

APPARATUS, SYSTEM AND METHOD FOR CHARGING A BATTERY

FIELD OF THE INVENTION

[0001] The present disclosure relates to an apparatus, a system and a method
5 for charging a battery.

BACKGROUND ART

[0002] The following discussion of the background to the disclosure is intended
to facilitate an understanding of the present disclosure only. It should be appreciated
that the discussion is not an acknowledgement or admission that any of the material
10 referred to was published, known or part of the common general knowledge of the
person skilled in the art in any jurisdiction as at the priority date of the disclosure.

[0003] Some apparatus comprising at least one charging pile to charge a battery
of an electric apparatus such as an electric vehicle has been proposed. In the case
where the electric apparatus requires relatively higher power to drive, the electric
15 apparatus may comprise a plurality of sockets, each of the plurality of sockets
configured to be connected to the corresponding charging pile and equipped with a
Power Line Communication (PLC) module for a power line communication. As such,
the cost for the electric apparatus may be relatively higher because two or more
PLC modules for the electric apparatus are required. There exists a need to alleviate
20 the aforementioned problem.

SUMMARY

[0004] The present disclosure seeks to address and/or ameliorate the problem in
the prior art by providing an apparatus, a system and a method for charging a
battery.

25 [0005] Throughout this document, unless otherwise indicated to the contrary, the
terms 'comprising', 'consisting of', 'having' and the like, are to be construed as non-
exhaustive, or in other words, as meaning 'including, but not limited to'.

[0006] Furthermore, throughout the document, unless the context requires otherwise, the word 'include' or variations such as 'includes' or 'including' will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

5 **[0007]** According to one aspect of the disclosure, an apparatus for charging a battery, comprising a first charging device configured to communicate with at least one second charging device, the first charging device and the at least one second charging device configured to charge the battery; and comprising a first controller configured to control the first charging device, wherein the first controller determines
10 the number of the at least one second charging devices by communicating with a second controller.

[0008] In some embodiments, when the first controller receives data including a first power data to charge the battery, and determines a second power data based on the number of the at least one second charging devices, the second power data
15 used for each of the at least one second charging device.

[0009] In some embodiments, the first charging device comprises a charging member for interfacing with a plurality of sockets, wherein the charging member is configured to be inserted into at least one corresponding socket of an electrical apparatus.

20 **[0010]** In some embodiments, the second power data is derived or calculated by dividing the first power data by the number of the at least one second charging devices.

[0011] In some embodiments, in the case where the second power data exceeds a power threshold value, the first controller sets the second power data to the power
25 threshold value.

[0012] In some embodiments, the electric apparatus is an electric boat, an electric ferry, an electric car, or an electric truck.

[0013] In some embodiments, a communication between the apparatus and the electric apparatus is performed by a Power Line Communication (PLC).

[0014] In some embodiments, a communication between the first charging device and the at least one second charging device is performed by a Controller Area Network (CAN) communication.

[0015] According to one aspect of the disclosure, a system comprises an apparatus and a server configured to communicate with at least one of the plurality of charging devices and to store data provided from at least one of the plurality of charging devices.

[0016] According to one aspect of the disclosure, a system comprises an apparatus and a device configured to communicate with at least one of the plurality of charging devices and to authenticate a user.

[0017] According to one aspect of the disclosure, a system comprises an apparatus, wherein the apparatus further comprises the at least one second charging device.

[0018] According to one aspect of the disclosure, a system comprises an apparatus and the electric apparatus.

[0019] According to one aspect of the disclosure, a method for charging a battery, comprising the steps of: communicating with at least one second charging device by a first charging device, the first charging device and the at least one second charging device configured to charge the battery; and controlling the first charging device by a first controller; determining, by the first controller, the number of the at least one second charging devices by communicating with a second controller.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] Various embodiments are described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 illustrates a system 1000 according to some embodiments of the present disclosure.

Figure 2 illustrates a method or process for determining a master charging pile and at least one slave charging pile according to some embodiments of the present disclosure.

5 Figure 3 illustrates a pre-charging logic of the parallel charging of multiple chargers according to some embodiments of the present disclosure.

Figure 4 illustrates an operation logic of master charging pile and at least one slave charging pile according to some embodiments of the present disclosure.

10 Figure 5 illustrates a method or process of allocating demand allocating between the chargers arranged in parallel according to some embodiments of the present disclosure.

Figure 6 illustrates a communication in a system 1000 according to some embodiments of the present disclosure.

DETAILED DESCRIPTION

15 **[0021]** The present disclosure may be suited for an apparatus, a system and a method for charging a battery.

