

DESCRIPTION**Invention Title: UNMANNED VEHICLE CHARGING SYSTEM AND
CONTROL METHOD THEREOF****Technical Field**

- [1] The present invention relates to an unmanned vehicle charging system and a control method thereof, and more particularly, to an unmanned vehicle charging system and a control method thereof configured to enable a vehicle to be charged by connecting a battery to a vehicle charging station by controlling the vehicle charging station and a mobile robot.

[2]

Background Art

- [3] In general logistics warehouses or factories, as well as in smart factories that manufacture products of different specifications using various parts, smart logistics vehicles are being introduced for flexible and efficient supply and transportation of parts.
- [4] A smart logistics vehicle is a concept collectively referring to an Autonomous Mobile Robot (AMR), an Automated Guided Vehicle (AGV), and an unmanned forklift, and such smart logistics vehicles may perform movement and tasks according to control of a control system.
- [5] As the flow of automobile technology changes from internal combustion engines to electric vehicles, various research on electric vehicle-related technologies is being conducted. In particular, various proposals are being made in relation to charging technology, which is the core of electric

vehicle technology and is most directly related to the spread of electric vehicles.

- [6] Charging technology is not only related to the convenience of using electric vehicles, but is also directly related to the future environment of the earth and each country's energy policy accordingly, and the main issue is how to secure energy efficiency. In this regard, the use of ESS, which stores energy and supplies it where needed, is expanding. ESS may supply power in combination with environmentally friendly renewable energy sources such as solar and wind power, and may store power at times when it is inexpensive and supply it during peak times, thereby securing efficiency in terms of power distribution and cost.
- [7] However, in the case of conventional traditional charging methods, electric vehicles were charged by receiving power in one direction through wired connection from power plants, and in this method, the path for supplying power became long and the process was complicated, resulting in power loss, and cost and space burdens occurred due to the installation of related facilities.
- [8] Recently, the Smart Power Interface Pillar (S-PIP) is emerging as a solution to reduce the cost and space burden due to the installation of related facilities by enabling vehicles to be charged using existing buildings.
- [9] Accordingly, there is a need for a solution to enable vehicles to be charged through mobile robots using S-PIP and AMR.
- [10]
- [11] The matters described as background art are merely for the purpose of enhancing understanding of the background of the present invention, and should not be taken as an acknowledgment that they correspond to prior art already known to those having ordinary skill in the art.

[12]

Disclosure

Technical Problem

[13] The present invention relates to an unmanned vehicle charging system and a control method thereof configured to enable a vehicle to be charged by a mobile robot transporting a battery and connecting it to a vehicle charging station by controlling the vehicle charging station and the mobile robot.

[14]

[15] The technical objects to be achieved by the present invention are not limited to the technical objects mentioned above, and other technical objects not mentioned will be clearly understood by those having ordinary skill in the art from the description below.

[16]

Technical Solution

[17] As a means for solving the technical problem, the present invention provides an unmanned vehicle charging system comprising: a vehicle charging station in which, in a state where a vehicle is parked, one side is connected with a vehicle charging port, and a docking port electrically connected with the vehicle charging port is formed at another side; a mobile robot on which a battery is loaded at a battery charging station, and which transports the battery to the vehicle charging station; and a controller configured to, when a preset charging entry condition is satisfied, control the vehicle charging station and the mobile robot to transport the battery from the battery charging station to the vehicle charging station, and couple the battery to the docking port so that the vehicle is charged.

- [18] For example, one side of the vehicle charging station may be connected with the vehicle charging port through a charging cable, and power may be supplied through the battery coupled with the docking port and transmitted to the vehicle.
- [19] For example, the battery may be coupled with the docking port through wired or wireless connection in a state where the battery is transported from the battery charging station to the vehicle charging station.
- [20] For example, the controller may set the charging entry condition including an SOC (State Of Charge) condition of the battery.
- [21] For example, the controller may determine whether the battery and the docking port are normally coupled, and when determined to be normally coupled, enable the vehicle to be charged.
- [22] For example, the controller may enable the vehicle to be charged based on charging data including charging option data of a user, target charging time data, and target charging SOC data.
- [23] For example, the controller may set a charging termination condition, and when the charging termination condition is satisfied during vehicle charging, control the vehicle charging station and the mobile robot to enable the battery to be separated from the docking port.
- [24] For example, the controller may set the charging termination condition including an SOC condition of the battery, an SOC condition of the vehicle, and an occupancy state condition of the battery charging station.
- [25] For example, a plurality of vehicles may be connected at one side of the vehicle charging station, and the controller may, when the battery is coupled to the docking

port, distribute charging power so that each of the vehicles is charged.

- [26] For example, the controller may set a charging priority of the vehicles based on the SOC of each of the plurality of vehicles, and enable the vehicles to be charged according to the charging priority.
- [27] The controller may determine whether vehicle discharging is necessary, and when it is determined that vehicle discharging is necessary, discharge the vehicle so that the battery is charged.
- [28] When it is determined that vehicle discharging is necessary, the controller may control the mobile robot to transport a battery requiring charging from the battery charging station to the vehicle charging station, and couple the battery requiring charging to the docking port so that the battery is charged.
- [29]
- [30] Also, as a method for solving the technical problem, the present invention provides an unmanned vehicle charging control method comprising a vehicle charging station in which, in a state where a vehicle is parked, one side is connected with a vehicle charging port, and a docking port electrically connected with the vehicle charging port is formed at another side, and a mobile robot on which a battery is loaded at a battery charging station and which transports the battery to the vehicle charging station, the method comprising: determining, at a controller, whether a preset charging entry condition is satisfied; transporting, by the mobile robot, the battery from the battery charging station to the vehicle charging station when the charging entry condition is satisfied; and coupling, by the controller, the battery to the docking port so that the vehicle is charged.

