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(54) AUTOMATIC CLEANING DEVICE

(57) An automatic cleaning device, comprising: a mobile platform (100) configured to automatically move on an operation surface; and a cleaning module (150) provided the mobile platform (100) and comprising a dry cleaning module (151) configured to clean at least part of the operation surface in a dry cleaning mode and a wet cleaning module (400) configured to clean at least part of the operation surface in a wet cleaning mode, wherein the wet cleaning module (400) comprises a cleaning head (410) configured to clean the operation surface and a driving unit (420) configured to drive the cleaning head (410) to reciprocate along a target surface, the target surface being a part of the operation surface. The cleaning head (400) of the automatic cleaning device can move substantially in a reciprocating manner, such that repeated cleaning can be performed on a surface to be cleaned, and multiple cleaning can be achieved in a certain area at a time in the movement trajectory of a cleaning robot, such that the cleaning effect is greatly enhanced, especially for areas with relatively large stains, and the cleaning effect is obvious.

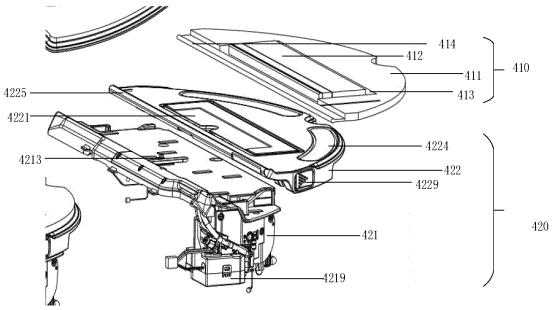

FIG. 9

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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority of Chinese Patent Application No. 202110004713.5, filed on January 4, 2021, and Chinese Patent Application No. 202110138563.7, filed on February 1, 2021, which are incorporated herein by reference in their entireties as a part of the present application.

TECHNICAL FIELD

[0002] The present invention relates to the field of cleaning robot technologies, and in particular to an automatic cleaning apparatus.

BACKGROUND

[0003] At present, there are two main types of cleaning robots, i.e., a sweeping robot and a mopping robot, each of which has a single function of only sweeping or mopping the floor. If people want to sweep and mop the floor simultaneously, the two apparatuses have to be prepared simultaneously, which, as a result, takes up a double space.

[0004] In the prior art, there may be a combination of a sweeping robot and a mopping robot by adding a mop cloth to the tail end of the sweeping robot to realize a sweeping and mopping integrated robot. However, the mopping function of the sweeping and mopping integrated robot is realized only by translating the mop cloth on the floor, and with the translation of the mop cloth, the floor is cleaned just one time in a movement trajectory of the cleaning robot. As a result, the mopping effect and the mopping efficiency are both greatly reduced, and especially for some environments with more stains and more dirty floors, the floor obviously cannot be cleaned up by mopping the floor one time in a moving manner.

SUMMARY

[0005] An object of the present invention is to provide an automatic cleaning apparatus, which can solve the technical problem that a floor cannot be cleaned up. The specific solutions are as below.

[0006] According to specific embodiments of the present invention, an automatic cleaning apparatus is provided. The automatic cleaning apparatus includes:

a mobile platform 100 configured to move automatically on an operation surface; and
a cleaning module 150 disposed on the mobile platform 100 and including:

a dry cleaning module 151 configured to clean at least part of the operation surface in a dry cleaning manner; and

a wet cleaning module 400 configured to clean at least part of the operation surface in a wet cleaning manner, wherein the wet cleaning module 400 includes:

a cleaning head 410 configured to clean the operation surface, and
a driving unit 420 configured to drive the cleaning head 410 to substantially reciprocate along a target surface that is a part of the operation surface.

[0007] Optionally, the driving unit 420 includes:

a driving platform 421 connected to the bottom surface of the mobile platform 100 and configured to provide a driving force; and
a supporting platform 422 detachably connected to the driving platform 421 and configured to support the cleaning head 410.

[0008] Optionally, the driving platform 421 includes:

a motor 4211 disposed on the side of the driving platform 421 close to the mobile platform 100 and outputting power by a motor output shaft; and
a driving wheel 4212 connected to the motor output shaft and being of an asymmetrical structure.

[0009] Optionally, the driving platform 421 further includes:
a vibrator 4213 disposed on the side of the driving platform 421 opposite to the motor 4211, connected to the driving wheel 4212 and substantially reciprocating under the asymmetrical rotation of the driving wheel 4212.

[0010] Optionally, the driving platform 421 further includes:
a connecting rod 4214 extending along an edge of the driving platform 421 and connecting the driving wheel 4212 to the vibrator 4213 such that the vibrator 4213 extends to a preset position.

[0011] Optionally, the vibrator 4213 is of a rod-like structure and extends perpendicular to the connecting rod 4214.

[0012] Optionally, the driving platform includes a vibration-buffering device 4215 disposed on the connecting rod 4214.

[0013] Optionally, the supporting platform 422 includes:
a cleaning substrate 4221 freely movably disposed on the supporting platform 422 and substantially reciprocating relative to the supporting platform 422 under the vibration of the vibrator 4213.

[0014] Optionally, the cleaning substrate 4221 includes:
an assembly notch disposed at a position in contact with the vibrator 4213, the vibrator 4213 being assembled in the assembly notch when the supporting platform 422 is

connected to the driving platform 421.

[0015] Optionally, the supporting platform 422 further includes:

a removal button 422 configured to detachably connect the supporting platform 422 to the driving platform 421.

[0016] Optionally, the supporting platform 422 further includes:

at least one assembly area 4224 disposed on the supporting platform 422 and configured for assembly of the cleaning head 410.

[0017] Optionally, the cleaning head 410 includes:

a movable area 412 connected to the cleaning substrate 4221 and substantially reciprocating along the target surface under the driving of the cleaning substrate 4221.

[0018] Optionally, a bonding layer is disposed on the side of the movable area 412 connected to the cleaning substrate 4221, and the movable area 412 is connected to the cleaning substrate 4221 by the bonding layer.

[0019] Optionally, the cleaning head 410 further includes:

a fixed area 411 connected to the bottom of the supporting platform 422 by at least one assembly area 4224 and configured to clean at least part of the operation surface with the movement of the supporting platform 422.

[0020] Optionally, the cleaning head 410 further includes:

a flexible connection part 413 disposed between the fixed area 411 and the movable area 412 and configured to connect the fixed area 411 to the movable area 412.

[0021] Optionally, the cleaning head 410 further includes:

a sliding buckle 414 extending along an edge of the cleaning head 410 and detachably mounted on the supporting platform 422.

[0022] Optionally, a lifting module is disposed between the cleaning module 150 and the mobile platform 100.

[0023] Optionally, the dry cleaning module 151 is connected to the mobile platform 100 by a passive lifting module.

[0024] Optionally, the wet cleaning module 400 is connected to the mobile platform 100 by an active lifting module.

[0025] Compared with the prior art, the embodiments of the present invention have the following technical effects.