[0022] Unless defined otherwise, all other technical and scientific terms used herein have the same meaning as is commonly understood by a skilled person to which the subject matter herein belongs.

[0023] System 1000

20 **[0024]** As shown in figure 1, a system 1000 may comprise a charging pile 111. The system 1000 may include, but not limited to, at least one of an electric boat 10, an electric car 13, a charging pile 112, a charging pile 113, an apparatus 200, and a server 300. Hereinafter, the electric boat 10 and the electric car 13 may be referred to as an electric apparatus 100. The charging pile 111 may be configured to
25 communicate (e.g. arranged in data or signal communication) with the electric apparatus 100, the apparatus 200, and the server 300.

[0025] Electric apparatus 100

[0026] The electrical apparatus 100, in the form of the electric boat 10, may have a plurality of ports, each of the plurality of ports capable of receiving a corresponding charging member. A port may be shaped and dimensioned for a charging member to be inserted therein. The electric boat 10 may include a second controller 10A for controlling various mechanisms of the electric boat 10. The plurality of ports may comprise a socket 11a, 11b, 12a, and 12b. In the case where a charging member is inserted to one of the plurality of ports, the electric car 13 may have at least one port to which at least one charging member is inserted. The at least one port may be a socket 13a. Hereinafter, the electric boat 10 as a non-limiting example of the electric apparatus 100 will be described below. One port of the plurality of sockets 11a, 11b, 12a, and 12b may be equipped with a PLC module. The electric boat 10 may comprise a second controller 10A, the second controller 10A which may be referred to as an EV communication controller (EVCC).

[0027] It is to be appreciated that the number of the plurality of ports of the electric boat 10 is not limited to two shown in figure 1 and may be other than two. It is to be appreciated that the number of the charging piles is not limited to three shown in figure 1 and may be other than one and three. The type of the electric apparatus 100 is not limited to an electric boat and an electric car and may include other electric vehicles such as electric ferry (E-Ferry), Electric Vehicle (EV), or electric truck (E-truck). Hereinafter, a charging pile 111, a charging pile 112, and a charging pile 113 may be collectively referred to as an apparatus 110.

[0028] Apparatus 110

[0029] As shown in figure 1, the charging pile 111 may comprise a first controller 111A, a port 111a and a port 111b, the charging pile 112 may comprise a port 112a and a port 112b, and the charging pile 113 may comprise a port 113a. Each of the charging pile 111, the charging pile 112, and the charging pile 113 may be connected with each other. The apparatus 110 may be referred to as an Electric Vehicle (EV) supply equipment (EVSE) or an EV charger. The first controller 111A may be referred to as communication controller of EV supply equipment (SECC). SECC may be used to establish PLC communication with EV communication controller. A communication between the first charging pile 111 and the at least one

second charging pile 112 is performed by a Controller Area Network (CAN) communication.

[0030] Each charging pile included in the apparatus 110 may have at least one charging member (not shown), each of the at least one charging member to be inserted to the corresponding port of the electric apparatus 100. Each of charging members may be attached to corresponding port of a plurality of ports 111a, 111b, 112a, 112b, and 113a. The plurality of ports 111a, 111b, 112a, 112b, and 113a may be respectively interfaced (via insertion) into the socket 11a, 11b, 12a, 12b, and 13a. The communication between the electric apparatus 100 and each charging pile included in the apparatus 110 may be a Power Line Communication (PLC).

[0031] Once the charging member is inserted to the corresponding port on the electric apparatus 100, the charging pile may determine whether the port on the electric apparatus 100 is equipped with a PLC module or not. In the case where the port on the electric apparatus 100 is equipped with the PLC module, the electric apparatus 100 may be charged by power provided from each charging pile included in the apparatus 110.

[0032] Hereinafter, one of the charging piles which is connected to a port equipped with the PLC module of the electric boat 10 may be referred to as a master pile. Hereinafter, one of the charging pile charges which is connected to port not equipped with the PLC module of the electric boat 10 may be referred to as a slave pile.

[0033] Each charging pile included in the apparatus 110 has the PLC module. Any charger (i.e. charging pile) that may plug into the master port on the vehicle will be recognized as Master (host). Any charging pile that plug into non-master port on the vehicle will be recognized as slave. Thus, as least one charger must plug into master port on the vehicle to become master chargers. Then, Fig.3 will be initiated to check the charging pile readiness.

[0034] The first controller 111A may be disposed in the charging pile separately disposed from the charging pile 111. The first controller 111A may perform at least one process shown in figures 3, 4, 5.