- [31] For example, the method may further comprise: determining, at the controller, whether the battery and the docking port are normally coupled; and when the battery and the docking port are determined to be normally coupled by the controller, enabling the vehicle to be charged.
- [32] For example, the enabling the vehicle to be charged may comprise: connecting a plurality of vehicles at one side of the vehicle charging station, and distributing, by the controller, charging power when the battery is coupled to the docking port so that each of the vehicles is charged.
- [33] For example, the enabling the vehicle to be charged may comprise: setting, at the controller, a charging priority of the vehicles based on the SOC of each of the plurality of vehicles; and enabling, at the controller, the vehicles to be charged according to the charging priority.
- [34] The method may further comprise:
- [35] determining, at the controller, whether vehicle discharging is necessary, wherein when it is determined that vehicle discharging is necessary, the vehicle is discharged so that the battery is charged.
- [36] When it is determined that vehicle discharging is necessary,
- [37] in the transporting from the battery charging station to the vehicle charging station, the mobile robot transports a battery requiring charging from the battery charging station to the vehicle charging station, and
- [38] in the enabling the vehicle to be charged, the vehicle is discharged and the battery is charged.
- [39]

Advantageous Effects

- [40] According to the unmanned vehicle charging system and the control method thereof of the present invention, by

controlling the vehicle charging station and the mobile robot, the mobile robot transports the battery and connects it to the vehicle charging station, thereby enabling construction of an efficient unmanned charging system.

[41]

[42] The effects obtainable from the present invention are not limited to the effects mentioned above, and other effects not mentioned will be clearly understood by those having ordinary skill in the art from the description below.

[43]

Description of Drawings

[44] FIG. 1 is a block diagram showing an example of a smart factory configuration applicable to embodiments of the present invention.

[45] FIG. 2 is a block diagram showing an example of a control device configuration applicable to embodiments of the present invention.

[46] FIG. 3 is a block diagram showing an example of a smart logistics vehicle configuration applicable to embodiments of the present invention.

[47] FIG. 4 is a perspective view showing an example of an external appearance of a smart logistics vehicle applicable to embodiments of the present invention.

[48] FIG. 5 is a flowchart showing an example of a driving process of a smart logistics vehicle applicable to embodiments of the present invention.

[49] FIG. 6 and FIG. 7 are drawings showing that a battery is coupled with a docking port through wired connection in an unmanned vehicle charging system according to an embodiment of the present invention.

[50] FIG. 8 and FIG. 9 are drawings showing that a battery is coupled with a docking port through wireless connection in an unmanned vehicle charging system according to an embodiment of the present invention.

[51] FIG. 10 is a drawing schematically illustrating charging power distribution by a controller when a plurality of vehicles are connected to a vehicle charging station according to an embodiment of the present invention.

[52] FIG. 11 is a flowchart showing operation of an unmanned vehicle charging control method according to an embodiment of the present invention.

[53]

Mode for Disclosure

[54] Hereinafter, embodiments disclosed in the present specification will be described in detail with reference to the accompanying drawings, and the same or similar components are given the same reference numerals regardless of the reference numerals, and redundant description thereof will be omitted. In the following description, the suffixes "module" and "unit" for components are given or used together in consideration of ease of preparation of the specification, and do not have meanings or roles that are distinguished from each other. In addition, in describing the embodiments disclosed in the present specification, when it is determined that a detailed description of related known technology may obscure the gist of the embodiments disclosed in the present specification, the detailed description will be omitted. In addition, the accompanying drawings are only for easy understanding of the embodiments disclosed in the present specification, and the technical idea disclosed in the present specification is not limited by the accompanying drawings, and should be understood to include all changes,

equivalents, and substitutes included in the spirit and technical scope of the present invention.

- [55] Terms including ordinal numbers such as first, second, etc. may be used to describe various components, but the components are not limited by the terms. The terms are used only for the purpose of distinguishing one component from another component.
- [56] When a component is referred to as being "connected" or "contacted" with another component, it should be understood that it may be directly connected or contacted with the other component, but other components may exist in between. On the other hand, when a component is referred to as being "directly connected" or "directly contacted" with another component, it should be understood that there are no other components in between.
- [57] The singular expression includes the plural expression unless the context clearly dictates otherwise.
- [58] In the present specification, terms such as "comprises" or "has" are intended to designate that a feature, number, step, operation, component, part, or a combination thereof described in the specification exists, and should be understood as not precluding the existence or addition of one or more other features, numbers, steps, operations, components, parts, or combinations thereof.
- [59] In addition, a unit or control unit included in the internal configuration name of a smart logistics vehicle or control device is only a term widely used for naming a controller that controls a specific function, and does not mean a generic function unit. For example, each control device may include a modem/transceiver for communicating with other control devices or sensors for control of a function in charge, a memory for storing an operating system or logic commands and input/output information, and

one or more processors for performing judgment, calculation, decision, etc. necessary for control of a function in charge. Depending on the implementation, one processor may be responsible for operations for a plurality of control devices.