[0026] The present invention provides a sweeping and mopping integrated cleaning apparatus, which can achieve a more comprehensive cleaning function because the cleaning module of the automatic cleaning apparatus is provided with both the dry cleaning module and the wet cleaning module. Meanwhile, in the wet cleaning module, by adding the driving unit and a vibration area, the cleaning head can reciprocate to repeatedly clean the surface to the cleaned. Therefore, in the movement trajectory of the cleaning robot, a certain area can be cleaned several times when the cleaning robot passes through this area just one time, thereby greatly improving the cleaning effect, and the cleaning effect is obvious especially for areas with more stains.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] The accompanying drawings herein, which are incorporated in and constitute a part of the description, illustrate embodiments consistent with the present invention and, together with the description, serve to explain the principles of the present invention. Apparently, the accompanying drawings in the following descriptions show merely some embodiments of the present invention, and a person of ordinary skill in the art may still derive other drawings from these accompanying drawings without creative efforts. In the accompanying drawings:

FIG. 1 is an oblique view of an automatic cleaning apparatus according to an embodiment of the present invention;

FIG. 2 is a schematic diagram of a bottom structure of an automatic cleaning apparatus according to an embodiment of the present invention;

FIG. 3 is an oblique view of a lateral driving wheel assembly according to an embodiment of the present invention;

FIG. 4 is a front view of a lateral driving wheel assembly according to an embodiment of the present invention;

FIG. 5 is an oblique view of a dust box according to an embodiment of the present invention;

FIG. 6 is an oblique view of a fan according to an embodiment of the present invention;

FIG. 7 is a schematic diagram of a dust box in an open state according to an embodiment of the present invention;

FIG. 8 is a schematic diagram of a dust box and a fan in an assembled state according to an embodiment of the present invention;

FIG. 9 is an exploded view of an automatic cleaning apparatus according to an embodiment of the present invention;

FIG. 10 is a structural diagram of a supporting platform of an automatic cleaning apparatus according to an embodiment of the present invention;

FIG. 11 is a structural diagram of a vibrator of an automatic cleaning apparatus according to an embodiment of the present invention;

FIG. 12 is a schematic diagram of a cleaning-head driving mechanism based on a crank-slider mechanism according to another embodiment of the present invention;

FIG. 13 is a schematic diagram of a cleaning-head driving mechanism based on a double-crank mechanism according to another embodiment of the present invention;

FIG. 14 is a schematic diagram of a cleaning-head driving mechanism based on a crank mechanism according to another embodiment of the present inven-

tion;

FIG. 15 is a structural diagram of a vibrator according to an embodiment of the present invention;

FIG. 16 is a schematic structural diagram of the assembly of a cleaning substrate according to an embodiment of the present invention;

FIG. 17 is a structural diagram of a clean water pump being driven by a motor according to an embodiment of the present invention; and

FIG. 18 is a structural diagram of a lifting module being driven by a motor according to an embodiment of the present invention.

[0028] Reference numbers in the drawings are described as below:

mobile platform 100; backward portion 110; forward portion 111; perception system 120; position-determining device 121; buffer 122; cliff sensor 123; control system 130; driving system 140; driving wheel assembly 141; steering component 142; elastic element 143; driving motor 146; cleaning module 150; dry cleaning module 151; dust box 152; filter screen 153; dust-suction inlet 154; air outlet 155; fan 156; energy system 160; human-machine interaction system 170; wet cleaning module 400; cleaning head 410; driving unit 420; driving platform 421; supporting platform 422; motor 4211; driving wheel 4212; vibrator 4213; connecting rod 4214; vibration-buffering device 4215; clamping jaw 4216; clean water pump pipe 4218; clean water pump 4219; cleaning substrate 4221; elastic removal button 4229; assembly area 4224; clamping position 4225; first sliding groove 4222; second sliding groove 4223; first slider 525; second slider 528; swiveling end 512 (4227); sliding end 514 (4226); first pivot 516 (624); second pivot 518 (626); and driving mechanism 500 (600, 700).

DETAILED DESCRIPTION

[0029] For clearer descriptions of the objects, technical solutions, and advantages of the present invention, the present invention will be further described in detail with reference to the accompanying drawings. Apparently, the described embodiments are merely a part of the embodiments of the present invention rather than all of the embodiments. All other embodiments obtained by a person of ordinary skill in the art based on the embodiments of the present invention without any creative efforts shall fall within the protection scope of the present invention.

[0030] The terms used in the embodiments of the present invention are only for the purpose of describing specific embodiments but are not intended to limit the present invention. The singular forms "a," "the" and "said" used in the embodiments and the appended claims of the present invention are intended to include the plural forms as well, unless otherwise clearly specified in the context. "A plurality of" generally includes at least two.

[0031] It should be understood that the term "and/or" used herein only describes the associated relationship of the associated objects, indicating three kinds of relationships. For example, A and/or B can represent that A exists alone, A and B exist concurrently, and B exists alone. In addition, the character "/" herein generally indicates that the contextual objects are in an "or" relationship.

[0032] It should be understood that although the terms first, second, third, etc. may be used in the embodiments of the present invention to describe certain objects, these objects should not be limited by these terms. These terms are merely used to distinguish the objects. For example, a first object may also be referred to as a second object, and, similarly, a second object may also be referred to as a first object, without departing from the scope of the embodiments of the present invention.

[0033] It should also be noted that the terms "comprise," "include" or any other variants are intended to cover the nonexclusive containing, such that the commodities or devices including a series of elements not only include those elements but also include other unclearly listed elements, or also include the inherent elements of such commodities or devices. Without more limitations, the element defined by the phrase "comprising a ..." does not exclude the existence of other identical elements in the commodity or device that includes such an element.

[0034] Alternative embodiments of the present invention will be described in detail below with reference to the accompanying drawings.

[0035] FIGs. 1 and 2 are schematic structural diagrams of an automatic cleaning apparatus according to an exemplary embodiment. As shown in FIGs. 1 and 2, the automatic cleaning apparatus may be a vacuum cleaning robot, a mopping/brushing robot, a window-climbing robot, or the like. The automatic cleaning apparatus may include a mobile platform 100, a perception system 120, a control system 130, a driving system 140, a cleaning module 150, an energy system 160, and a human-machine interaction system 170.

[0036] The mobile platform 100 may be configured to automatically move on an operation surface in a target direction. The operation surface may be a surface to be cleaned by the automatic cleaning apparatus. In some embodiments, the automatic cleaning apparatus may be a mopping robot, in which case the automatic cleaning apparatus works on a floor and the floor serves as the operation surface; the automatic cleaning apparatus may also be a window-cleaning robot, in which case the automatic cleaning apparatus works on the exterior surface of glass of a building and the glass serves as the operation surface; and the automatic cleaning apparatus may also be a pipeline-cleaning robot, in which case the automatic cleaning apparatus works on the interior surface of a pipeline and the interior surface of the pipeline serves as the operation surface. Merely for the purpose of illustration, the following descriptions of the present application are given by taking a mopping robot as an example.

