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(54) **CHARGING DEVICE**

(71) Applicant: **Honda Motor Co., Ltd.**, Tokyo (JP)

(72) Inventors: **Ryuta Matsui**, Saitama (JP); **Takero Arima**, Torrance, CA (US)

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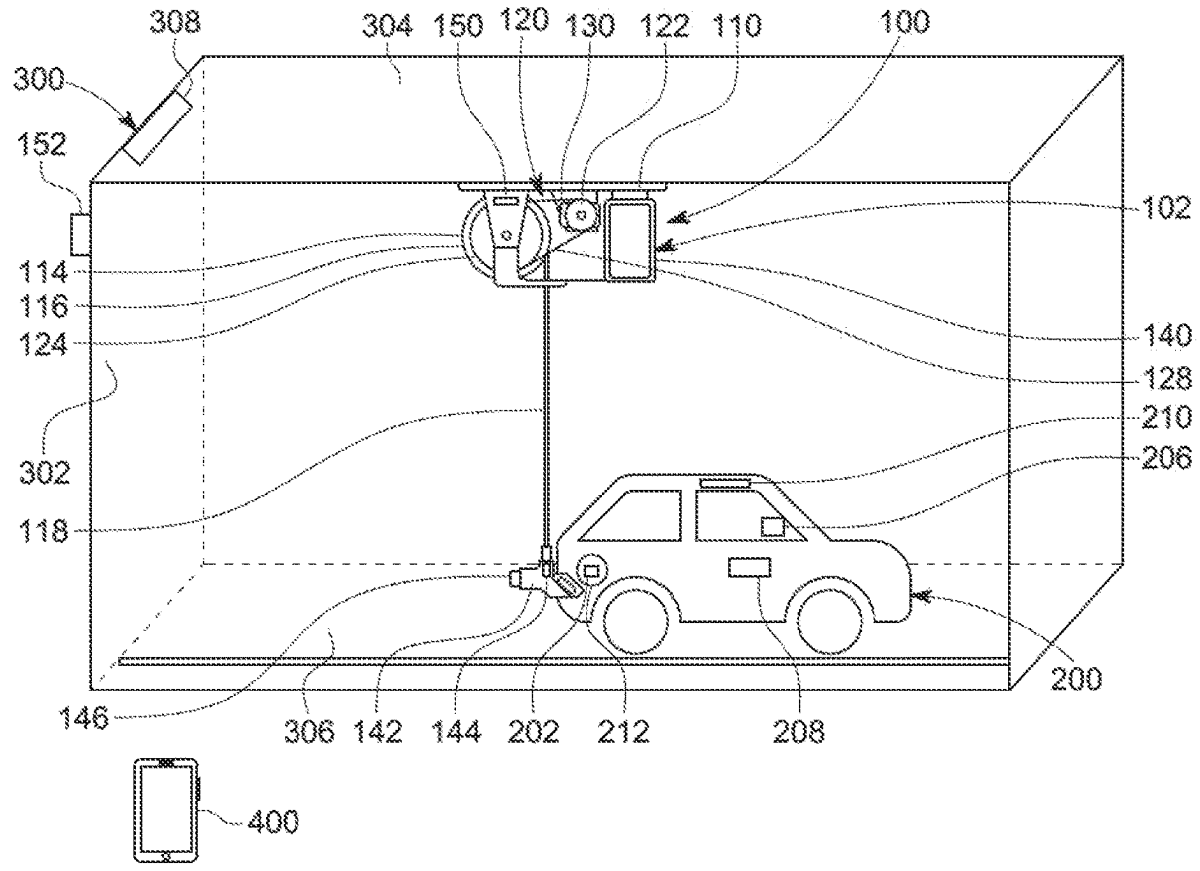
(57) **ABSTRACT**

A charging device for charging a vehicle includes a frame adapted to be mounted to an overhead structure of a garage having a garage door and a cable holder rotatably mounted on the frame. The charging device includes an electric cable wound around the cable holder and including a first end electrically connected to a power supply equipment, a charger adapted to be removably connected to the vehicle to charge the vehicle, connected to a second end of the electric cable, and configured to move between an up position and a down position, and an actuator operatively coupled with the cable holder. The charging device further includes a controller configured to determine an approach of the vehicle to the garage and control the actuator to lower the charger to the down position in response to the determination of the approach of the vehicle to the garage.