- [60] First, the configuration of a smart factory in which smart logistics vehicles according to the embodiment are deployed and operated will be described with reference to FIG. 1.
- [61] FIG. 1 is a block diagram illustrating an example of a smart factory configuration applicable to embodiments.
- [62] Referring to FIG. 1, the smart factory 100 may include a smart logistics vehicle 110, a production device 120, a monitoring device 130, and a control device 140.
- [63] The smart factory 100 may be provided with a plurality of smart logistics vehicles 110, a plurality of production devices 120, and a plurality of monitoring devices 130 according to the production process of products and the target production speed. Hereinafter, each component will be described.
- [64] First, the smart logistics vehicle 110 may include an Autonomous Mobile Robot (hereinafter, referred to as 'AMR' for convenience), an Automated Guided Vehicle (hereinafter, referred to as 'AGV' for convenience), and an unmanned forklift. According to the operation policy of the smart logistics vehicle 110 in the smart factory 100, only one type of AGV or AMR may be operated, or AGV and AMR may be operated together within a single smart factory 100.
- [65] The AGV generally performs operations (movement, direction change, stop, etc.) required in the smart factory 100 by recognizing and following guidance equipment deployed on the floor for guidance of the AGV. Here, the guidance equipment may mean a marker (spot, 2D code, etc.) that can be recognized optically, a tag (e.g., NFC tag, RFID tag,

etc.) that can be recognized in a non-contact manner at a short distance, a magnetic strip, a wire, etc., but this is exemplary and is not necessarily limited thereto. The guidance equipment may be continuously deployed on the floor, or may be deployed spaced apart from each other discontinuously. Since the AGV basically performs operations through recognition and following of the guidance equipment, it requires that the guidance equipment be installed in advance before operation, and when the AGV needs to be moved to a new path or an existing path needs to be modified, the guidance equipment needs to be newly established or modified physically. In addition, since the AGV does not deviate from the path set through the guidance equipment, when an obstacle is detected on or around the path, it is generally stopped until the detected obstacle disappears or receives separate control. In the operation of the AGV, since the control device 140 must control the AGV based on the guidance equipment, the control device 140 may transmit a command meaning such as 'drive until the 3rd marker is recognized' at the current position, 'switch the heading direction by 90 degrees when the 3rd marker is recognized' to the AGV in individual command units or mission units including a plurality of commands (e.g., collection, supply, charging, patrol, etc.).

- [66]** The AMR can determine the current position through peripheral detection (i.e., localization), and can perform self path planning using localization and a map, which is the most distinguishing point from the AGV. Therefore, when a map in which coordinates are compatible is shared between the AMR and the control device 140, the control device 140 can control the AMR in a manner of instructing a path to the AMR based on coordinates. In addition, when an obstacle is detected during driving, the AMR can set an avoidance path on its own, avoid the obstacle, and return to the existing path. The function of the control device 140

setting the path of the AMR with one or more waypoint coordinates may be referred to as global path planning, and the function of the AMR setting a movement path or an avoidance path between waypoint coordinates according to global path planning may be referred to as local path planning.

- [67] A more detailed configuration of the smart logistics vehicle 110 will be described later with reference to FIGS. 3 and 4, and the driving control process of the AMR will be described later with reference to FIG. 5, respectively.
- [68] Next, the production device 120 may mean a device (e.g., a robot arm, a conveyor belt, etc.) that performs a production process of products in the smart factory 100, and in a broader sense, may mean a device deployed to assist the mission performance such as entry and exit of the smart logistics vehicle 110 when the production process is performed by a person. A device deployed to assist mission performance means a device for detecting the state of a designated position where the smart logistics vehicle 110 can put down or collect a pallet carried in an area where a specific production process is performed, a device for determining the progress of the process, a means for blocking entry into the area, etc., but is not necessarily limited thereto.
- [69] For example, the production device 120 is controlled through a PLC (Programmable Logic Controller), and may communicate with the control device 140 in relation to the process progress.
- [70] The monitoring device 130 may perform a function of obtaining information for determining a situation in the smart factory 100 and transmitting it to the control device 140. For example, the monitoring device 130 may include a camera, a proximity sensor, etc., but is not necessarily limited thereto.

- [71] The control device 140 may communicate with the above-described components 110, 120, 130 to obtain information necessary for the operation of the smart factory 100 or to control each component. For example, the control device 140 may perform dispatching of the smart logistics vehicle 110, path setting, mission assignment, process management for each product, material management, etc.
- [72] In implementation, the control device 140 may include a local control device (ACS: AMR/AGV Control System) that controls peripheral process equipment based on the position of the AGV/AMR and performs mission-based control of the AGV/AMR, and an integrated control device (MoRIMS: Mobile Robot Integrated Monitoring System) that integrates and controls two or more local control devices. The integrated control device may perform the status and path of all smart logistics vehicles 110 in the smart factory 100 from each of the plurality of local control devices, logistics flow setting, and traffic control. For example, when the local control device (ACS) is provided for each smart logistics robot of the same manufacturer or the same model, the integrated control device may perform integrated control for collision prevention such as bottleneck level analysis of intersecting/overlapping areas, driving acceleration/deceleration control, and avoidance path regeneration through traffic distribution control between different models based on information obtained through the plurality of local control devices (ACS).
- [73] In addition, the integrated control device may also have a Manufacturing Execution System (MES: Manufacturing Execution System) as its upper control subject, and the Manufacturing Execution System (MES) may be linked with an Advanced Planning & Scheduling (APS: Advanced Planning & Scheduling) again.