[0037] In some embodiments, the mobile platform 100 may be an autonomous mobile platform or a non-auton-

omous mobile platform. The autonomous mobile platform means that the mobile platform 100 itself can automatically and adaptively make operation decisions according to unexpected environmental inputs, while the non-autonomous mobile platform itself, instead of adaptively making operation decisions according to unexpected environmental inputs, can execute given programs or run according to a certain logic. Correspondingly, in the case that the mobile platform 100 is the autonomous mobile platform, the target direction may be autonomously determined by the automatic cleaning apparatus; and, in the case that the mobile platform 100 is the non-autonomous mobile platform, the target direction may be set systematically or manually. The mobile platform 100 includes a forward portion 111 and a backward portion 110 when the mobile platform 100 is the autonomous mobile platform.

[0038] The perception system 120 includes a position-determining device 121 located above the mobile platform 100, a buffer 122 located on the forward portion 111 of the mobile platform 100, and sensing devices such as a cliff sensor 123, an ultrasonic sensor (not shown in the figures), an infrared sensor (not shown in the figures), a magnetometer (not shown in the figures), an accelerometer (not shown in the figures), a gyroscope (not shown in the figures) and an odometer (not shown in the figures), which are located at the bottom of the mobile platform for providing various position information and motion-state information of the machine for the control system 130.

[0039] For clearer descriptions of the actions of the automatic cleaning apparatus, the following directions are defined: the automatic cleaning apparatus may travel on the floor by various combinations of movement relative to the following three perpendicular axes defined by the mobile platform 100: a transverse axis x, a front-back axis y, and a central vertical axis z. A forward driving direction along the front-back axis y is marked as "forward," and a backward driving direction along the front-back axis y is marked as "backward." The transversal axis x extends substantially between a right wheel and a left wheel of the automatic cleaning apparatus along an axis center defined by the center point of a driving wheel assembly 141. The automatic cleaning apparatus may rotate about the axis x. It is called "pitch up" when the forward portion of the automatic cleaning apparatus is tilted up and the backward portion thereof is tilted down, and it is called "pitch down" when the forward portion of the automatic cleaning apparatus is tilted down and the backward portion thereof is tilted up. In addition, the automatic cleaning apparatus may rotate around the axis z. In the forward direction of the automatic cleaning apparatus, it is called "turn right" when the automatic cleaning apparatus is tilted to the right of the axis y, and it is called "turn left" when the automatic cleaning apparatus is tilted to the left of the axis y.

[0040] As shown in FIG. 2, the cliff sensors 123 are disposed at the bottom of the mobile platform 100 and in front and rear of the driving wheel assembly 141 and configured to prevent the automatic cleaning apparatus from falling off when the automatic cleaning apparatus moves back, so as to protect the automatic cleaning apparatus against damage. The aforementioned "front" refers to the side in the same direction as the traveling direction of the automatic cleaning apparatus, and the aforementioned "rear" refers to the side in a direction opposite to the traveling direction of the automatic cleaning apparatus.

[0041] The position-determining device 121 includes, but is not limited to, a camera and a laser distance sensor (LDS).

[0042] The various components in the perception system 120 may work independently or jointly to achieve intended functions more accurately. The surface to be cleaned is identified by the cliff sensor 123 and the ultrasonic sensor to determine the physical properties, including surface materials, the degree of cleanliness, etc., of the surface to be cleaned, and may be more accurately determined in combination with the camera and the LDS, etc.

[0043] For example, whether the surface to be cleaned is a carpet may be determined by the ultrasonic sensor, and, if the ultrasonic sensor determines that the surface to be cleaned is made of a carpet material, the control system 130 controls the automatic cleaning apparatus to conduct carpet-mode cleaning.

[0044] The buffer 122 is disposed on the forward portion 111 of the mobile platform 100. The buffer 122 detects one or more events (or objects) in a travel path of the automatic cleaning apparatus via the perception system (for example, an infrared sensor) when the driving wheel assembly 141 propels the automatic cleaning apparatus to walk on the floor in the process of cleaning. The automatic cleaning apparatus may control, according to the events (or objects), such as an obstacle and a wall, detected by the buffer 122, the driving wheel assembly 141 to make the automatic cleaning apparatus respond to the events (or objects), for example, moving away from the obstacle.

[0045] The control system 130 is disposed on a main circuit board in the mobile platform 100 and includes a computing processor, such as a central processing unit or an application processor, that communicates with non-temporary memories such as a hard disk, a flash memory and a random-access memory. The application processor is configured to receive environmental information sensed by the plurality of sensors and transmitted from the perception system 120 to draw, by using a positioning algorithm (for example, SLAM) according to obstacle information fed back by the laser distance sensor, a simultaneous map of an environment where the automatic cleaning apparatus is located, autonomously determine the travel path according to the environmental information and the environmental map, and then control the driving system 140 to move forward, backward and/or turn according to the autonomously determined travel

path. Further, the control system 130 may also determine, according to the environmental information and the environmental map, whether to activate the cleaning module 150 to perform a cleaning operation.

[0046] Specifically, the control system 130 may comprehensively determine a current working state (such as crossing a threshold, getting on a carpet, being at a cliff, being stuck from above or below, having a full dust box or being picked up) of the sweeping robot according to distance information and speed information fed back by the buffer 122 and the sensing devices such as the cliff sensor 123, the ultrasonic sensor, the infrared sensor, the magnetometer, the accelerometer, the gyroscope and the odometer, and may also give specific strategies for next actions according to different situations, making the work of the automatic cleaning apparatus more in line with the requirements of an owner and achieving a better user experience. Furthermore, the control system may plan the most efficient and reasonable cleaning path and cleaning mode based on the information of the simultaneous map drawn by SLAM, which greatly improves the cleaning efficiency of the automatic cleaning apparatus.

[0047] The driving system 140 may execute a driving command based on specific distance and angle information, such as x, y and θ components, and thus control the automatic cleaning apparatus to travel across the floor. FIGs. 3 and 4 are, respectively, an oblique view and a front view of a lateral driving wheel assembly 141 according to an embodiment of the present invention. As shown in the figures, the driving system 140 includes a driving wheel assembly 141 and may control a left wheel and a right wheel simultaneously. In order to control the movement of the automatic cleaning apparatus more accurately, the driving system 140 preferably includes a left driving wheel assembly and a right driving wheel assembly that are symmetrically arranged along a transverse axis defined by the mobile platform 100. The driving wheel assembly includes a body part, a driving wheel and an elastic element. One end of the body part is connected to a rack. The driving wheel is disposed on the body part and driven by a driving motor 146. The elastic element is connected between the body part and the rack and configured to provide an elastic force between the rack and the body part. The driving motor 146 is located on the outer side of the driving wheel assembly 141, and an axis of the driving motor 146 is located within a cross-sectional projection of the driving wheel. The driving wheel assembly 141 may also be connected to a circuit for measuring a driving current and an odometer.

[0048] For more stable movement on the floor or higher movement ability of the automatic cleaning apparatus, the automatic cleaning apparatus may include one or more steering components 142, which may be driven wheels or driving wheels and may structurally include but are not limited to universal wheels. The steering component 142 may be located in front of the driving wheel assembly 141.

[0049] The driving motor 146 provides power for rotation of the driving wheel assembly 141 and/or the steering component 142.