[0035] Apparatus 200

[0036] The apparatus 200 may be configured to a personal computer, a mobile phone, a tablet, or the like, and may be configured to have an application such as a mobile Application (App), Radio-frequency identification (RFID), and/or a plug to be inserted to the charging pile included in the apparatus 110. A user may obtain information from the electric apparatus 100 and/or the charging pile included in the apparatus 110 via the apparatus 200.

[0037] Server 300

[0038] As shown in figure 1, the server 300 (backoffice server) may be configured to store data transmitted from the charging pile included in the apparatus 110. The communication between the charging pile included in the apparatus 110 and the server 300 may be performed by an open charge point protocol (OCPP). The OCPP may be an open and common protocol for the communication. The communication may be performed by means such as a wireless communication or a wired communication.

[0039] An exemplary flowchart of the system 1000

[0040] Figure 2 illustrates a method for determining a master charging pile and at least one slave charging pile according to some embodiments of the present disclosure.

[0041] As shown in figure 2, the first controller 111A may determine whether the charging member of any pile included in the apparatus 110 is inserted to a socket of the electric boat 10 at S210. If properly inserted (i.e. 'Yes') at S210, the process may proceed to S220. If not properly inserted (i.e. 'No') at S210, the first controller 111A may control the pile so that the charging pile included in the apparatus 110 exits Controller Area Network (CAN) communication at S215. Upon completion of the step S215, the process may proceed to the step S310 shown in figure 3.

[0042] At S220, the first controller 111A may determine whether a handshake signal is transmitted from the electric boat 10 to the pile of the charging pile included in the apparatus 110. If properly transmitted (i.e. 'Yes') at S220, the pile may be set

to host at S225, and the process may subsequently proceed to S210. If not properly transmitted (i.e. 'No') at S220, the process may proceed to S230.

[0043] At S230, the first controller 111A may determine whether other handshake signal is transmitted from the electric boat 10 to the pile of the apparatus 110. The other handshake signal may be a signal from other apparatus other than the electric boat 10. If properly transmitted (i.e. 'Yes') at S230, the charging pile included in the apparatus 110 may exit CAN communication at S240 and the process may return back to S210. If not properly transmitted (i.e. 'No') at S230, the charging pile included in the apparatus 110 may be set to slave at S235 and a counter used for counting the number of the plurality of charging piles is incremented at S236, and the process may subsequently return back to S210.

[0044] Hereinafter, it is assumed that the charging pile 111 is a host charging pile and the charging pile 112 is a slave charging pile. Hereinafter, the host charging pile may be simply referred to as a host and the slave charging pile may be simply referred to as a slave.

[0045] Figure 3 illustrates a pre-charging logic of the parallel charging of multiple chargers according to some embodiments of the present disclosure. The details will be described with reference to S310 to S380 of figure 3.

[0046] At S310, the host may shake hands with the electric boat 10. At S320, the first controller 111A may determine whether the handshake between the host and the electric boat 10 is normal. If the handshake between the host and the electric boat 10 is normal (i.e. 'Yes') at S320, the process may proceed to S330. If the handshake between the host and the electric boat 10 is not normal (i.e. 'No') at S320, the host may send a shutdown command to the slave at S325.

[0047] At S330, the first controller 111A may control the host so that the host sends an insulation detection command to the slave. At S340, the first controller 111A may determine whether all slave insulation tests are normal. If all slave insulation tests are normal (i.e. 'Yes') at S340, the process may proceed to S350, otherwise the process may proceed to S345. At S345, slaves which failed to perform insulation detection may exit CAN communication.

[0048] At S350, the first controller 111A may determine whether the host insulation detection is normal. If the host insulation detection is normal (i.e. 'Yes') at S350, the process moves to S360, otherwise the system is shutdown at S355. At S360, the first controller 111A may determine the number of slaves based on the processes shown in figure 2 and may send a good signal to the electric boat 10. The good signal may be a signal to indicate that the host is ready to charge the battery of the electric apparatus 100.

[0049] At S370, the first controller 111A may determine whether the charging pile included in the apparatus 110 is ready to charge. If the charging pile 110 is ready to charge (i.e. 'Yes') at S370, then the process moves to S380, otherwise the S370 may be repeated. At S380, the electric boat 10 may send charging requirements to the host. Upon completion of S380, the process may proceed to S410 or S510.

[0050] Figure 4 illustrates an operation logic of master charging pile and at least one slave charging pile according to some embodiments of the present disclosure. As shown in figure 4, the system 1000 may perform the processes S410 to S450. At S410, the first controller 111A may control the host so that the host sends a signal to the slave.

[0051] At S420, the first controller 111A may determine whether the signal has been received by the slave. If properly received (i.e. 'Yes') at S420, the process may proceed to S430. If not properly received (i.e. 'No') at S420, the first controller 111A may control the slave so that the slave exits CAN communication at S425.