- [74] In addition to the above-described configuration 110, 120, 130, 140 of the smart factory 100, devices for mutual communication between each component such as beacons, repeaters, APs (Access Points), chargers for charging the smart logistics vehicle 110, loading space for storing or loading parts, space for storing finished products or intermediate products, traffic lights, barriers, waiting space for idle smart logistics vehicles 110, etc. may be appropriately deployed in the smart factory 100.
- [75] Hereinafter, the configuration of the control device 140 applicable to the embodiments of the present invention will be described with reference to FIG. 2.
- [76] FIG. 2 is a block diagram illustrating an example of a control device configuration applicable to the embodiments of the present invention. Each component shown in FIG. 2 is shown mainly with components related to the embodiments of the present invention, and in the actual implementation of the control device 140, more or fewer components may be included.
- [77] Referring to FIG. 2, the control device 140 may include a firmware management unit 141, a traffic control unit 142, a process management unit 143, a production/logistics management unit 144, an inventory management unit 145, a communication unit 146, a vehicle monitoring unit 147, and a map management unit 148.
- [78] The firmware management unit 141 may obtain the latest firmware of the smart logistics vehicle 110 through the communication unit 146, transmit it to the smart logistics vehicle 110 to perform firmware update, and maintain the firmware of the smart logistics vehicle 110 in the latest state.
- [79] The traffic control unit 142 controls traffic lights and barriers based on the path of the smart logistics vehicle

110, and may also recalculate the path of the smart logistics vehicle 110 according to traffic.

- [80] The process management unit 143 may define a process for each product and manage missions such as process progress, progress position, etc.
- [81] The production/logistics management unit 144 may dispatch the smart logistics vehicle 110 based on missions.
- [82] The inventory management unit 145 manages the position and quantity for each material, and this information may be useful for more efficient process operation, such as starting the smart logistics vehicle 110 to the destination in advance before the time when the actual assembly/consumption of the material is detected for pallet pickup or collection.
- [83] The communication unit 146 may communicate not only with internal components of the smart factory 100 such as the smart logistics vehicle 110, the production device 120, and the monitoring device 130, but also with external entities such as firmware update servers.
- [84] The vehicle monitoring unit 147 may monitor the position, path, battery state, communication state, power train state, etc. of each smart logistics vehicle 110. Here, the path is a concept including a waypoint-based global path and a real-time local path. In addition, the battery state may include voltage, current, temperature, peak values of voltage and current, State Of Charge (SOC), State Of Health (SOH), etc. The communication state may include information on the currently activated communication protocol (Wi-Fi, etc.), connected AP, distance from the AP, channel in use, etc. In addition, the power train state may include load, temperature, RPM, etc. of the drive system.

- [85] In addition, the vehicle monitoring unit 147 may also check the mission currently assigned to each smart logistics vehicle 110, the operation mode, the firmware version, etc.
- [86] The map management unit 148 may obtain map data in the form of a grid map obtained while the AMR among the smart logistics vehicles 110 drives inside the smart factory 100, and may provide a tool for a factory manager to edit the obtained map data. Through editing of the map data, a zone where the smart logistics vehicle 110 performs one or more preset operations upon entry, a virtual lane, an intersection, a restricted area, etc. may be set, but this is exemplary and is not necessarily limited thereto. In addition, the map management unit 148 may distribute the map to the remaining smart logistics vehicles 110 other than the smart logistics vehicle 110 that obtained the initial grid map through actual driving through the communication unit 146.
- [87] Next, the smart logistics vehicle will be described with reference to FIGS. 3 and 4.
- [88] FIG. 3 is a block diagram illustrating an example of a smart logistics vehicle configuration applicable to the embodiments of the present invention.
- [89] Referring to FIG. 3, the smart logistics vehicle 110 may include a driving unit 111, a sensing unit 112, a loading unit 113, a communication unit 114, and a control unit 115. Hereinafter, each component will be described.
- [90] The driving unit 111 may include a drive source, wheels, and suspension, etc. related to movement, steering, and stop of the smart logistics vehicle 110. An electric motor that receives power from an embedded battery (not shown) may be used as the drive source. The wheels may include one or more drive wheels that receive driving force from the drive source, and non-drive wheels that rotate by the

movement of the vehicle body without receiving driving force. Depending on the implementation, when a plurality of drive wheels are provided, a drive source may be matched for each drive wheel, and the rotation of each drive wheel may be controlled independently. In this case, by making the rotation directions of different drive wheels different, steering may be performed by rotating the vehicle body without separate steering means. At least some of the non-drive wheels may be composed of caster type wheels, but this is exemplary and is not necessarily limited thereto.

[91] The sensing unit 112 is for detecting the surrounding environment of the smart logistics vehicle 100 or its own operation state, and may include at least one of a 2D laser scanner (e.g., LiDAR), a 3D vision (stereo) camera, a multi-axis gyro sensor, an acceleration sensor, a wheel encoder, and a proximity sensor.

[92] The encoder can output information that can determine how much the wheel has rotated by using light emitted from a light emitting element (e.g., a photodiode). For example, the encoder may count the number of slits arranged along the circumferential direction on the wheel or a disk rotating together with the wheel during unit time. The control unit 115 can perform odometry that estimates displacement by analyzing the amount of position change versus time with data obtained through the encoder and the gyro sensor. However, there may be an error between the displacement estimated based on the encoder data and the actual displacement due to wheel slip or wear (wheel radius change). Therefore, when performing odometry, the control unit 115 may perform correction for noise and error with a predetermined algorithm (e.g., EKF: Extended Kalman Filter) on information collected from the wheel and the gyro sensor to output a result having a tendency close to the actual value. Such odometry may be particularly useful when

localization using a 2D laser scanner described later is impossible.