[0050] The driving wheel assembly 141 may be detachably connected to the mobile platform 100, and it is thus convenient to dismount, mount and maintain. The driving wheel may be provided with an offset drop-suspension system, which is movably fastened, for example, rotatably attached, to the mobile platform 100 of the automatic cleaning apparatus and maintains contact and traction with the floor with a certain ground-adhering force by the elastic element 143, such as a tension spring or a compression spring. Meanwhile, with a certain pressure, the cleaning module 150 of the automatic cleaning apparatus is also in contact with the surface to be cleaned.

[0051] The energy system 160 includes a rechargeable battery, such as a nickel-hydrogen battery and a lithium battery. The rechargeable battery may be connected to a charging control circuit; a battery pack-charging, temperature-detecting circuit; and a battery-undervoltage monitoring circuit, which are then connected to a single-chip microcomputer control circuit. A host of the automatic cleaning apparatus is connected to a charging pile by a charging electrode disposed on a side of or below the body of the automatic cleaning apparatus for charging. If the exposed charging electrode is covered with dust, due to the accumulative effect of charges in the process of charging, a plastic body around the electrode will be melted and deformed, and even the electrode itself will be deformed and thus unable to continue to normally charge the automatic cleaning apparatus.

[0052] The human-machine interaction system 170 includes buttons on a panel of the host for a user to select functions and may further include a display screen and/or an indicator light and/or a speaker, as well as a mobile phone client program. The display, the indicator light and the speaker show the user the current status or function options of the automatic cleaning apparatus. For a route-navigation-type cleaning apparatus, a mobile phone client may show the user a map of the environment where the apparatus is located, as well as the location of the apparatus, thereby providing the user with richer and more user-friendly function items.

[0053] The cleaning module 150 may include a dry cleaning module 151 and/or a wet cleaning module 400.

[0054] As shown in FIGs. 5-8, the dry cleaning module 151 includes a roller brush, a dust box, a fan, and an air outlet. The roller brush with certain interference with the floor sweeps up debris on the floor and rolls it up to the front of a dust-suction inlet between the roller brush and the dust box, and then the debris is sucked into the dust box by a gas with a suction force that is generated by the fan and passes through the dust box. The dust-removal capacity of the sweeping robot can be characterized by the dust pickup (DPU) efficiency of the debris, which is affected by the structure and the material of the roller brush, the utilization rate of air in an air passage formed by the dust-suction inlet, the dust box, the fan, the air

outlet and connecting parts among the dust-suction inlet, the dust box, the fan and the air outlet, and the type and the power of the fan, and thus is a complex problem of system design. The improvement of dust-removal capacity is of greater significance to the energy-limited automatic cleaning apparatus than an ordinary plug-in vacuum cleaner. This is because the improvement of the dust-removal capacity directly and effectively reduces the demand for energy, i.e., an original cleaning apparatus capable of cleaning 80 square meters of the floor with one charge may be improved to clean 180 square meters or more with one charge. In addition, the service life of a battery with a reduced number of charging times may be greatly prolonged, such that the frequency of replacing the battery by the user may be reduced. More intuitively and importantly, the improvement of the dust-removal capacity is the most obvious and important user experience because the user can directly draw a conclusion about whether the thorough sweeping/mopping is achieved. The dry cleaning module may further include a side brush, provided with a rotating shaft angled with respect to the floor, for moving the debris into a roller-brush area of the cleaning module 150.

[0055] FIG. 5 is a schematic structural diagram of a dust box 152 in the dry cleaning module, FIG. 6 is a schematic structural diagram of a fan 156 in the dry cleaning module, FIG. 7 is a schematic diagram of the dust box 152 in an open state, and FIG. 8 is a schematic diagram of the dust box and the fan in an assembled state.

[0056] The roller brush, with certain interference with the floor, sweeps up the debris on the floor and rolls it up to the front of the dust-suction inlet 154 between the roller brush and the dust box 152, then the debris is sucked into the dust box 152 by a gas with a suction force that is generated by the fan 156 and passes through the dust box 152. The debris is isolated on the side, close to the dust-suction inlet 154, in the dust box 152 by a filter screen 153. The filter screen 153 completely isolates the dust-suction inlet 154 from the air outlet 155, and air enters the fan 156 through the air outlet 155 after being filtered.

[0057] Typically, the dust-suction inlet 154 of the dust box 152 is located in front of the automatic cleaning apparatus, the air outlet 155 is located on a side of the dust box 152, and an air-suction inlet of the fan 156 is docked with the air outlet of the dust box.

[0058] A front panel of the dust box 152 may be opened for cleaning the debris inside the dust box 152.

[0059] The filter screen 153 is detachably connected to the body of the dust box 152 and is thus convenient to remove and clean.

[0060] According to a specific embodiment of the present invention, as shown in FIGs. 9-11, the wet cleaning module 400 provided by the present invention is configured to clean at least part of the operation surface in a wet cleaning manner. The wet cleaning module 400 includes a cleaning head 410 and a driving unit 420. The cleaning head 410 is configured to clean at least part of the operation surface, and the driving unit 420 is configured to drive the cleaning head 410 to substantially reciprocate along a target surface that is a part of the operation surface. The cleaning head 410 reciprocates along the surface to be cleaned. A cleaning cloth or a cleaning plate is disposed on a surface of the cleaning head 410 in contact with the surface to be cleaned, and it generates high-frequency friction with the surface to be cleaned by the reciprocating motion thereof, such that stains on the surface to be cleaned are removed.

[0061] The higher the friction frequency is, the larger the number of friction times per unit time is. The high-frequency reciprocating motion, also known as reciprocating vibration, has a cleaning ability much higher than that of an ordinary reciprocating motion, such as rotational friction cleaning. Optionally, the friction frequency is approximate to the frequency of sound waves, and the cleaning effect may be much higher than that of rotational friction cleaning with dozens of revolutions per minute. On the other hand, tufts on the surface of the cleaning head may spread more neatly in the same direction under shaking of high-frequency vibration, such that the overall cleaning effect is more uniform, rather than that under the condition of low-frequency rotation in which only downward pressure is applied to increase a friction force to improve the cleaning effect, since the downward pressure alone may not make the tufts spread in approximately the same direction. Therefore, in terms of the effect, water marks on the operation surface cleaned by high-frequency vibration are more uniform, and no chaotic water stains will be left.

[0062] The reciprocating motion may be either repeated motion in any one or more directions within the operation surface or vibration motion perpendicular to the operation surface, which is not strictly limited. Optionally, the reciprocating direction of the cleaning module is substantially perpendicular to the traveling direction of the automatic cleaning apparatus because the reciprocating direction parallel to the traveling direction of the automatic cleaning apparatus may cause the automatic cleaning apparatus itself, which is traveling, to be unstable for the reason that thrust and resistance in the traveling direction may make the driving wheel skid easily, and the impact of skid is more obvious when the wet cleaning module is included since the slippery operation surface increases the possibility of skid. The skid not only adversely affects the smooth traveling for cleaning of the automatic cleaning apparatus, but it also leads to inaccurate distance measurement by the odometer, the gyroscope and other sensors, and thus disables the navigation-type automatic cleaning apparatus from accurately locating and drawing maps. In the case of frequent skid, the impact on SLAM may not be ignored, so it is necessary to prevent the automatic cleaning apparatus from skidding as much as possible. In addition to skid, a motion component of the cleaning head in the traveling direction of the automatic cleaning apparatus makes the automatic cleaning apparatus constantly push forward and backward when the

automatic cleaning apparatus travels, and, as a result, the automatic cleaning apparatus may travel unstably.

