least one hardware device and performing network management functions to control the network elements. The elements include blocks which can be at least one of a hardware device, or a combination of hardware device and software module.

[0050] The embodiment disclosed herein describes methods and systems for managing the operating modes of a battery charging and swapping station. Therefore, it is understood that the scope of the protection is extended to such a program and in addition to a computer readable means having a message therein, such computer readable storage means contain program code means for implementation of one or more steps of the method, when the program runs on a server or mobile device or any suitable programmable device. The method is implemented in at least one embodiment through or together with a software program written in e.g., Very high speed integrated circuit Hardware Description Language (VHDL) another programming language, or implemented by one or more VHDL or several software modules being executed on at least one hardware device. The hardware device can be any kind of portable device that can be programmed. The device may also include means which could be e.g., hardware means like e.g., an ASIC, or a combination of hardware and software means, e.g., an ASIC and an FPGA, or at least one microprocessor and at least one memory with software modules located therein. The method embodiments described herein could be implemented partly in hardware and partly in software. Alternatively, the invention may be implemented on different hardware devices, e.g., using a plurality of CPUs.

[0051] The foregoing description of the specific embodiments will so fully reveal the general nature of the embodiments herein that others can, by applying current knowledge, readily modify and/or adapt for various applications such specific embodiments without departing from the generic concept, and, therefore, such adaptations and modifications should and are intended to be comprehended within the meaning and range of equivalents of the disclosed embodiments. It is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation. Therefore, while the embodiments herein have been described in terms of embodiments and examples, those skilled in the art will recognize that the embodiments and examples disclosed herein can be practiced with modification within the scope of the embodiments as described herein.

## STATEMENT OF CLAIMS

We claim:

1. A battery charging and swapping station comprising:
   a Dock Control Unit (DCU); and
   a memory,
   wherein the DCU is coupled with the memory and configured to:
   operate the battery charging and swapping station in at least one of a normal mode, a vacation mode, and a night mode.
2. The battery charging and swapping station, as claimed in claim 1, wherein in the normal mode, the DCU is configured to operate the battery charging and swapping station normally.
3. The battery charging and swapping station, as claimed in claim 1, wherein in the vacation mode, the DCU is configured to:
   disable swapping at the battery charging and swapping station;
   perform thermal management of at least one battery present in at least one dock in the battery charging and swapping station, if grid power is available;
   keep charging management active of the at least one battery present in at least one dock in the battery charging and swapping station, if grid power is available; and
   shut down the battery charging and swapping station, if grid power is not available.
4. The battery charging and swapping station, as claimed in claim 1, wherein in the night mode, the DCU is configured to make the battery charging and swapping station offline.
5. The battery charging and swapping station, as claimed in claim 1, wherein the DCU is configured to operate the battery charging and swapping station in a power mode, wherein in the power mode, the DCU is configured to charge the at least one battery present in at least one dock in the battery charging and swapping station at a higher power level.
6. The battery charging and swapping station, as claimed in claim 1, wherein the DCU is configured to operate the battery charging and swapping station in a backup mode, wherein in the backup mode, the DCU is configured to operate

the battery charging and swapping station according to availability of the grid power and at least one other power source.

7. The battery charging and swapping station, as claimed in claim 1, wherein the DCU is configured to operate the battery charging and swapping station in an optimize mode, wherein in the optimize mode, the DCU is configured to optimize battery temperature management based on ambient temperature.

8. The battery charging and swapping station, as claimed in claim 1, wherein the DCU is configured to operate the battery charging and swapping station in a quick swap mode, wherein in the quick swap mode, the DCU is configured to allow for partial swapping of the battery packs from the battery charging and swapping station.

9. The battery charging and swapping station, as claimed in claim 1, wherein the DCU is further configured to:

check if grid power is available;

check if State of Charge (SOC) of the at least one battery present in at least one dock in the battery charging and swapping station is within an optimal SOC range, if the grid power is not available;

operate the battery charging and swapping station using the at least one battery present in at least one dock in the battery charging and swapping station, if the SOC of the at least one battery present in at least one dock in the battery charging and swapping station is within the optimal range; and

shut down the battery charging and swapping station, if the SOC of the at least one battery present in at least one dock in the battery charging and swapping station is not within the optimal range.