[0052] At S430, the first controller 111A may determine whether the slave is ready to charge. If the slave is ready to charge (i.e. 'Yes') at S430, the process may proceed to S440. If the slave is not ready to charge (i.e. 'No') at S430, the first controller 111A may control the slave so that the slave exits CAN communication at S435.

[0053] At S440, the first controller 111A may determine whether the host is ready to charge. If the host is ready to charge (i.e. 'Yes') at S440, the process may proceed to S450. If the host is not ready to charge (i.e. 'No') at S440, the first controller 111A

may control the host so that all charging piles exit CAN communication shutdown at S445.

[0054] At S450, the number of slaves may be determined. That is, the first controller 111A may determine the number of slaves based on the processes S210 to S240 shown in figure 2 and the processes S410 to S440 in figure 4. Upon completion of S450, the process may proceed to S510.

[0055] Figure 5 illustrates a method or process of allocating demand between the chargers arranged in parallel according to some embodiments of the present disclosure. The allocation of demand is preferably optimal or near optimal. The process is described with reference to S510 to S550 of figure 5. The step S510 may be performed following the step S215 shown in figure 2, the step S380 shown in figure 3, or the step S450 shown in figure 4.

[0056] At S510, the host may receive a determined demand P. At S520, The host may calculate an average power P1 based on the number of slaves determined at S210 to S240, S310 to S380, and/or S410 to S450. For example, in the case where the first controller 111A determines that the number of slaves is three in accordance with processes of S210 to S240 and the number of slaves which are ready to charge is two in accordance with processes of S410 to S450, the first controller 111A may determine the average power P1 by dividing demand P by two.

[0057] At S530, the first controller 111A may determine whether P1 is greater than slave maximum power. If P1 is greater than slave maximum power (i.e. 'Yes') at S530, the process may proceed to S540. If P1 is not greater than slave maximum power (i.e. 'No') at S530, the slave may limit a power of the slave to the maximum power P1 at S535 and may proceed to S550.

[0058] At S540, the first controller 111A may determine whether P1 is lower than a slave minimum power. If P1 is lower than a slave minimum power (i.e. 'Yes') at S540, the host may exit a slave communication at S545 and the process may return back to S540. If P1 is not lower than a slave minimum power (i.e. 'No') at S540, the host may send the demand to at least one existing slave on average on S550. The at least one existing slave may be at least one slave which may be ready to charge

the electric boat 10. It is to be appreciated that P and P1 is not limited to particular number.

[0059] Figure 6 illustrates a communication in a system 1000 according to some embodiments of the present disclosure. As shown in figure 6, the first controller 111A may determine whether the charging member of any pile included in the apparatus 110 is inserted to a socket of the electric boat 10 at S610. If properly inserted (i.e. 'Yes') at S610, the process may proceed to S620. If not properly inserted (i.e. 'No') at S610, the process may repeat the process again.

[0060] At S620, the apparatus 200 may operate App such as mobile App to control the first controller 111A so that the charging pile 111 starts to charge a battery of the electric boat 10. For example, by using App, the apparatus 200 may authenticate a user whether the user using the apparatus 200 is authorized person. It is to be appreciated that in the case where the authentication for the user fails, the charging pile included in the apparatus 110 may put the charge on hold until the authorized person uses the apparatus 200.

[0061] At S630, once receiving the data, from the apparatus 200, to commence a communication between the electric apparatus 100 and the charging pile included in the apparatus 110, the first controller 111A may control that the communication between the electric apparatus 100 and the charging pile included in the apparatus 110 is established.

[0062] At S640, the first controller 111A may obtains a vehicle ID from the electric apparatus 100 via the communication. The vehicle ID may include, but not limited to, a car manufacturer and/or model information. At S650, the charging pile 111 may send the vehicle ID to the server 300. At S660, the server 300 may obtain data including the vehicle ID from the charging pile 111. The server 300 may further obtain data including, but not limited to, services, fee, required attention, preference, and/or service history. As such, the server 300 will recognize the EV manufacturer and model of the electric boat 10 and bind this information to the user's account.

[0063] Advantageous effect

[0064] According to the present disclosure, in the case where a communication is established between the charging pile 111 (the host) and the electric apparatus 100, the first controller 111A determines the number of the at least one charging pile 112 (the slave) configured to charge the battery, by communicating with the second controller. As such, even though an only one first controller 111A such as PLC is provided in the electric apparatus 100, the charging piles included in the apparatus 110 can charge a battery of the electric apparatus 100 by using the first controller 111A, thus reducing cost of the electric apparatus 100.