[0063] As an alternative embodiment of the present invention, as shown in FIG. 9, the driving unit 420 includes a driving platform 421 connected to the bottom surface of the mobile platform 100 and configured to provide a driving force; and a supporting platform 422 detachably connected to the driving platform 421, configured to support the cleaning head 410 and being capable of ascending and descending under the driving of the driving platform 421.

[0064] As an alternative embodiment of the present invention, a lifting module is disposed between the cleaning module 150 and the mobile platform 100 so that the cleaning module 150 is in better contact with the surface to be cleaned or different cleaning strategies are used for surfaces made of different materials to be cleaned.

[0065] Optionally, the dry cleaning module 151 may be connected to the mobile platform 100 by a passive lifting module, and, when the cleaning apparatus encounters an obstacle, the dry cleaning module 151 may pass over the obstacle more conveniently by the lifting module.

[0066] Optionally, the wet cleaning module 400 may be connected to the mobile platform 100 by an active lifting module. When the wet cleaning module 400 is temporarily not involved in the work or encounters a surface to be cleaned that cannot be cleaned by the wet cleaning module 400, the wet cleaning module 400 is lifted by means of the active lifting module and separated from the surface to be cleaned, thereby achieving a change of the cleaning means.

[0067] As shown in FIGs. 10-11, the driving platform 421 includes a motor 4211 disposed on the side of the driving platform 421 close to the mobile platform 100 and outputting power by a motor output shaft; a driving wheel 4212 connected to the motor output shaft and being of an asymmetrical structure; and a vibrator 4213 disposed on the side of the driving platform 421 opposite to the motor 4211, connected to the driving wheel 4212, and reciprocating under the asymmetric rotation of the driving wheel 4212.

[0068] The driving platform 421 may further include a gear mechanism. The gear mechanism may be connected to the motor 4211 and the driving wheel 4212. The motor 4211 may directly drive the driving wheel 4212 to swivel, or it may indirectly drive the driving wheel 4212 to swivel by the gear mechanism. It can be understood by a person of ordinary skill in the art that the gear mechanism may be one gear, or a gear set consisting of a plurality of gears.

[0069] The motor 4211 transmits power to the cleaning head 410, the driving platform 421, the supporting platform 422, a water-delivery mechanism, a water tank, etc., simultaneously by a power transmission device. The energy system 160 provides power and energy for the motor 4211 and is entirely controlled by the control system 130. The power transmission device may be a gear drive, a chain drive, or a belt drive, and may also be a worm gear or the like.

[0070] The motor 4211 has a forward output mode and a reverse output mode. In the forward output mode, the motor 4211 rotates forward, and, in the reverse output mode, the motor 4211 rotates reversely. In the forward output mode of the motor 4211, the motor 4211 may drive, by the power transmission device, the vibrator 4213 of the driving platform in the wet cleaning module 400 to substantially reciprocate and the water-delivery mechanism to move synchronously. In the reverse output mode of the motor 4211, the motor 4211 drives the driving platform 421 to ascend and descend by the power transmission device.

[0071] Further, the driving platform 421 further includes a connecting rod 4214 extending along an edge of the driving platform 421 and connecting the driving wheel 4212 to the vibrator 4213 such that the vibrator 4213 extends to a preset position. The vibrator 4213 extends perpendicular to the connecting rod 4214, such that the reciprocating direction of the vibrator 4213 is substantially perpendicular to the traveling direction of the machine.

[0072] The motor 4211 is connected to the driving wheel 4212, the vibrator 4213, the connecting rod 4214 and a vibration-buffering device 4215 by the power transmission device. The vibrator 4213 and the connecting rod 4214 constitute an approximately L-shaped structure, as shown in FIG. 15, and the vibrator 4213 is driven to reciprocate by the connecting rod 4214. The vibration-buffering device 4215 serves to damp the vibration and reduce the shake of the motion behavior driven by the driving wheel 4212 so that the vibrator 4213 vibrates smoothly within the range of motion provided by the supporting platform 422. Optionally, the vibration-buffering device 4215 is made of a soft material, is optionally of a rubber structure, and sleeves the connecting rod 4214. On the other hand, the vibration-buffering device 4215 may also protect the vibrator 4213 from being damaged due to collision with the driving platform 421, and, in turn, affects the reciprocating motion of the vibrator 4213. A movable part and a fixed part of the driving platform 421 are connected in a less-flexible way in the traveling direction of the automatic cleaning apparatus to restrict the movement, and connected in a flexible way in a direction (i.e., a vibration direction of the vibrator 4213) approximately perpendicular to the traveling direction to allow the movement. The above motion restriction of the two parts enables the vibrator 4213 to reciprocate substantially but not exactly. When the wet cleaning module 400 is activated, the motor 4211 starts to rotate forward, and the motor 4211 drives, by the driving wheel 4212, the connecting rod 4214 to reciprocate along the surface of the driving platform 421. At the same time, the vibration-buffering device 4215 drives the vibrator 4213 to substantially reciprocate along the surface of the driving platform 421, the vibrator 4213 drives the cleaning substrate 4221 to substantially reciprocate along the surface of the supporting platform 422, and the cleaning substrate 4221

drives the movable area 412 to substantially reciprocate along the surface to be cleaned. At this time, clean water flows out of a clean water tank by means of a clean water pump and is sprinkled onto the cleaning head 410 by a water-discharge device 4217, and the surface to be cleaned is cleaned by the cleaning head 410 through reciprocating motion.

[0073] The cleaning intensity/efficiency of the automatic cleaning apparatus may also be automatically and dynamically adjusted according to the working environment of the automatic cleaning apparatus. For example, the automatic cleaning apparatus may be dynamically adjusted according to physical information of the surface to be cleaned that is detected by the perception system 120. For example, the perception system 120 may detect such information as the flatness, the material and the presence of oil and dust of the surface to be cleaned, then transmit the information to the control system 130 of the automatic cleaning apparatus. Correspondingly, the control system 130 may instruct the automatic cleaning apparatus to automatically and dynamically adjust the rotational speed of the motor and the transmission ratio of the power transmission device according to the working environment of the automatic cleaning apparatus, and thus to adjust the preset reciprocation cycle of the reciprocating motion of the cleaning head 410.

[0074] For example, when the automatic cleaning apparatus works on a flat floor, the preset reciprocation cycle may be automatically and dynamically adjusted to be longer, and the water flow of the water pump may be automatically and dynamically adjusted to be lower; and, when the automatic cleaning apparatus works on a less flat floor, the preset reciprocation cycle may be automatically and dynamically adjusted to be shorter, and the water flow of the water pump may be automatically and dynamically adjusted to be higher. This is because it is easier to clean the flat floor than the less flat floor, so cleaning the uneven floor requires the reciprocating motion of the cleaning head 410 at a higher speed (i.e., higher frequency) and a higher water flow.