10. A method for operating a battery charging and swapping station, the method comprising:

operating, by a Dock Control Unit (DCU), the battery charging and swapping station in at least one of a normal mode, a vacation mode, and a night mode.

11. The method, as claimed in claim 10, wherein in the normal mode, the DCU operates the battery charging and swapping station normally.

12. The method, as claimed in claim 10, wherein in the vacation mode, the method comprises:

disable swapping, by the DCU, at the battery charging and swapping station;

performing thermal management, by the DCU, of at least one battery present in at least one dock in the battery charging and swapping station, if grid power is available;

keeping charging management active, by the DCU, of the at least one battery present in at least one dock in the battery charging and swapping station, if grid power is available; and

shutting down, by the DCU, the battery charging and swapping station, if grid power is not available.

13. The method, as claimed in claim 10, wherein in the night mode, the DCU makes the battery charging and swapping station offline.
14. The method, as claimed in claim 10, wherein the method comprises operating, by the DCU, the battery charging and swapping station in a power mode, wherein in the power mode, the DCU charges the at least one battery present in at least one dock in the battery charging and swapping station at a higher power level.
15. The method, as claimed in claim 10, wherein the method comprises operating, by the DCU, the battery charging and swapping station in a backup mode, wherein in the backup mode, the DCU operates the battery charging and swapping station according to availability of the grid power and at least one other power source.
16. The method, as claimed in claim 10, wherein the method comprises operating, by the DCU, the battery charging and swapping station in an optimize mode, wherein in the optimize mode, the DCU optimizes battery temperature management based on ambient temperature.
17. The method, as claimed in claim 10, wherein the method comprises operating, by the DCU, the battery charging and swapping station in a quick swap mode, wherein in the quick swap mode, the DCU allows for partial swapping of the battery packs from the battery charging and swapping station.
18. The method, as claimed in claim 10, wherein the method further comprises: checking, by the DCU, if grid power is available;

checking, by the DCU, if State of Charge (SOC) of the at least one battery present in at least one dock in the battery charging and swapping station is within an optimal SOC range, if the grid power is not available;

operating, by the DCU, the battery charging and swapping station using the at least one battery present in at least one dock in the battery charging and swapping station, if the SOC of the at least one battery present in at least one dock in the battery charging and swapping station is within the optimal range; and

shutting down, by the DCU, the battery charging and swapping station, if the SOC of the at least one battery present in at least one dock in the battery charging and swapping station is not within the optimal range.