[0065] According to the present disclosure, the first controller 111A receives data including a first power from the electric apparatus 100 required to charge a battery and determines a second power based on the number of the at least one second charging piles, the second power used for each of the at least one second charging piles. As such, the first controller 111A can determine power required to charge the battery.

[0066] According to the present disclosure, a communication between the electric apparatus 100 the charging pile 111 is PLC. Using the PLC, there is no need to prepare extra pins to perform the communication.

[0067] Possible Variants

[0068] It is to be appreciated that a communication between the charging pile included in the apparatus 110 and the apparatus 200 and a communication between the charging pile included in the apparatus 110 and the server 300 may be any communication protocol. It is to be appreciated that the wireless communication protocols or standards may include Wireless Fidelity (WiFi) such as IEEE 802.11 a/b/g/n/ax/ba/EHT, Bluetooth, Near Field Communication (NFC), radio frequency identifier (RFID), or cellular communication (e.g., Long Term Evolution (LTE), LTE-Advanced (LTE-A), 5th Generation (5G). The wired communication may be implemented by, for example, Universal Serial Bus (USB), High Definition Multimedia Interface (HDMI), or Recommended Standard 232 (RS-232).

[0069] It is to be appreciated that at least one of the present disclosure (e.g. the first controller 111A, the second controller 10A) is configured with a hardware by

way of example, but the disclosure may also be provided by software in concert with hardware.

[0070] In addition, the functional blocks (not shown) used for the hardware are typically implemented as LSI devices, which are integrated circuits. The functional blocks may be formed as individual chips, or a part or all of the functional blocks may be integrated into a single chip.

[0071] It is to be appreciated by the person skilled in the art that variations and combinations of features described above, not being alternatives or substitutes, may be combined to form yet further embodiments falling within the intended scope of the disclosure.

[0072] As would be understood by a person skilled in the art, each embodiment, may be used in combination with other embodiment or several embodiments.

Reference numerals

10 : electric boat
10A : second controller
11a, 11b, 12a, 12b, 13a : socket
13 : electric car
100 : electric apparatus
110 : apparatus
111 : charging pile (first charging device)
112 : charging pile (second charging device)
113 : charging pile (third charging device)
111A : first controller
111a, 111b, 112a, 112b, 113a : port
200 : apparatus
300 : server
1000 : system

CLAIMS

1. An apparatus for charging a battery, comprising:

a first charging device configured to communicate with at least one second charging device, the first charging device and the at least one second charging device configured to charge the battery; and

a first controller configured to control the first charging device, wherein the first controller determines the number of the at least one second charging devices by communicating with a second controller.

2. The apparatus according to claim 1, wherein when the first controller receives data including a first power data to charge the battery and determines a second power data based on the number of the at least one second charging devices, the second power data used for each of the at least one second charging device.

3. The apparatus according to claim 1, wherein the first charging device comprises a charging member for interfacing with a plurality of sockets, wherein the charging member is configured to be inserted into at least one corresponding socket of an electrical apparatus.

4. The apparatus according to claim 1 or 2, the second power data is derived or calculated by dividing the first power data by the number of the at least one second charging devices.

5. The apparatus according to any one of preceding claims, wherein in the case where the second power data exceeds a power threshold value, the first controller sets the second power data to the power threshold value.

6. The apparatus according to claim 3, wherein the electric apparatus is an electric boat, an electric ferry, an electric car, or an electric truck.

7. The apparatus according to 3 or 6, wherein a communication between the apparatus and the electric apparatus is performed by a Power Line Communication (PLC).

8. The apparatus according to any one of preceding claims, wherein a communication between the first charging device and the at least one second charging device is performed by a Controller Area Network (CAN) communication.

9. A system according to any one of claims 1 to 8, comprising:

5 the apparatus; and

a server configured to communicate with at least one of the plurality of charging devices and to store data provided from at least one of the plurality of charging devices.

10. A system according to any one of claims 1 to 8, comprising:

10 the apparatus; and

a device configured to communicate with at least one of the plurality of charging devices and to authenticate a user.

11. A system according to any one of claims 1 to 8, comprising:

15 the apparatus, wherein the apparatus further comprises the at least one second charging device.

12. A system according to any one of claims 1 to 8, comprising:

the apparatus; and

the electric apparatus.

13. A method for charging a battery, comprising the steps of:

20 communicating with at least one second charging device by a first charging device, the first charging device and the at least one second charging device configured to charge the battery; and

controlling the first charging device by a first controller;

25 determining, by the first controller, the number of the at least one second charging devices by communicating with a second controller.