- [93] The 2D laser scanner may scan the surrounding environment by irradiating a laser around through a rotating reflector and detecting a signal reflected back. At this time, a detection result in the form of a point cloud may be output by analyzing the intensity of the reflected signal and the time difference between irradiation/reception.
- [94] The 3D vision camera can calculate the distance to an object based on the parallax between two cameras spaced apart by a certain distance, that is, the pixel distance between images captured through each camera. At this time, a texture projector that projects infrared light of a predetermined pattern may be provided so that detection is possible even for a flat object of the same color (e.g., a white wall).
- [95] In general, the 2D laser scanner is used for mapping, navigation, object recognition, etc., and the 3D camera may be used for obstacle avoidance, especially during navigation, but this is exemplary and is not necessarily limited thereto.
- [96] The loading unit 113 is a means for loading goods to be transported, and may be the top plate itself at the top of the vehicle body or a table deployed on the top plate, a lift, a turntable rotating along a vertical axis, a fork lift, a conveyor, or a combination thereof. In the case of a fork lift, similar to a forklift, telescopic and tilting functions may be supported.
- [97] The communication unit 114 may communicate with other components in the smart factory 100 such as the production device 120 and the control device 140, may also support communication between smart logistics vehicles 110, and may

also communicate with a charger when performing a charging mission.

- [98] The control unit 115 is a subject that performs overall control of each of the above-described components 111, 112, 113, 114, and may perform current mission, current position, destination determination, path planning, loading unit control, etc. based on information obtained from the control device 140 through the communication unit 114.
- [99] FIG. 4 is a perspective view illustrating an example of the exterior of a smart logistics vehicle applicable to the embodiments of the present invention.
- [100] Referring to FIG. 4, an example of an AMR is shown as the smart logistics vehicle 110. The vehicle body may have a track-type planar shape having a long axis extending along a 1-axis direction as a whole. One drive wheel 111-1 is disposed at a central portion of the vehicle body in the 1-axis direction, and may be disposed at one side in the 2-axis direction, and the other drive wheel (not shown) may be disposed at the other side in the 2-axis direction so as to face the one drive wheel 111-1. This drive wheel arrangement may be referred to as a 'differential drive (DD)'. Although not shown in FIG. 4, two or more non-drive wheels may be disposed at a lower portion of the vehicle body. In this case, when the two drive wheels rotate in the same direction at the same speed, forward or backward movement along the 1-axis direction is possible, and when rotating in opposite directions at the same speed, rotation may be performed based on a rotation axis extending along the 3-axis direction and passing through the planar center (C) of the vehicle body. In addition, the sensor unit 112 may be disposed at a front portion of the vehicle body, and the loading unit 113 may be disposed at an upper surface portion. The loading unit 113 may be configured to be able

to be elevated along the 3-axis direction, and a rack or tray may be fixed to an upper surface through a guide 113-1.

[101] However, the AMR form of FIG. 4 described above is exemplary, and the AGV may have a similar form to this, or the AMR may have a different form from this.

[102] Next, the driving process of the smart logistics vehicle 110 will be described with reference to FIG. 5.

[103] FIG. 5 is a flowchart illustrating an example of a driving process of the smart logistics vehicle 110 applicable to the embodiments of the present invention. In FIG. 5, for convenience, it is assumed that the smart logistics vehicle 110 is an AMR capable of localization and local path setting.

[104] Referring to FIG. 5, first, the AMR may obtain an actual grid map through LiDAR while driving inside the smart factory 100 in step S501.

[105]

[106] When the AMR transmits the obtained grid map to the control device 140, a grid map editing and matching process may be performed in the map management unit 148 of the control device 140 in step S502. Here, the editing process may include a process of setting various zones described above on the grid map described above, a process of giving a cost for each grid, etc. Here, the giving of the cost may be performed in a direction in which the cost is given higher as the obstacle is closer to the obstacle or the restricted area so that the AMR does not move around the obstacle or to the restricted area. This is because the AMR selects a set of cells with the lowest cost as a path in setting a local path between waypoints.

[107] In addition, the map matching process may mean a process of matching coordinates between a CAD map used in

the design of the smart factory 100, an actual grid map (LiDAR map) and a topology map that has undergone the editing process.

[108] Thereafter, the control device 140 may share the topology map with all AMRs in the factory through the communication unit 146 in step S503.

[109] Subsequent steps may be processes applied to individual AMRs.

[110] The AMR may determine (localization) the current position on the map through the sensor data of the sensing unit 112 and the obtained map in step S504. For example, the AMR may determine the current position by comparing the surrounding terrain obtained through LiDAR with the map based on feature points.

[111] The control device 140 may select a specific AMR and assign a mission, and the mission may generally be given one or more waypoints determined through global path planning. A waypoint may be defined as coordinates on the map, and information about the direction (i.e., heading) that the AMR should face at that coordinate may be accompanied. According to this mission assignment, a destination may be set in the AMR (Yes in step S505), and the AMR may perform local path planning between waypoints based on the cost of the topology map in step S506.

[112] When the path is determined, the AMR starts driving in step S507, and when an obstacle is detected through the sensing unit 112 during driving (Yes in step S508), a local path search may be performed to bypass the detected obstacle to perform avoidance maneuver in step S509. In some cases, depending on the avoidance maneuver or the failure of the avoidance maneuver, the control device 140 may update the mission of the AMR.