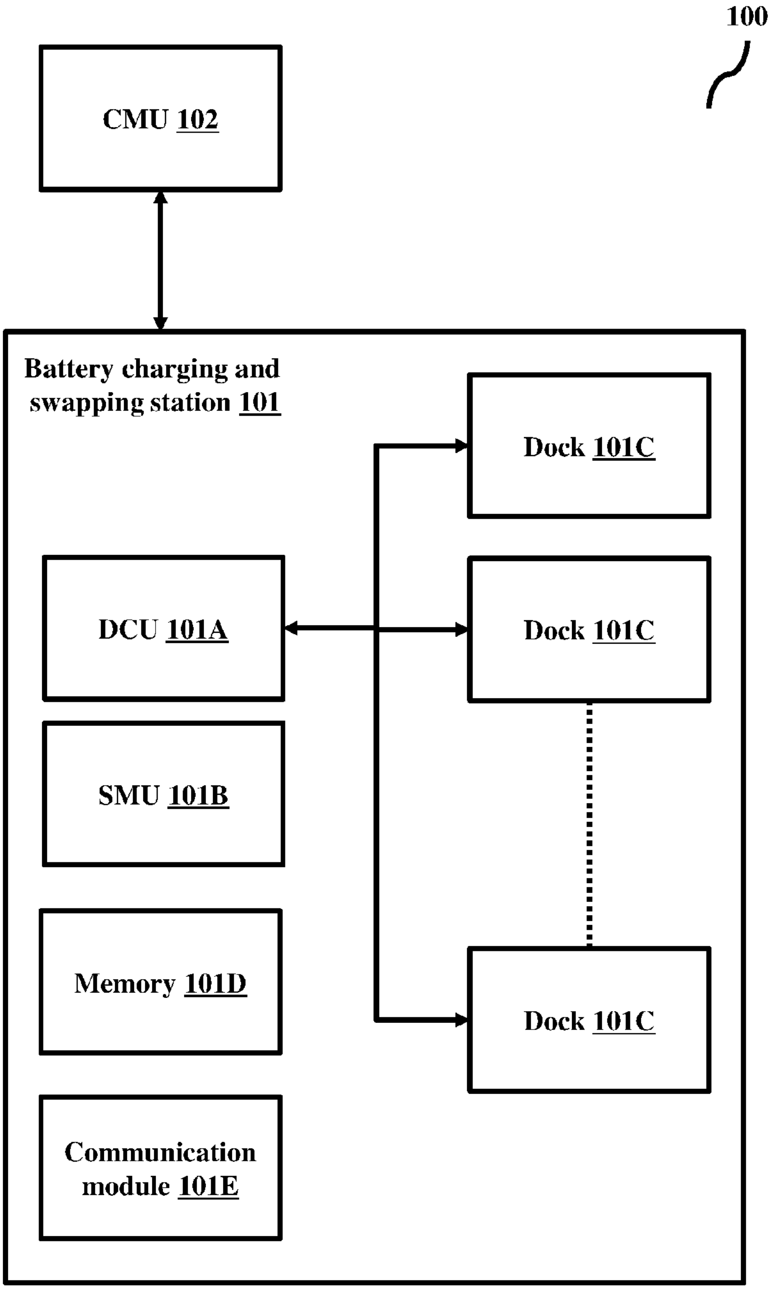
100
CMU 102
Battery charging and swapping station 101
Dock 101C
DCU 101A
Dock 101C
SMU 101B
Memory 101D
Dock 101C
Communication module 101E

FIG. 1

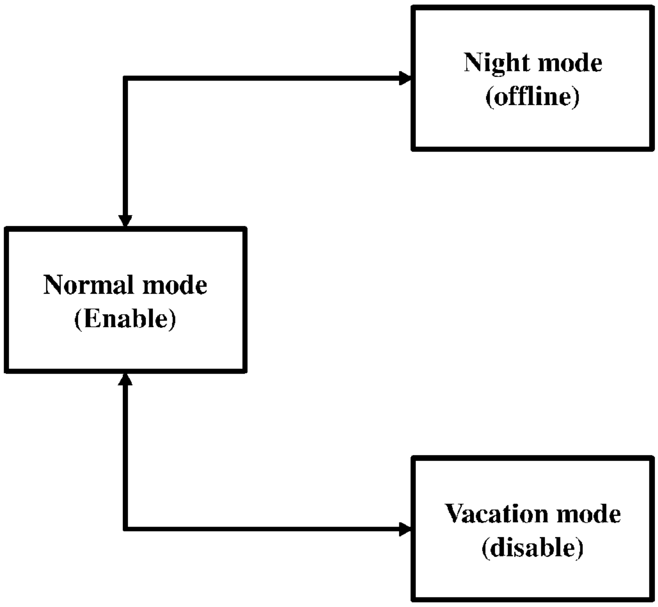
Night mode
(offline)
Normal mode
(Enable)
Vacation mode
(disable)