[0075] For another example, when the automatic cleaning apparatus works on a table, the preset reciprocation cycle may be automatically and dynamically adjusted to be longer and the water flow of the water pump may be automatically and dynamically adjusted to be lower; and, when the automatic cleaning apparatus 100 works on a floor, the preset reciprocation cycle may be automatically and dynamically adjusted to be shorter and the water flow of the pump may be automatically and dynamically adjusted to be higher. This is because, as compared with the floor, the table has less dust and oil and is made of a material easier to clean. Therefore, the table can be cleaned with a fewer number of reciprocating motions of the cleaning head 410 and a lower water flow of the water pump.

[0076] As an alternative embodiment of the present invention, the supporting platform 422 includes a cleaning substrate 4221 freely movably disposed on the supporting platform 422, and the cleaning substrate 4221 substantially reciprocates under the vibration of the vibrator 4213. Optionally, as shown in FIG. 16, the cleaning substrate 4221 includes an assembly notch 42211 disposed at a position in contact with the vibrator 4213, and the vibrator 4213 is assembled in the assembly notch 42211 when the supporting platform 422 is connected to the driving platform 421, such that the cleaning substrate 4221 may substantially reciprocate synchronously with the vibrator 4213. Four first limiting positions 42212 are included in the traveling direction of the cleaning apparatus of the cleaning substrate 4221, and the four first limiting positions 42212 are flexibly connected to the cleaning substrate 4221 with a small elastic scaling space, thereby limiting the movement of the cleaning substrate 4221 relative to the supporting platform 422 in the traveling direction of the cleaning apparatus. Two second limiting positions 42213 are included in a direction perpendicular to the traveling direction of the cleaning apparatus of the cleaning substrate 4221, and the two second limiting positions 42213 limit the range of the reciprocating motion of the cleaning substrate 4221 in the direction perpendicular to the traveling direction of the cleaning apparatus. In addition, a water discharge hole 42214 is disposed near the assembly notch 42211 of the cleaning substrate 4221, allowing water flowing out of the water-discharge device 4217 to flow to the cleaning head 410 through the water-discharge hole. The motion of the cleaning substrate 4221 is substantially reciprocating motion under the impact of the limiting positions and the vibration-buffering device. The cleaning substrate 4221 is located on a part of the supporting platform 422, and the vibration frequency may be made higher by local vibration, for example, up to a frequency range of sound waves. The movable part and the fixed part of the driving platform 421 are connected in a less-flexible way in the traveling direction of the automatic cleaning apparatus to restrict the movement, and they are connected in a flexible way in a direction (i.e., a vibration direction of the vibrator 4213) approximately perpendicular to the traveling direction to allow the movement.

[0077] FIG. 12 illustrates another cleaning head driving mechanism 500 based on a crank-slider mechanism according to various embodiments of the present application. The driving mechanism 500 is applicable to the driving platform 421. The driving mechanism 500 includes a driving wheel 4212, a vibrator 4213, a cleaning substrate 4221, a sliding groove 4222 (a first sliding groove), and a sliding groove 4223 (a second sliding groove).

[0078] The sliding grooves 4222 and 4223 are formed in the supporting platform 422. A slider 525 (a first slider) and a slider 528 (a second slider) are disposed at two ends of the cleaning substrate 4221, respectively. Each of the sliders 525 and 528 is a projection at each of the two ends of the cleaning substrate 4221. The slider 525 is inserted into and slidable along the sliding groove 4222; and the slider 528 is inserted into and slidable along the sliding groove 4223. In some embodiments, the sliding

groove 4222 is on the same straight line as the sliding groove 4223. In some embodiments, the sliding groove 4222 is not on the same straight line as the sliding groove 4223. In some embodiments, the sliding groove 4222 and the sliding groove 4223 extend in the same direction. In some embodiments, the sliding groove 4222 and the sliding groove 4223 extend in the same direction as the cleaning substrate 4221. In some embodiments, the sliding groove 4222 and the sliding groove 4223 extend in a different direction from the cleaning substrate 4221. In some embodiments, the sliding groove 4222 and the sliding groove 4223 extend in different directions. For example, as shown in FIG. 12, the sliding groove 4222 and the cleaning substrate 4221 extend in the same direction, while the extending direction of the sliding groove 4223 forms a certain angle with that of the sliding groove 4222.

[0079] The vibrator 4213 includes a swiveling end 512 and a sliding end 514. The swiveling end 512 is connected to the driving wheel 4212 by a first pivot 516, and the sliding end 514 is connected to the cleaning substrate 4221 by a second pivot 518.

[0080] The rotation center of the driving wheel 4212 is a point O, and the pivot center of the first pivot 516 is a point A. The point O does not coincide with the point A, and the distance therebetween is a preset distance d.

[0081] When the driving wheel 4212 rotates, the point A swivels circularly with it. Correspondingly, the swiveling end 512 swivels circularly with the point A; and the sliding end 514 drives, by the second pivot 518, the cleaning substrate 4221 to slide. Correspondingly, the slider 525 of the cleaning substrate 4221 reciprocates linearly along the sliding groove 4222; and the slider 528 reciprocates linearly along the sliding groove 4223. In FIG. 4, the moving speed of the mobile platform 100 is V0 and the moving direction thereof is a target direction. According to some embodiments, the overall displacement of the cleaning substrate 4221 is substantially perpendicular to the target direction when the sliding grooves 4223 and 4222 are approximately perpendicular to the moving direction of the mobile platform 100. According to some other embodiments, when either of the sliding grooves 4223 or 4222 forms an angle other than 90 degrees with the target direction, the overall displacement of the cleaning substrate 4221 includes a component perpendicular to the target direction and a component parallel to the target direction.

[0082] Further, a vibration-buffering device 4215 is included, disposed on the connecting rod 4214, and configured to mitigate the vibration in a particular direction. In this embodiment, the vibration-buffering device is configured to reduce the vibration in a moving component direction perpendicular to the target direction of the automatic cleaning apparatus.

[0083] FIG. 13 illustrates another cleaning head driving mechanism 600 based on a double-crank mechanism according to various embodiments of the present application. The driving mechanism 600 is applicable to the driving platform 421. The driving mechanism 600 includes a driving wheel 4212 (a first driving wheel), a driving wheel 4212' (a second driving wheel) and a cleaning substrate 4221.

[0084] The cleaning substrate 4221 has two ends; a first end thereof is connected to the driving wheel 4212 by a pivot 624 (a first pivot), and a second end thereof is connected to the driving wheel 4212' by a pivot 626 (a second pivot). The rotation center of the driving wheel 4212 is a point O and the pivot center of the pivot 624 is a point A. The point O does not coincide with the point A, and the distance therebetween is a preset distance d. The rotation center of the driving wheel 4212' is a point O' and the pivot center of the pivot axis 626 is a point A'. The point O' does not coincide with the point A', and the distance therebetween is a preset distance d. In some embodiments, the point A, the point A', the point O and the point O' are located on the same plane. Thus, the driving wheel 4212, the driving wheel 4212' and the cleaning substrate 4221 may form the double-crank mechanism (or a parallelogram mechanism) in which the cleaning substrate 4221 is used as a coupling rod and the driving wheels 4212 and 4212' serve as two cranks.