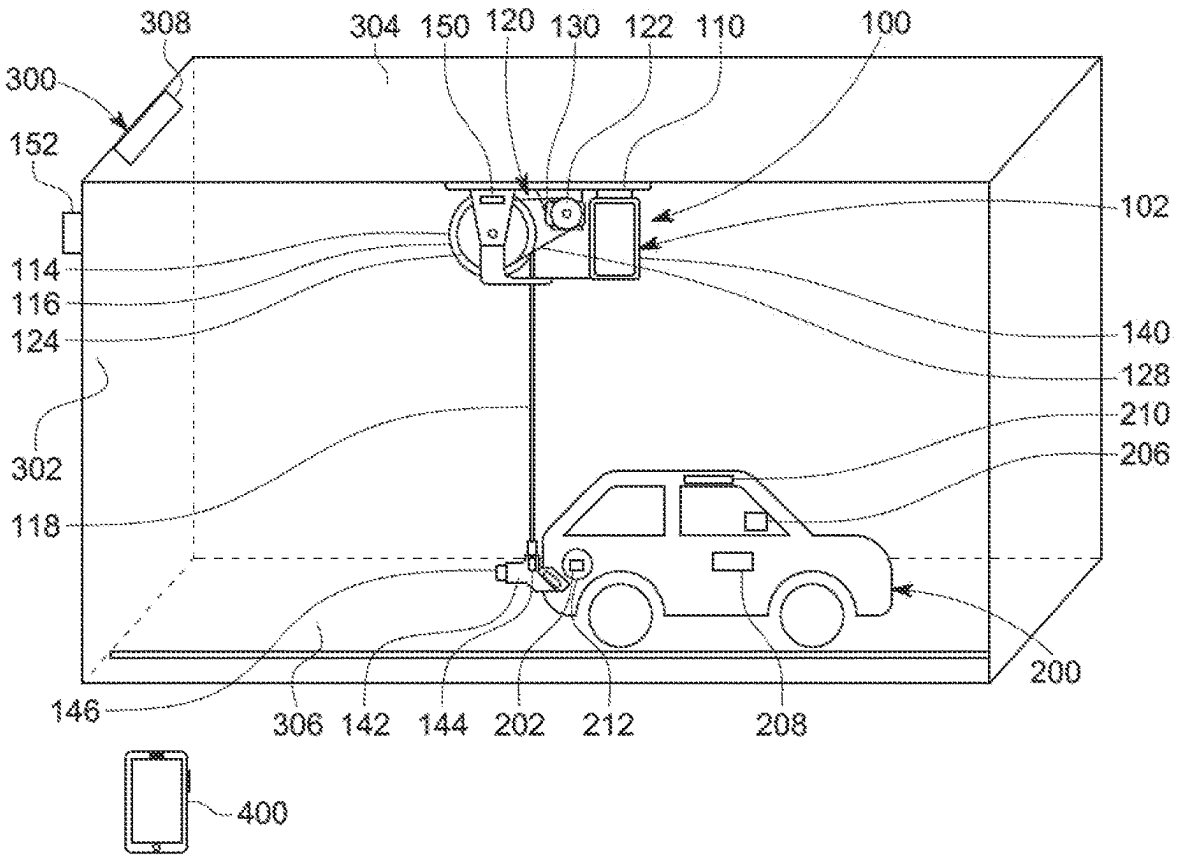

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FIG. 1