FIG. 2

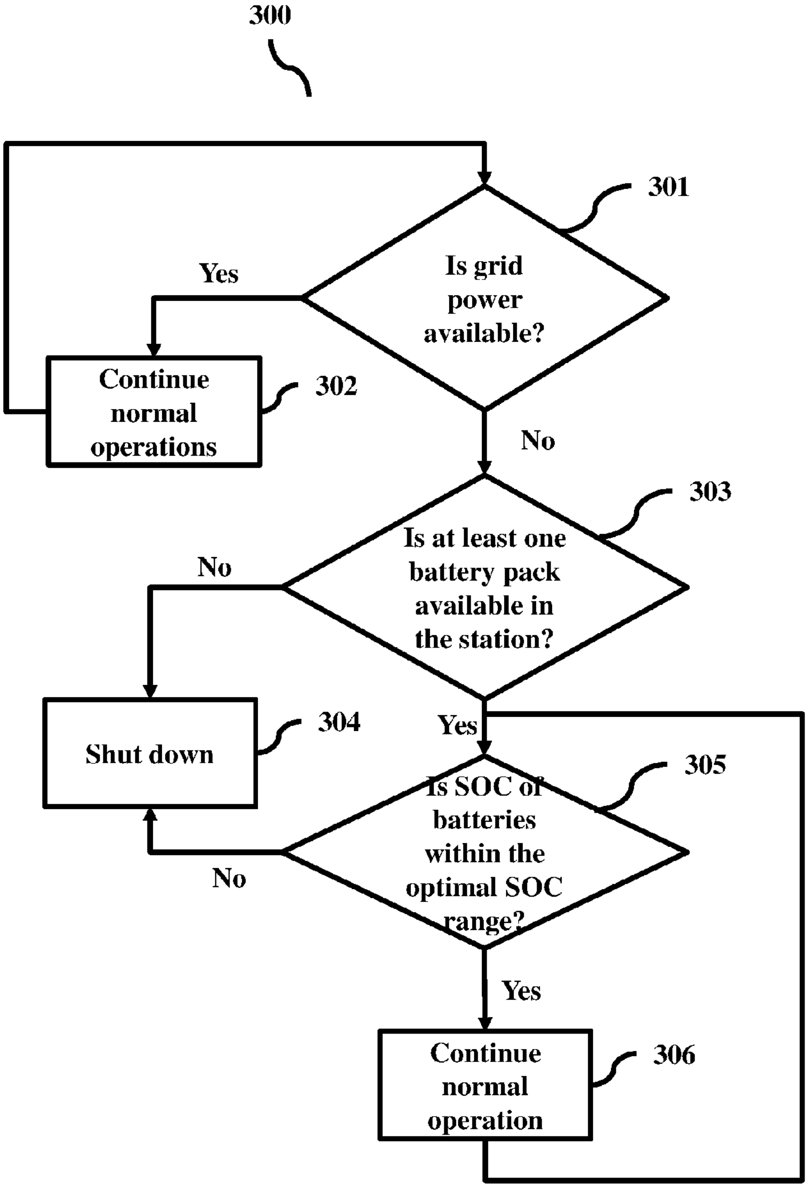
300
301
Is grid power available?
Yes
Continue normal operations
302
No
303
Is at least one battery pack available in the station?
No
Shut down
304
Yes
305
Is SOC of batteries within the optimal SOC range?
No
Yes
Continue normal operation
306