[113] In addition, the AMR may correct the position error during movement through the odometry technique described above while driving until reaching the destination in step S510.

[114] Thereafter, when the destination is reached in step S511, the AMR may perform mission-based maneuver in step S512. For example, the AMR may determine whether conditions for entering a specific process area are cleared, collect an empty pallet at the destination, or drop the load loaded on the loading unit 113.

[115]

[116] In one embodiment of the present invention, it is proposed to construct an efficient unmanned charging system by controlling the vehicle charging station and the mobile robot so that the mobile robot transports the battery and connects it to the vehicle charging station.

[117] Before description, the V2E (Vehicle-to-ESS) technology will be described first. ESS is an Energy Storage System, which is a device that stores generated power and takes it out to use when power is needed.

[118] As a basic concept, charging the battery of a vehicle through an energy storage device, or conversely, charging an energy storage device through the battery of a vehicle corresponds to V2E.

[119] That is, when it is determined that battery management of the vehicle is necessary, such as overcharging the battery of the vehicle or temporary discharging of the battery of the vehicle, the customer can charge the energy storage device by discharging the battery of the vehicle.

[120]

[121] At this time, as an embodiment, V2E may be performed in the following process. First, the customer decides the

required charging amount, scans a QR code in a state where the vehicle and the energy storage device (ESS) are connected to each other with a cable. Thereafter, when the user receives a notification from the application that the cable is normally connected as a result of scanning the QR code, the V2E function for charging the energy storage device is started, and charging of the energy storage device may be started. When the charging of the energy storage device is completed, the battery discharging monitoring information through the V2E function and the compensation fee information according to the charging amount of the energy storage device may be stored in the energy storage device (ESS). The energy storage device transmits the information to the application, and the customer can check the compensation fee according to the battery discharging of the vehicle, and can cash the compensation fee, trade necessary goods, or consume it for charging the battery of the vehicle.

[122] In general, it is expected that the battery of the vehicle will be charged through the energy storage device, and hereinafter, the unmanned vehicle charging system will be described.

[123]

[124] The unmanned vehicle charging system is divided into two types depending on whether the method of coupling the battery with the docking port is wired or wireless. First, wired connection will be described, and the unmanned vehicle charging system according to the embodiment will be described with reference to FIGS. 6 to 9.

[125] FIGS. 6 and 7 are views illustrating that a battery is coupled with a docking port by wire in an unmanned vehicle charging system according to an embodiment of the present invention, and FIGS. 8 and 9 are views illustrating that a battery is coupled with a docking port by wireless.

[126] Referring to FIG. 6, the unmanned vehicle charging system may include a vehicle charging station 210, a mobile robot, and a controller 140. Hereinafter, each component will be described.

[127] First, in the vehicle charging station 210, in a state where a vehicle is parked, one side is connected with a vehicle charging port, and docking ports 212 and 213 electrically connected with the vehicle charging port may be formed at another side. At this time, one side of the vehicle charging station 210 is connected with the vehicle charging port through a charging cable 240, and power is supplied through the battery 10 coupled with the docking ports 212 and 213 and transmitted to the vehicle. In addition, a plurality of vehicles may be connected to the vehicle charging station 210, and in this case, one battery 10 distributes charging power to each vehicle at another side.

[128] In addition, the battery 10 is loaded at the battery charging station 210, and the mobile robot may transport the battery 10 to the vehicle charging station 210. As described above, the mobile robot is a smart logistics vehicle, and the battery 10 may be transported through the driving unit in a state where the battery 10 is loaded on the loading unit 113. When the charging of the battery 10 is completed at the battery charging station 210 or when the charging state of the battery 10 is determined to be above a certain value, the battery 10 charging is terminated, and loading of the battery 10 by the mobile robot may be started. The charging of the battery 10 is performed at the battery charging station 210. An internal space is formed in the battery charging station 210 or the vehicle charging station 210, and a first cable 211 is provided in the internal space to electrically connect one side and another side of the charging station. When a power storage 220 connected with a second cable 230 is connected

to one side, charging of the battery 10 is performed, and when connected with a vehicle charging port through a charging cable 240 at one side, vehicle charging is performed through discharging of the battery 10.

[129] In addition, the battery 10 and the battery control unit 23 are provided at an upper portion of the mounting part 21 to facilitate loading of the battery 10 by the mobile robot. The battery control unit 23 is connected with a battery cable 25 that allows the battery charging station 210 or the vehicle charging station 210 and the battery 10 to be connected to each other when the battery 10 is charged or discharged.

[130] The wired connection and the wireless connection of the battery 10 and the docking ports 212 and 213 will be described respectively as follows.

[131] The battery 10 is separated from the battery charging station 210 and transported to the vehicle charging station 210 through the mobile robot. In this state, the mobile robot connects the coupling part 212' with the sensing unit 112, and the battery 10 may be coupled to the docking port 212 by directly connecting the coupling part 212' with the docking port 212. In addition, in the case of wireless connection, a coupling part 213' is provided at one side of the battery 10 transported to the vehicle charging station 210, and the battery 10 may be coupled to the docking port 213 by the coupling part 213' being adjacent to the docking port 213. The coupling of the battery 10 and the docking ports 212 and 213 may be performed when it is determined that a preset charging entry condition is satisfied through the controller 140.

[132] FIG. 10 is a view schematically illustrating charging power distribution of a controller when a plurality of vehicles are connected to a vehicle charging station according to an embodiment of the present invention.

[133] Referring to FIG. 10, the unmanned vehicle charging system according to the present invention will be briefly described as follows.