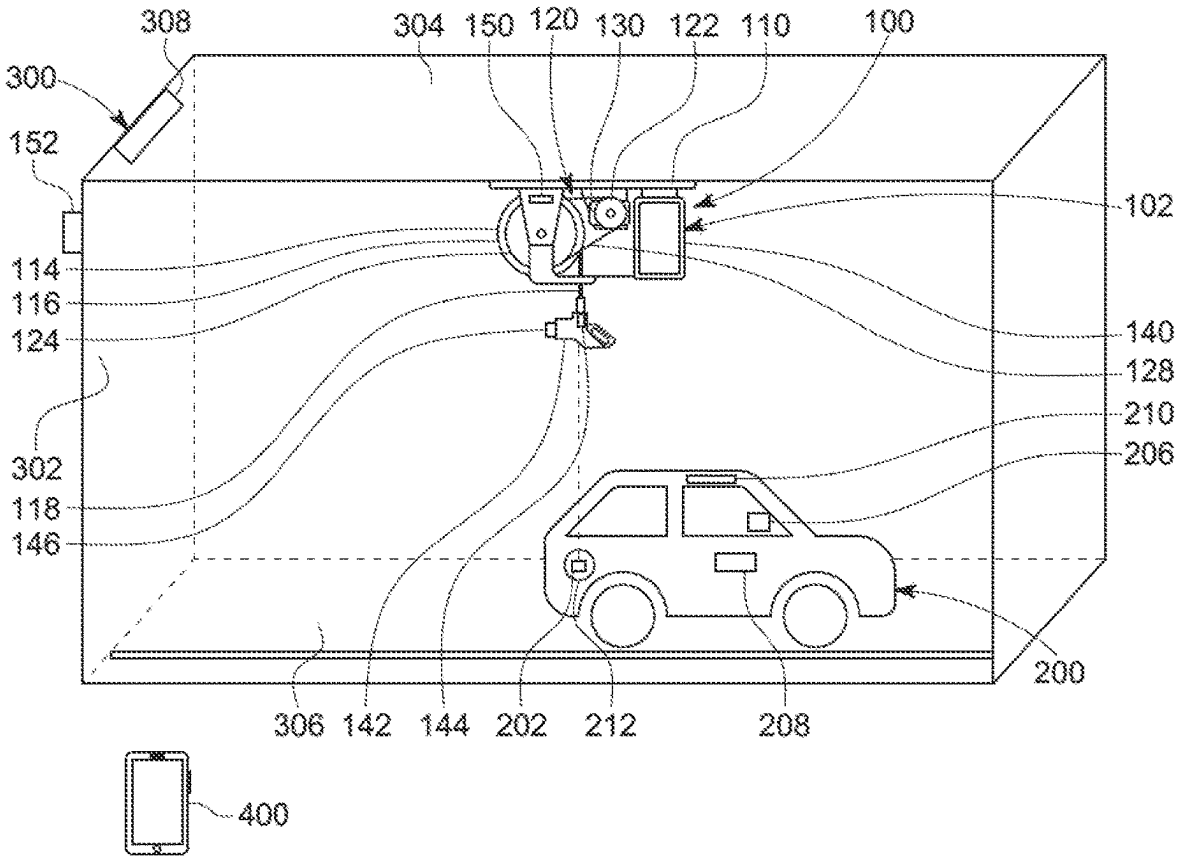
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FIG. 2