FIG. 3

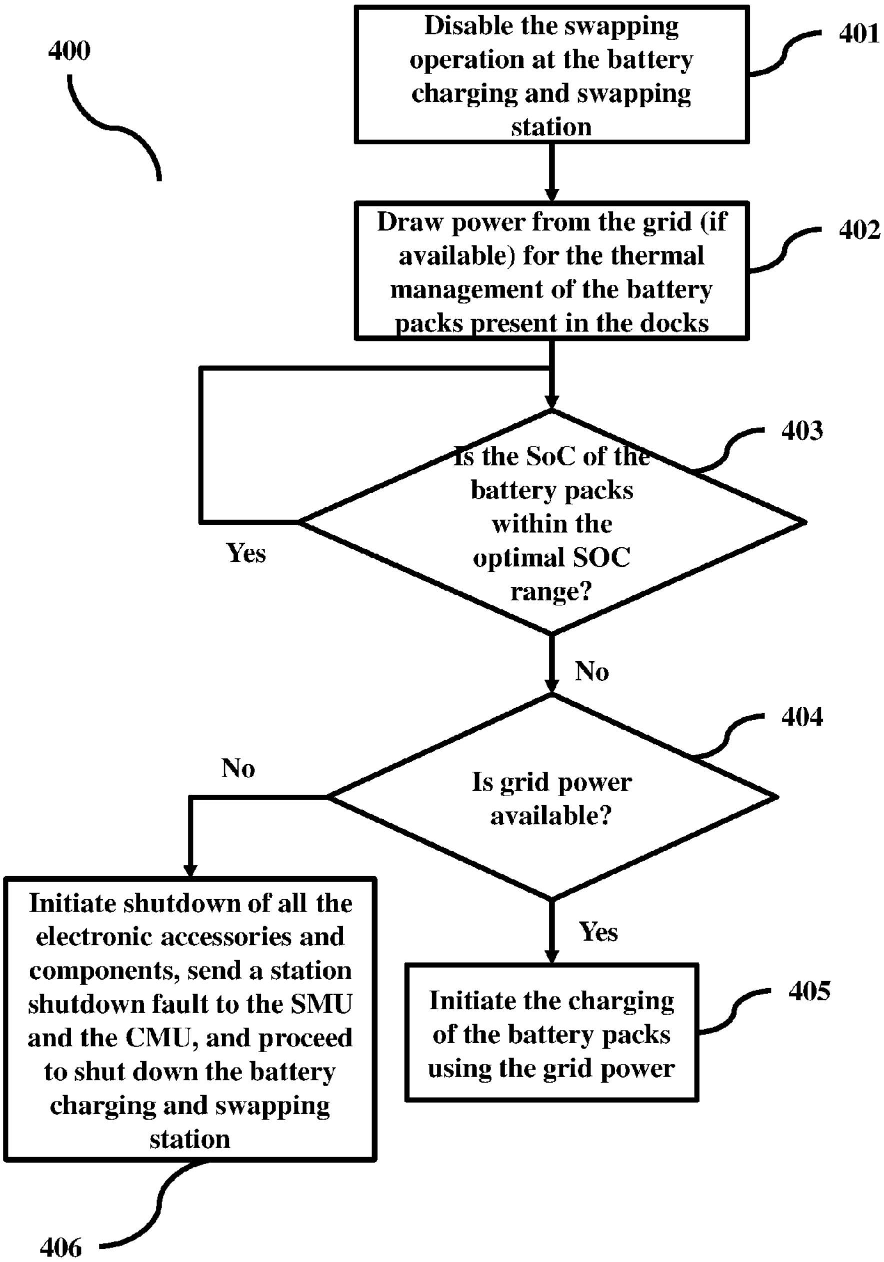
400
Disable the swapping operation at the battery charging and swapping station
401
Draw power from the grid (if available) for the thermal management of the battery packs present in the docks
402
Is the SoC of the battery packs within the optimal SOC range?
403
Yes
No
Is grid power available?
404
No
Yes
Initiate shutdown of all the electronic accessories and components, send a station shutdown fault to the SMU and the CMU, and proceed to shut down the battery charging and swapping station
406
Initiate the charging of the battery packs using the grid power
405

FIG. 4

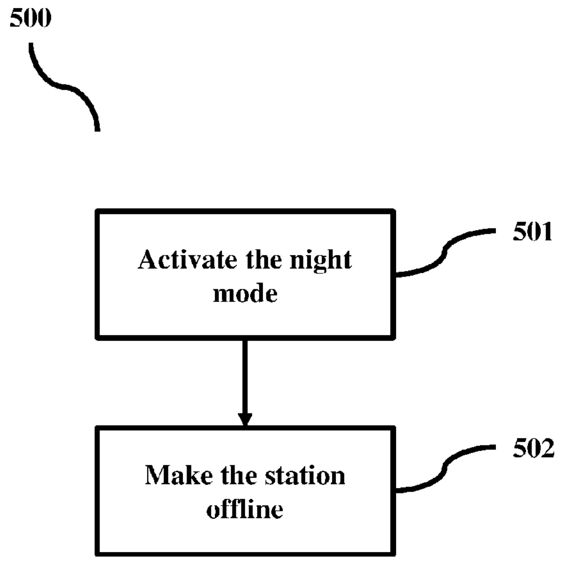
500
Activate the night mode
501
Make the station offline
502