[0085] Further, a vibration-buffering device 4215 is included, disposed on the connecting rod 4214, and configured to mitigate the vibration in a particular direction. In this embodiment, the vibration-buffering device is configured to reduce the vibration in a moving component direction perpendicular to the target direction of the automatic cleaning apparatus.

[0086] FIG. 14 illustrates a driving mechanism 700 based on a crank-slider mechanism according to various embodiments of the present application. The driving mechanism 700 is applicable to the driving platform 421. The driving mechanism 700 includes a driving wheel 4212, a cleaning substrate 4221 and a sliding groove 4222.

[0087] The sliding groove 4222 is formed in the supporting platform 422. The cleaning substrate 4221 includes a swiveling end 4227 and a sliding end 4226. The swiveling end 4227 is connected to the driving wheel 4212 by a pivot 4228. The rotation center of the driving wheel 4212 is a point O, and the pivot center of the pivot 4228 is a point A. The point O does not coincide with the point A, and the distance therebetween is a preset distance d. The sliding end 4226 includes a slider 4225, which is a projection on the sliding end 4226. The slider 4225 is inserted into and slidable along the sliding groove 4222. Thus, the driving wheel 4221, the cleaning substrate 4221, the slider 4225 and the sliding groove 4222 constitute the crank-slider mechanism.

[0088] When the driving wheel 4212 rotates, the point A swivels circularly. Correspondingly, the swiveling end 4227 of the cleaning substrate 4221 swivels circularly with the point A, and the slider 4225 slides in the sliding groove 4222 and reciprocates linearly. As a result, the cleaning substrate 4221 starts to reciprocate. According to some embodiments, the sliding groove 4222 is approximately perpendicular to the target direction of the mobile

platform, such that the linear motion of the sliding end 4226 includes a component perpendicular to the target direction, and the circular swiveling motion of the swiveling end 4227 includes both a component perpendicular to the target direction and a component parallel to the target direction.

[0089] In FIG. 14, the moving speed of the mobile platform is V0 and the moving direction thereof is the target direction; and the sliding groove 4222 is approximately perpendicular to the target direction. At this time, the overall reciprocating motion of the cleaning substrate 4221 includes not only a moving component parallel to the target direction of the automatic cleaning apparatus but also a moving component perpendicular to the target direction of the automatic cleaning apparatus.

[0090] Further, the supporting platform 422 further includes an elastic removal button 4229, which is disposed on at least one side of the supporting platform 422 and configured to detachably connect the supporting platform 422 to a clamping jaw 4216 of the driving platform 421 such that the supporting platform 422 is detachably and mechanically secured to the driving platform 421 and fixed relative to the driving platform and the automatic cleaning apparatus. At least one assembly area 4224 is disposed on the supporting platform 422 and configured for assembly of the cleaning head 410. The assembly area 4224 may be made from a bonding material having a bonding layer.

[0091] As an alternative embodiment of the present invention, as shown in FIG. 9, the cleaning head 410 includes a movable area 412 connected to the cleaning substrate 4221 and substantially reciprocating along a surface to be cleaned under the driving of the cleaning substrate 4221. The movable area 412 is disposed at a substantially central position of the cleaning head 410.

[0092] Optionally, a bonding layer is disposed on the side of the movable area 412 connected to the cleaning substrate 4221, and the movable area 412 is connected to the cleaning substrate 4221 by the bonding layer.

[0093] Optionally, the cleaning head 419 further includes a fixed area 411 connected to the bottom of the supporting platform 422 by at least one assembly area 4224 and cleaning at least part of the operation surface with the movement of the supporting platform 422.

[0094] Further, the cleaning head 410 further includes a flexible connection part 413 disposed between the fixed area 411 and the movable area 412 and configured to connect the fixed area 411 to the movable area 412. The cleaning head 410 further includes a sliding buckle 414 extending along an edge of the cleaning head 410 and detachably mounted in a clamping position 4225 of the supporting platform 422.

[0095] In this embodiment, as shown in FIG. 9, the cleaning head 410 may be made of a material having certain elasticity, and the cleaning head 410 is secured to the surface of the supporting platform 422 by the bonding layer so as to reciprocate. When the cleaning head 410 works, the cleaning head 410 is always in contact with the surface to be cleaned.

[0096] The water-delivery mechanism includes a water-discharge device 4217 that may be directly or indirectly connected to a cleaning fluid outlet of the water tank (not shown in the figure) (i.e., a liquid outlet of the clean water tank). A cleaning fluid may flow to the water-discharge device 4217 through the cleaning-fluid outlet of the water tank and may be evenly applied by the water-discharge device to the surface to be cleaned. The water-discharge device may be provided with a connector (not shown in the figure) and connected to the cleaning-fluid outlet of the water tank by means of the connector. The water-discharge device is provided with a dispensing opening, which may be a continuous opening or a combination of a plurality of discontinuous small openings, and a plurality of nozzles may be disposed at the dispensing opening. The cleaning fluid flows to the dispensing opening through the cleaning-fluid outlet of the water tank and the connector of the water-discharge device and is evenly applied to the operation surface through the dispensing opening.

[0097] The water-delivery mechanism may further include a clean water pump 4219 and/or a clean water pump pipe 4218, and the clean water pump 4219 may be communicated with the cleaning fluid outlet of the water tank directly or by the clean water pump pipe 4218.

[0098] The clean water pump 4219 may be connected to the connector of the water discharge device, and it may be configured to pump the cleaning fluid from the water tank to the water-discharge device. The clean water pump may be a gear pump, a vane pump, a plunger pump, a peristaltic pump, or the like.

[0099] The water delivery mechanism pumps the cleaning fluid from the clean water tank by the clean water pump 4219 and the clean water pump pipe 4218 and delivers the cleaning fluid to the water-discharge device. The water-discharge device 4217 may be a nozzle, a dripping hole, a wet cloth, or the like, and it evenly distributes water on the cleaning head so as to wet the cleaning head and the surface to be cleaned. Therefore, stains on the wetted surface to be cleaned may be cleaned more easily. In the wet cleaning module 400, the power/flow rate of the clean water pump is adjustable.

[0100] Further, as shown in FIG. 17, the motor 4211 drives, by a gear set 42193, the clean water pump 4219 to creep, and, through the creeping of the clean water pump 4219, clean water enters from a water inlet 42191, flows out from a water outlet 42192, and is then delivered to the water-discharge device 4217 by the clean water pump pipe 4218, and water flowing out from the water-discharge device 4217 flows to the cleaning head 410 through the water-discharge hole.

[0101] Further, as shown in FIG. 18, the motor 4211 drives, by the gear set 42193, a cable gear 42196 to rotate. The cable gear 42196 is wound with a cable 42194, and the cable 42194 is wound around the driving platform 421. The cable gear 42196 pulls the cable 42194 to ascend and descend so as to realize ascending and

descending of the driving platform 421. The cable gear 42196 and the cable 42194 are core components of the lifting module.