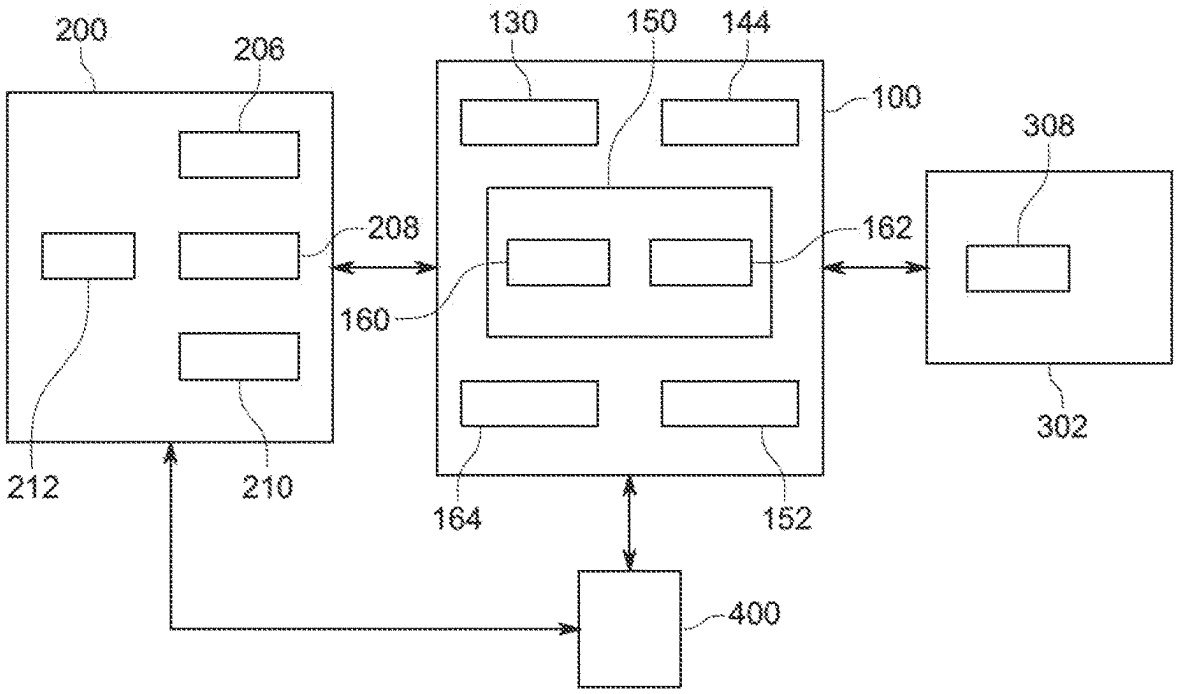

FIG. 3

CHARGING DEVICE

BACKGROUND

[0001] The disclosed subject matter relates generally to a charging device. More particularly, the disclosed subject matter relates to a charging device mounted to an overhead structure of a parking space, for example, a garage to suitably control a lowering and raising of a charger.

[0002] Electric vehicles are generally charged via an Electric Vehicle Supply Equipment (EVSE). In a parking space, for example, a garage, while charging the electric vehicle, the electric cable connecting the EVSE to vehicle, generally, occupies a significant amount of space and is arranged on a floor of the garage, leading to entanglement of the cable, which is undesirable.

SUMMARY

[0003] According to an embodiment of the disclosure, a charging device for charging a vehicle is provided. The charging device includes a frame adapted to be mounted to an overhead structure of a garage having a garage door and a cable holder rotatably mounted on the frame. The charging device includes an electric cable wound around the cable holder and including a first end electrically connected to a power supply equipment, a charger adapted to be removably connected to the vehicle to charge the vehicle, connected to a second end of the electric cable, and configured to move between an up position and a down position, and an actuator operatively coupled with the cable holder to operate the cable holder to wound the electrical cable on the cable holder and unwound the electrical cable from the cable holder to move the charger between the up position and the down position. The charging device further includes a controller configured to determine an approach of the vehicle to the garage and control the actuator to lower the charger to the down position in response to the determination of the approach of the vehicle to the garage.

[0004] According to an embodiment of the disclosure, a method is provided. The method includes providing a charging device including a frame mounted to an overhead structure of a garage and a cable holder rotatably mounted on the frame. The charging device includes an electric cable wound around the cable holder and including a first end electrically connected to a power supply equipment and a charger adapted to be removably connected to the vehicle to charge the vehicle and connected to a second end of the electric cable and configured to move between an up position and a down position. The method further includes determining by a controller of the charging device, an approach of a vehicle to the garage and controlling the cable holder to lower the charger to the down position in response to the determination of the approach of the vehicle to the garage.

[0005] According to another embodiment of the disclosure, a charging device for charging a vehicle is provided. The charging device may include a frame adapted to be mounted to an overhead structure of a garage having a garage door and a cable holder rotatably mounted on the frame. The charging device may further include an electric cable wound around the cable holder. The electric cable further includes a first end electrically connected to a power supply equipment. The charging device may include a charger adapted to be removably connected to the vehicle to charge the vehicle and connected to a second end of the electric cable and configured to move between an up position and a down position, the charger includes a switch adapted to be actuated by a user. The charging device may further include an actuator operatively coupled with the cable holder to operate the cable holder to wound the electrical cable on the cable holder and unwound the electrical cable from the cable holder to move the charger between the up position and the down position. The charging device may include a controller configured to determine an approach of the vehicle to the garage and control the actuator to lower the charger to the down position in response to determination of the approach of the vehicle to the garage and the controller configured to control the actuator to raise the charger to the up position from the down position in response to the actuation of the switch.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] Certain embodiments of the present disclosure will be better understood from the following description taken in conjunction with the accompanying drawings in which:

[0007] FIG. **1** is a schematic view of a charging device mounted to a roof of a garage and having a charger arranged at a charging position, in accordance with one embodiment of the present disclosure;

[0008] FIG. **2** is a schematic view of the charging device mounted to the roof of the garage and depicting the charger arranged at a stowed position, in accordance with one embodiment of the present disclosure; and

[0009] FIG. **3** is a block diagram depicting the charging device arranged in communication with a vehicle, a garage door, and a mobile device, in accordance with one embodiment of the present disclosure.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0010] A few inventive aspects of the disclosed embodiments are explained in detail below with reference to the various figures. Exemplary embodiments are described to illustrate the disclosed subject matter, not to limit its scope, which is defined by the claims. Those of ordinary skill in the art will recognize a number of equivalent variations of the various features provided in the description that follows. Embodiments are hereinafter described in detail in connection with the views and examples of FIGS. **1-3**, wherein like numbers indicate the same or corresponding elements throughout the views.

[0011] FIGS. **1** and **2** illustrate a charging device **100** for charging electric components, for example, an electric vehicle **200**, in accordance with an example embodiment of the disclosure. The charging device **100** is an overhead charging device **102** fixedly or slidably mounted to an overhead or elevated structure, for example a roof **304** of a garage **300** or a parking area. As shown, the charging device **100** includes a frame **110** mounted to the overhead structure and supporting various components of the charging device **100**. To facilitate the movement of the charging device **100** relative to the overhead structure, in some embodiments, the frame **110** may include one or more guide rails, which may be configured to be fastened with an additional support (not shown) at a height above a floor surface **306** of the garage **300**.

[0012] Moreover, the charging device **100** includes a cable holder **114**, for example, a drum **116**, rotatably coupled to the frame **110** and an electric cable **118** at least partially wound around the drum **116**. The electric cable **118** is unwound/unreeled from the drum **116** to enable a charging of an electric vehicle **200** disposed inside the garage **300** and is retracted back and wound/reeled back around the drum **116** upon charging of the electric vehicle **200**. To enable the extension/unwinding of the electric cable **118** from the drum **116** and retraction or reeled back of the cable **118** on the drum **116**, the charging device **100** includes a drive assembly **120**.

[0013] In the illustrated embodiments, the drive assembly **120** is a belt-pulley assembly having a drive pulley **122** rotatably mounted to the frame **110** and arranged to rotate relative to the frame **110** about its central axis, a driven pulley **124** coupled to the drum **116** to rotate the drum **116** in response to the rotation of the drive pulley **122**. Moreover, the drive assembly **120** includes a belt **128** extending from the drive pulley **122** to the driven pulley **124** to rotate the driven pulley **124**, hence the drum **116** in response to the rotation of the drive pulley **122**. To rotate the drive pulley **122**, the charging device **100** includes an actuator **130**, for example, an electric motor **130**, and the drive pulley **122** may be suitably arranged and coupled/connected/engaged with the electric motor **130** such that the drive pulley **122** rotates in response to an operation/actuation of the electric motor **130**. In an embodiment, the drive pulley **122** is mounted to a motor shaft of the electric motor **130**. Although the drive assembly **120** is shown and contemplated to include a belt-pulley assembly, it may be appreciated that drive assembly **120** may include any other mechanism, such as, but not limited to, a gear drive, a chain sprocket mechanism, or even a direct drive in which the drum **116** is mounted on the motor shaft, or any other mechanism suitable to rotate the drum **116** to enable retraction and/or the extension of the cable from the drum **116**. In some embodiments, the electric motor **130** is a bi-directional motor.