FIG. 5

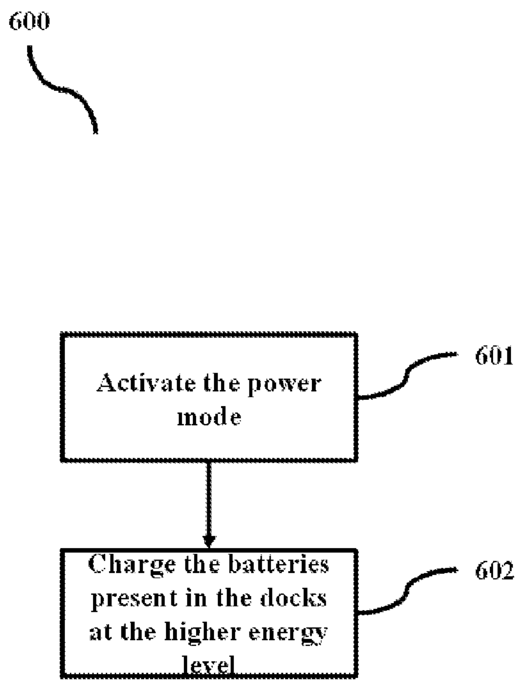
600
Activate the power mode
601
Charge the batteries present in the docks at the higher energy level
602

FIG. 6

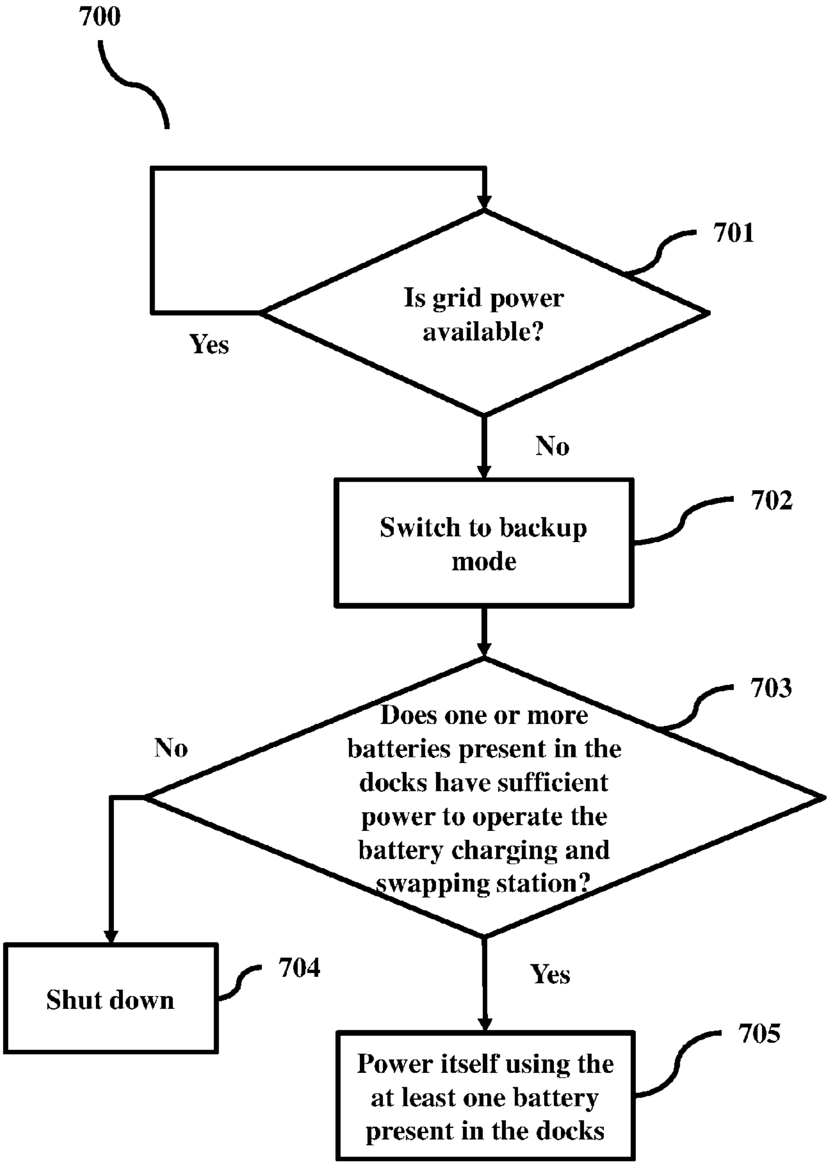
700
701
Is grid power available?
Yes
No
702
Switch to backup mode
703
Does one or more batteries present in the docks have sufficient power to operate the battery charging and swapping station?
No
Yes
704
Shut down
705
Power itself using the at least one battery present in the docks