[134] When a preset charging entry condition is satisfied, the controller 140 may control the vehicle charging station 210 and the mobile robot to transport the battery 10 from the battery charging station 210 to the vehicle charging station 210. Here, the controller 140 may refer to the control device 140 described above. In addition, the charging entry condition includes a charging state (SOC, State Of Charge) condition of the battery 10. For example, when the controller 140 determines that the SOC of the battery 10 is lower than the minimum SOC required for vehicle charging, the controller 140 may not transport the battery 10 to the vehicle charging station 210 because the charging entry condition is not satisfied. For example, when the charging of the battery 10 is completed or when the SOC of the vehicle battery 10 is less than 10%, the mobile robot may transport the battery 10 to the power storage 220 to charge the battery 10. At this time, when the power storage 220 for charging the battery 10 is already in use, the mobile robot may transport the battery 10 to a separate storage.

[135] In addition, when the power storage 220 is not in use and the SOC of the battery 10 is less than 70%, the mobile robot may transport the battery 10 from a separate storage to the power storage 220. At this time, when the transportation path of the mobile robot overlaps with the path of vehicles and people, the controller 140 may set the transportation path of the mobile robot to avoid it.

[136] In addition, the user may transmit a charging request signal through a display device such as a mobile device, or the controller 140 may start battery charging without a charging request signal from the user. The charging request

signal of the user may include various charging data according to the user's selection result, and the controller 140 enables the vehicle to be charged based on the charging data. Here, the charging data includes charging option data of the user, target charging time data, and target charging SOC data. For example, when the target time for the vehicle to be charged is set to 1 hour, the controller 140 may enable the vehicle to be charged for 1 hour, and when the user sets the target electricity rate limit, the controller 140 may enable the vehicle to be charged according to the set electricity rate limit. In addition, when the user sets the target charging amount of the vehicle, the controller 140 may enable the vehicle to be charged according to the target charging amount of the vehicle.

[137] In addition, the controller 140 may determine whether the battery 10 and the docking ports 212 and 213 are normally coupled, and when the coupling of the battery 10 and the docking ports 212 and 213 is determined to be normal, the controller 140 may enable the vehicle to be charged. This is to prevent a dangerous situation such as a fire from occurring when the battery 10 and the docking ports 212 and 213 are abnormally coupled by determining in advance whether the coupling is normal by the controller 140.

[138] In addition, the controller 140 sets a charging termination condition in advance, and when the charging termination condition is satisfied during vehicle charging, the controller 140 may control the vehicle charging station 210 and the mobile robot to enable the battery 10 to be separated from the docking ports 212 and 213. Here, the charging termination condition of the vehicle may include an SOC condition of the battery 10, an SOC condition of the vehicle, and an occupancy state condition of the battery charging station 210. For example, when the SOC of the

battery 10 decreases below a certain reference value according to vehicle charging, the battery 10 may be separated from the docking ports 212 and 213 for battery 10 charging, and the separated battery 10 may be transported to the battery charging station 210 to enable the battery 10 to be charged.

[139] Meanwhile, as described above, according to the concept of V2E, when it is determined that vehicle discharging is necessary, the vehicle may be discharged and the battery may be charged.

[140] To perform this, the controller determines whether vehicle discharging is necessary. Whether vehicle discharging is necessary may be determined by whether the vehicle is overcharged or by the request of the customer, and when the controller determines that vehicle discharging is necessary, the controller discharges the vehicle so that the battery is charged.

[141] At this time, the controller may control the mobile robot to transport a battery requiring charging from the battery charging station to the vehicle charging station, and couple the battery requiring charging to the docking port so that the vehicle is discharged and the battery is charged.

[142]

[143] Based on the configuration of the unmanned vehicle charging system described above, the unmanned vehicle charging method according to the embodiment will be described with reference to FIG. 11.

[144] FIG. 11 is a flowchart illustrating an unmanned vehicle charging control method according to an embodiment of the present invention.

- [145] Referring to FIG. 11, first, the vehicle may be parked near the vehicle charging station 210 in step S610. When the vehicle is parked, the user may connect one side of the vehicle charging station 210 with the charging port of the vehicle in step S620. Thereafter, the controller 140 may receive a charging request signal from the user for control of the vehicle charging station 210 and the mobile robot in step S630. Here, the user may transmit a charging request signal, or the controller 140 may start battery charging without a charging request signal from the user.
- [146] When the charging request signal of the user is received, the controller 140 may determine whether a preset charging entry condition is satisfied in step S640. When the charging entry condition is determined to be satisfied (Y in step S640), the controller 140 may control the mobile robot to transport the battery 10 from the battery charging station 210 to the vehicle charging station 210 in step S650. Thereafter, the controller 140 may control the vehicle charging station 210 and the mobile robot to couple the battery 10 to the docking ports 212 and 213 in step S660 and enable the vehicle to be charged in step S670.
- [147] Meanwhile, as described above, the vehicle may be discharged to charge the battery. Referring to FIG. 11, as described above, when the vehicle is parked near the vehicle charging station, the user may connect one side of the vehicle charging station with the charging port of the vehicle in step S620.
- [148] In the charging request signal receiving step in step S630, the controller may determine whether vehicle discharging is necessary, and when the controller receives a discharging request signal (when it is determined that vehicle discharging is necessary due to the user's request, etc.), vehicle discharging may be started.