[0014] The electric cable **118** may include one or more electric wires which may be configured to transmit electrical power or signals from a source location for example, a power supply equipment **140** to a charger **142** attached at an end of the cable **118** that moves up and down in response to the rotation of the drum **116**. In an embodiment, the power supply equipment **140** may be an electric vehicle supply equipment, which may be configured to move on the guide rail. For example, the power supply equipment **140** may supply electric power via the electric cable **118**, to charge the electric vehicle **200**. The power supply equipment **140** may include an AC power source or a DC power source that may deliver the electric power to the electric vehicle **200** via the electric cable **118** wounded on the drum **116**. Examples of the power supply equipment **140** may include one of: a standard household **120**-volt power source, or a **240**-volt power source, or other fast charging power sources (such as a DC fast charging power source, or a battery pack), which may be disposed at the floor surface **306** of the garage **300** or the frame **110** of the charging device **100**.

[0015] The charger **142** may include a suitable design, shape, and structure, which may be configured to be coupled at the end of the electric cable **118** is adapted to move between a stowed position (i.e., up position), shown in FIG. **2**, and a charging position (i.e., down position), shown in FIG. **1**. In an embodiment, the charger **142** may be coupled with the end of the electric cable **118**, via a mechanical fastener (not shown). As shown, the charger **142** includes a switch **144** adapted to be operated by a user to actuate the drive assembly **120** (i.e., electric motor **130**) to reel in the electric cable **118** on the drum **116** and raise the charger **142** and position the charger **142** at the stowed position above a certain height from the floor surface **306** of the garage **300**.

[0016] In an embodiment, the charger **142** may further include an electric contact **146**, which may be configured to connect with a socket **202** associated with a battery of the electric vehicle **200**. In an embodiment, the electric contact **146** may be formed as a plurality of connector pins that may protrude from a portion (not shown) of the charger **142**. The plurality of connector pins may be aligned and mate with the socket **202** to charge the electric vehicle **200**.

[0017] Further, to control various electrical and electronic components of the charging device **100**, the charging device **100** includes a controller **150** to control the lowering and raising of the charger **142** to enable the charging of the electric vehicle **200**. In an embodiment, the controller **150** is configured to detect/determine that the vehicle **200** is approaching the garage **300**, and initiates the lowering of the charger **142** upon detection of the approach of the vehicle **200** to the garage **300**. In some embodiments, the controller **150** may determine the approach of the vehicle **200** based on an input received from the vehicle **200** and/or a garage door **302**. For example, the device **100** may include a sensor **152** to detect the vehicle **200** in a vicinity of the garage **300**, and upon detection of the vehicle **200**, based on the input from the sensor **152**, the controller **150** is arranged to initiate the opening of the garage door **302** and lowering of the charger **142**. In some embodiments, the controller **150** is arranged in communication with a garage door opener **308** and configured to activate the actuator/electric motor **130** and hence the drive assembly **120** to lower the charger **142** upon detection of the opening of the garage door **302** based on the input received from the garage door opener **308**.

[0018] In some embodiments, as shown in FIG. **3**, the controller **150** may be arranged to communicate with a user interface **206** of the vehicle **200** or a vehicle controller **208**, and actuates the actuator/electric motor **130** to lower the charger **142** based on a command, for example, a voice command input or an actuation of a switch of the user interface **206**, by a driver of the vehicle **200**. It may be appreciated that the controller **150** actuates the lowering of the charger **142** based on the command received from the vehicle **200** when the vehicle **200** is within a predefined distance from the parking space of the garage door **302**. In some embodiments, the vehicle **200** may include a short-range communication device **210**, for example, a Bluetooth or a near field communication (NFC) device, and the controller **150** may be configured to initiate the lowering of the charger **142** upon detection of the such short range communication device **210** based on a signal received from the short range communication device **210**.

[0019] In addition to the lowering of the charger **142**, the controller **150** is configured to communicate with the garage door opener **308** to enable the opening of the garage door **302** based on the input received from the vehicle **200**. It may be appreciated that the controller **150** is configured to authenticate the vehicle **200** before initiating the lowering of the charger **142** as well as opening of the garage door **302**.

[0020] Further, in some embodiments, the controller **150** is arranged in communication with a vehicle controller **208**

and facilitates an opening a charging lid **212** covering the socket **202** upon parking of the vehicle **200** inside the garage **300**. Further, the controller **150** is arranged in communication with a mobile device **400** of a user/owner of the vehicle **200** and shares a notification to the mobile device **400** to inform a charging status of the vehicle **200**. In some embodiments, the controller **150** may receive an input/information related to the completion of charging of the vehicle **200** from the vehicle controller **208**, and controls the power supply equipment **140** to electrically disconnect the charger **142** from the battery of the vehicle **200**. In some embodiments, the controller **150**, upon determining the completion of the charging of the vehicle **200**, raises an alarm to inform the vehicle driver to prompt the vehicle's user to disconnect the charger **142** from the socket **202** of the vehicle **200**.