FIG. 7

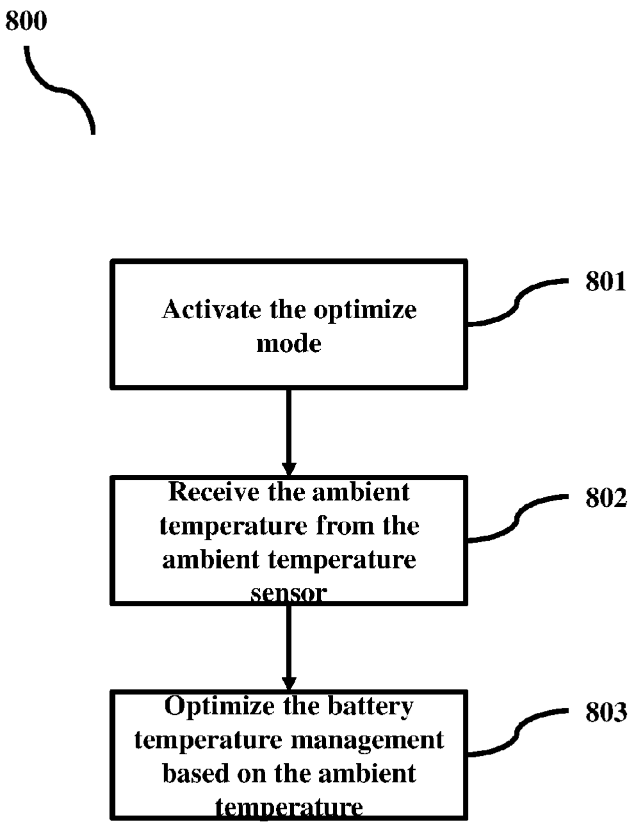
800
Activate the optimize mode
801
Receive the ambient temperature from the ambient temperature sensor
802
Optimize the battery temperature management based on the ambient temperature
803

FIG. 8

## INTERNATIONAL SEARCH REPORT

International application No.

**PCT/SG2024/050031**

**A. CLASSIFICATION OF SUBJECT MATTER**

***B60L 53/60 (2019.01) B60L 53/80 (2019.01)***

According to International Patent Classification (IPC)

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

B60L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PATSNAP: battery, charging, swapping, station, dock, control, state, mode, disable, enable, offline, online, shutdown, partial, selective and other related terms

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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| X | US 2022/0393491 A1 (ZHANG, J. ET AL.) 8 December 2022<br>Para. [0049], [0055]-[0056], [0058], fig. 1 | 1-2, 5-6, 10-11, 14-15 |
| A | US 2018/0244167 A1 (PENILLA, A. A. ET AL.) 30 August 2018 | |
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☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

*Special categories of cited documents:

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 29/04/2024 (day/month/year) | 13/05/2024 (day/month/year) |

| Name and mailing address of the ISA/SG | Authorized officer |
|---|---|
| **Intellectual Property Office of Singapore**<br>1 Paya Lebar Link, #11-03<br>PLQ 1, Paya Lebar Quarter<br>Singapore 408533<br>Email: pct@ipos.gov.sg | Sim Cheow Hin (Dr)<br>IPOS Customer Service Tel. No.: (+65) 6339 8616 |

# INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
**PCT/SG2024/050031**

*Note: This Annex lists known patent family members relating to the patent documents cited in this International Search Report. This Authority is in no way liable for these particulars which are merely given for the purpose of information.*

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