[149] When it is determined that vehicle discharging is necessary, in the step of transporting from the battery charging station to the vehicle charging station in step S650, the mobile robot transports a battery requiring charging from the battery charging station to the vehicle charging station, and at this time, in the step of enabling the vehicle to be charged in steps S660 and S670, the vehicle is discharged and the battery is charged.

[150]

[151] According to the embodiments of the present invention described so far, an efficient unmanned charging system can be constructed by controlling the vehicle charging station and the mobile robot so that the mobile robot transports the battery and connects it to the vehicle charging station.

[152]

[153] Although the present invention has been shown and described with respect to specific embodiments of the present invention, it will be apparent to those skilled in the art that the present invention may be variously improved and changed within the limit that does not deviate from the technical idea of the present invention provided by the following claims.

[154]

[155] Description of Reference Numerals

[156] 100: smart factory 110: smart logistics vehicle

[157] 120: production device 130: monitoring device

[158] 140: control device

CLAIMS

[Claim 1]

An unmanned vehicle charging system comprising:

a vehicle charging station in which, in a state where a vehicle is parked, one side is connected with a vehicle charging port, and a docking port electrically connected with the vehicle charging port is formed at another side;

a mobile robot on which a battery is loaded at a battery charging station, and which transports the battery to the vehicle charging station; and

a controller configured to, based on a preset charging entry condition is satisfied, control the vehicle charging station and the mobile robot to transport the battery from the battery charging station to the vehicle charging station, and couple the battery to the docking port so that the vehicle is charged.

[Claim 2]

The unmanned vehicle charging system of claim 1, wherein one side of the vehicle charging station is connected with the vehicle charging port through a charging cable, and power is supplied through the battery coupled with the docking port and transmitted to the vehicle.

[Claim 3]

The unmanned vehicle charging system of claim 1, wherein the battery is coupled with the docking port through wired or wireless connection in a state where the battery is transported from the battery charging station to the vehicle charging station.

[Claim 4]

The unmanned vehicle charging system of claim 1, wherein the controller sets the charging entry condition including an SOC (State Of Charge) condition of the battery.

[Claim 5]

The unmanned vehicle charging system of claim 1, wherein the controller determines whether the battery and the docking port are normally coupled, and when determined to be normally coupled, enables the vehicle to be charged.

[Claim 6]

The unmanned vehicle charging system of claim 1, wherein the controller enables the vehicle to be charged based on charging data including charging option data of a user, target charging time data, and target charging SOC data.

[Claim 7]

The unmanned vehicle charging system of claim 1, wherein the controller sets a charging termination condition, and when the charging termination condition is satisfied during vehicle charging, controls the vehicle charging station and the mobile robot to enable the battery to be separated from the docking port.

[Claim 8]

The unmanned vehicle charging system of claim 7, wherein the controller sets the charging termination condition including an SOC condition of the battery, an SOC condition of the vehicle, and an occupancy state condition of the battery charging station.

[Claim 9]

The unmanned vehicle charging system of claim 1, wherein a plurality of vehicles are connected at one side of the vehicle charging station, and

the controller, when the battery is coupled to the docking port, distributes charging power so that each of the vehicles is charged.

[Claim 10]

The unmanned vehicle charging system of claim 9, wherein the controller sets a charging priority of the vehicles based on the SOC of each of the plurality of vehicles, and enables the vehicles to be charged according to the charging priority.

[Claim 11]

The unmanned vehicle charging system of claim 1, wherein the controller determines whether vehicle discharging is necessary, and when it is determined that vehicle discharging is necessary, discharges the vehicle so that the battery is charged.

[Claim 12]

The unmanned vehicle charging system of claim 11, wherein when it is determined that vehicle discharging is necessary, the controller controls the mobile robot to transport a battery requiring charging from the battery charging station to the vehicle charging station, and couples the battery requiring charging to the docking port so that the battery is charged.

[Claim 13]

An unmanned vehicle charging control method using a vehicle charging station and a mobile robot, the method comprising:

determining, at a controller, whether a preset charging entry condition is satisfied;

transporting, by the mobile robot, the battery from the battery charging station to the vehicle charging station when the charging entry condition is satisfied; and

coupling, by the controller, the battery to the docking port so that the vehicle is charged.

[Claim 14]

The unmanned vehicle charging control method of claim 13, further comprising:

determining, at the controller, whether the battery and the docking port are normally coupled; and

when the battery and the docking port are determined to be normally coupled by the controller, enabling the vehicle to be charged.

[Claim 15]

The unmanned vehicle charging control method of claim 13, wherein the enabling the vehicle to be charged comprises:

connecting a plurality of vehicles at one side of the vehicle charging station, and distributing, by the controller, charging power when the battery is coupled to the docking port so that each of the vehicles is charged.

[Claim 16]

The unmanned vehicle charging control method of claim 15, wherein the enabling the vehicle to be charged comprises:

setting, at the controller, a charging priority of the vehicles based on the SOC of each of the plurality of vehicles; and

enabling, at the controller, the vehicles to be charged according to the charging priority.

[Claim 17]

The unmanned vehicle charging control method of claim 13, further comprising:

determining, at the controller, whether vehicle discharging is necessary,

wherein when it is determined that vehicle discharging is necessary, the vehicle is discharged so that the battery is charged.

[Claim 18]

The unmanned vehicle charging control method of claim 17, wherein when it is determined that vehicle discharging is necessary,

in the transporting from the battery charging station to the vehicle charging station, the mobile robot transports a battery requiring charging from the battery charging station to the vehicle charging station, and

in the enabling the vehicle to be charged, the vehicle is discharged and the battery is charged.