[0021] To enable the raising of the charger **142** to the stowed position i.e., at a predetermined height from the floor of the garage **300**, the charger **142** includes the switch **144** adapted to be pressed or actuated by the user. In response to pressing of the switch **144**, the controller **150** activates the actuator/electric motor **130** and operates the actuator **130** to rotate the drum **116** to reel in the electric cable **118** on the drum **116**. In some embodiments, the controller **150** may detect a disengagement of the charger **142** from the socket **202**, and automatically operates the actuator **130** based on such detection. It may be appreciated that the controller **150** may actuate the actuator/electric motor **130** if the charger **142** remains disengaged from the socket **202** for a predetermined time duration.

[0022] In some embodiments, the vehicle controller **208** is arranged to disengage the charger **142** from the socket **202** upon detection of the completion of charging of the battery of the vehicle **200**. In such a case, the controller **150** receives such information from the vehicle controller **208**, and actuates the actuator/electric motor **130** to raise the charger **142** upon disengagement of the charger **142** from the socket **202** without waiting for the elapse of the predetermined time duration from the disengagement of the charger **142** from the socket **202**. In this manner, the charging device **100** facilitates an easy and efficient charging of the electric vehicle **200** without having the entangled wires/cables disposed inside the garage **300**. Also, as the charging device **100** is located at the height above the floor surface **306** i.e., proximate to the roof **304** of the garage **300** or the cable holder **114** in the stowed position, a significant amount of space is saved on the floor surface **306**, which may be used to for other purpose.

[0023] In the embodiments, as shown in FIG. **3**, the controller **150** may include a processor **160** for executing specified instructions, which controls and monitors various functions associated with charging device **100**. The processor **160** may be operatively connected to a memory **162** for storing instructions related to the control of the charging device **100** and components of the charging device **100**. The memory **162** as illustrated is integrated into the controller **150**, but those skilled in the art will understand that the memory **162** may be separate from the controller **150** but onboard the charging device **100**, and/or remote from the controller **150** and the charging device **100**, while still being associated with and accessible by the controller **150** to store information in and retrieve information from the memory **162** as necessary during the operation of charging device **100**. Although the processor **160** is shown, it is also possible and contemplated to use other electronic components such as a microcontroller, an application specific integrated circuit (ASIC) chip, or any other integrated circuit device. Moreover, the controller **150** may refer collectively to multiple control and processing devices across which the functionality of the charging device **100** may be distributed. For example, the actuator **130**, the sensor **152**, and the charger **142** may each have one or more controllers that communicate with the controller **150**. Moreover, the charging device **100** may include at least one communication device **164** to enable the communication of the controller i.e., charging device **100** with the vehicle **200**, one or more components of the garage **300**, and/or the mobile device **400**. In an embodiment, the at least one communication device **164** may be a short-range communication device and/or a long range communication device.

[0024] The foregoing description of embodiments and examples has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the forms described. Numerous modifications are possible in light of the above teachings. Some of those modifications have been discussed and others will be understood by those skilled in the art. The embodiments were chosen and described in order to best illustrate certain principles and various embodiments as are suited to the particular use contemplated. The scope of the invention is, of course, not limited to the examples or embodiments set forth herein, but can be employed in any number of applications and equivalent devices by those of ordinary skill in the art. Rather it is hereby intended the scope of the invention be defined by the claims appended hereto.

What is claimed is:

1. A charging device for charging a vehicle, the charging device comprising:

a frame adapted to be mounted to an overhead structure of a garage having a garage door;

a cable holder rotatably mounted on the frame;

an electric cable wound around the cable holder and including a first end electrically connected to a power supply equipment;

a charger adapted to be removably connected to the vehicle to charge the vehicle and connected to a second end of the electric cable and configured to move between an up position and a down position;

an actuator operatively coupled with the cable holder to operate the cable holder to wound the electrical cable on the cable holder and unwound the electrical cable from the cable holder to move the charger between the up position and the down position; and

a controller configured to determine an approach of the vehicle to the garage and control the actuator to lower the charger to the down position in response to the determination of the approach of the vehicle to the garage.

2. The charging device of claim **1**, wherein the controller is configured to determine the approach of the vehicle based on a signal received from the vehicle.

3. The charging device of claim **2**, wherein the vehicle includes a short range communication device and the controller determines the approach of the vehicle based on the signal received from the short range communication device.

4. The charging device of claim **1**, wherein the controller is configured to determine an opening of the garage door and determine the approach of the vehicle based on the opening of the garage door.

5. The charging device of claim 4, wherein the garage includes a garage door opener configured to open the garage door and the controller is arranged in communication with the garage door opener and determines the approach of the vehicle based on input from the garage door opener.

6. The charging device of claim 1 further comprising a sensor to detect an approach of the vehicle and the controller operates the actuator based on input from the sensor.

7. The charging device of claim 1, wherein the charger includes a switch adapted to be operated by a user to actuate the actuator to raise the charger to the up position.

8. The charging device of claim 1, wherein the controller is arranged to communicate with a vehicle controller to open a charging lid of the vehicle upon actuation of the actuator to lower the charger to the down position.

9. The charging device of claim 1 further comprising a drive assembly operatively coupling the actuator with the cable holder to rotate the cable holder in response to the actuation of the actuator.

10. The charging device of claim 9, wherein the drive assembly includes a belt-pulley assembly having a driven pulley operatively coupled to the cable holder and a drive pulley operatively coupled to the actuator and configured to rotate the driven pulley.

11. A method, comprising:

providing a charging device including

a frame mounted to an overhead structure of a garage,

a cable holder rotatably mounted on the frame,

an electric cable wound around the cable holder and including a first end electrically connected to a power supply equipment,

a charger adapted to be removably connected to the vehicle to charge the vehicle and connected to a second end of the electric cable and configured to move between an up position and a down position, and

determining, by a controller of the charging device, an approach of a vehicle to the garage; and

controlling the cable holder to lower the charger to the down position in response to the determination of the approach of the vehicle to the garage.

12. The method of claim 11, wherein the controller is configured to determine the approach of the vehicle based on a signal received from the vehicle.

13. The method of claim 12, wherein the vehicle includes a short range communication device and the controller determines the approach of the vehicle based on the signal received from the short range communication device.

14. The method of claim 11, wherein the controller is configured to determine an opening of the garage door and determine the approach of the vehicle based on the opening of the garage door.

15. The method of claim 11, wherein the charging device further comprises a sensor to detect an approach of the vehicle and the controller operates the cable holder based on input from the sensor.

16. The method of claim 11, wherein the charger includes a switch adapted to be operated by a user to operate the cable holder to raise the charger to the up position.

17. A charging device for charging a vehicle, the charging device comprising:

a frame adapted to be mounted to an overhead structure of a garage having a garage door;

a cable holder rotatably mounted on the frame;

an electric cable wound around the cable holder and including a first end electrically connected to a power supply equipment;

a charger adapted to be removably connected to the vehicle to charge the vehicle and connected to a second end of the electric cable and configured to move between an up position and a down position, the charger includes a switch adapted to be actuated by a user;

an actuator operatively coupled with the cable holder to operate the cable holder to wound the electrical cable on the cable holder and unwound the electrical cable from the cable holder to move the charger between the up position and the down position; and

a controller configured to

determine an approach of the vehicle to the garage and control the actuator to lower the charger to the down position in response to the determination of the approach of the vehicle to the garage, and

control the actuator to raise the charger to the up position from the down position in response to the actuation of the switch.

18. The charging device of claim 17, wherein the controller is configured to determine the approach of the vehicle based on a signal received from the vehicle.

19. The charging device of claim 17, wherein the controller is configured to determine an opening of the garage door and determine the approach of the vehicle based on the opening of the garage door.

20. The charging device of claim 17 further comprising a sensor to detect an approach of the vehicle and the controller operates the actuator based on input from the sensor.

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