[0102] A clutch 42195 is disposed on the gear set 42193 and the cable gear 42196. The clutch 42195 includes a spring and a sheet-like component. By controlling the clutch 42195 to engage and disengage, the motor 4211 controls the three moving modules to rotate in one direction so as to drive the vibrator to vibrate and simultaneously realize water supply of the clean water pump 4219, and to rotate in the opposite direction to drive, by the cable 42194, the lifting module to ascend and descend. Optionally, owing to the combined design of the gear set, different combinations of the three moving modules can be controlled. For example, rotation in one direction realizes that the clean water pump supplies water, and rotation in the opposite directions realizes control on lifting and vibration. Optionally, two motors may be employed to control the three moving modules, but using one more motor may lead to cost increase.

[0103] The sweeping and mopping integrated cleaning apparatus provided by the present invention can achieve a more comprehensive cleaning function because the cleaning module of the automatic cleaning apparatus is provided with both the dry cleaning module and the wet cleaning module. Meanwhile, in the wet cleaning module, by adding the driving unit and a vibration area, the cleaning head can reciprocate to repeatedly clean the surface to the cleaned. Therefore, in the movement trajectory of the cleaning robot, a certain area can be cleaned several times when the cleaning robot passes through this area just one time, thereby greatly improving the cleaning effect, and the cleaning effect is especially obvious for areas with more stains.

[0104] In cooperation with sensors (for example, a surface medium sensor) that can detect the surface type of the surface to be cleaned, the lifting module enables the wet cleaning module to perform a cleaning operation according to different surfaces to be cleaned, such as lifting up the wet cleaning module on a carpet surface and lowering the wet cleaning module on the surfaces of floors/floor tiles for cleaning, thereby achieving a more comprehensive cleaning effect. Finally, it should be noted that the various embodiments in the description are described in a progressive manner, each embodiment focuses on the differences from the other embodiments, and the same or similar parts between the various embodiments may be referred to each other. As for the system or device disclosed by the embodiments, since it corresponds to the method disclosed by the embodiments, its description is relatively simple, and, for the relevant parts, reference may be made to the descriptions of the method embodiment.

[0105] The above embodiments are only used to illustrate, instead of limiting, the technical solutions of the present disclosure. Although the present disclosure is described in detail with reference to the foregoing embodiments, those of ordinary skill in the art shall understand that they can still modify the technical solutions described in the foregoing embodiments, or make equivalent substitutions for some of the technical features; these modifications or substitutions do not deviate the nature of the corresponding technical solutions from the spirit and scope of the technical solutions of the embodiments of the present disclosure.

Claims

1. An automatic cleaning apparatus, comprising:

   a mobile platform (100) configured to move automatically on an operation surface; and
   a cleaning module (150) disposed on the mobile platform (100) and comprising:

   a dry cleaning module (151) configured to clean at least part of the operation surface in a dry cleaning manner; and
   a wet cleaning module (400) configured to clean at least part of the operation surface in a wet cleaning manner, wherein the wet cleaning module (400) comprises:

   a cleaning head (410) configured to clean the operation surface, and
   a driving unit (420) configured to drive the cleaning head (410) to substantially reciprocate along a target surface in a direction substantially perpendicular to a moving direction of the automatic cleaning apparatus, the target surface being a part of the operation surface.

2. The automatic cleaning apparatus according to claim 1, wherein the driving unit (420) comprises:

   a driving platform (421) connected to a bottom surface of the mobile platform (100) and configured to provide a driving force; and
   a supporting platform (422) detachably connected to the driving platform (421) and configured to support the cleaning head (410).

3. The automatic cleaning apparatus according to claim 2, wherein the driving platform (421) comprises:

   a motor (4211) disposed on a side of the driving platform (421) close to the mobile platform (100) and outputting power by a motor output shaft; and
   a driving wheel (4212) connected to the motor output shaft and being of an asymmetrical structure.

4. The automatic cleaning apparatus according to claim 3, wherein the driving platform (421) further comprises:
a vibrator (4213) disposed on a side of the driving platform (421) opposite to the motor (4211), connected to the driving wheel (4212) and substantially reciprocating under asymmetrical rotation of the driving wheel (4212).

5. The automatic cleaning apparatus according to claim 4, wherein the driving platform (421) further comprises:
a connecting rod (4214) extending along an edge of the driving platform (421), and connecting the driving wheel (4212) and the vibrator (4213) such that the vibrator (4213) extends to a preset position.

6. The automatic cleaning apparatus according to claim 5, wherein the vibrator (4213) is of a rod-like structure and extends perpendicular to the connecting rod (4214).

7. The automatic cleaning apparatus according to claim 5, wherein the driving platform comprises a vibration buffering device (4215) disposed on the connecting rod (4214).

8. The automatic cleaning apparatus according to claim 2, wherein the supporting platform (422) comprises:
a cleaning substrate (4221) freely movably disposed on the supporting platform (422) and substantially reciprocating relative to the supporting platform (422) under vibration of the vibrator (4213).

9. The automatic cleaning apparatus according to claim 8, wherein the cleaning substrate (4221) comprises:
an assembly notch disposed at a position in contact with the vibrator (4213), the vibrator (4213) being assembled in the assembly notch when the supporting platform (422) is connected to the driving platform (421).

10. The automatic cleaning apparatus according to claim 2 or claim 8, wherein the supporting platform (422) further comprises:
a removal button (4229) configured to detachably connect the supporting platform (422) to the driving platform (421).

11. The automatic cleaning apparatus according to claim 8, wherein the supporting platform (422) further comprises:
at least one assembly area (4224) disposed on the supporting platform (422) and configured to assemble the cleaning head (410).

12. The automatic cleaning apparatus according to claim 11, wherein the cleaning head (410) comprises:
a movable area (412) connected to the cleaning substrate (4221) and substantially reciprocating along the target surface under driving of the cleaning substrate (4221).

13. The automatic cleaning apparatus according to claim 12, wherein
a bonding layer is disposed on a side of the movable area (412) connected to the cleaning substrate (4221), and the movable area (412) is connected to the cleaning substrate (4221) by the bonding layer.

14. The automatic cleaning apparatus according to claim 13, wherein the cleaning head (410) further comprises:
a fixed area (411) connected to a bottom of the supporting platform (422) by the at least one assembly area (4224) and configured to clean at least part of the operation surface along movement of the supporting platform (422).

15. The automatic cleaning apparatus according to claim 14, wherein the cleaning head (410) further comprises:
a flexible connection part (413) disposed between the fixed area (411) and the movable area (412) and configured to connect the fixed area (411) and the movable area (412).

16. The automatic cleaning apparatus according to claim 13, wherein the cleaning head (410) further comprises:
a sliding buckle (414) extending along an edge of the cleaning head (410) and detachably mounted on the supporting platform (422).

17. The automatic cleaning apparatus according to claim 1, wherein a lifting module is disposed between the cleaning module (150) and the mobile platform (100).

18. The automatic cleaning apparatus according to claim 17, wherein the dry cleaning module (151) is connected to the mobile platform (100) by a passive lifting module.

19. The automatic cleaning apparatus according to claim 17, wherein the wet cleaning module (400) is connected to the mobile platform (100) by an active lifting module.

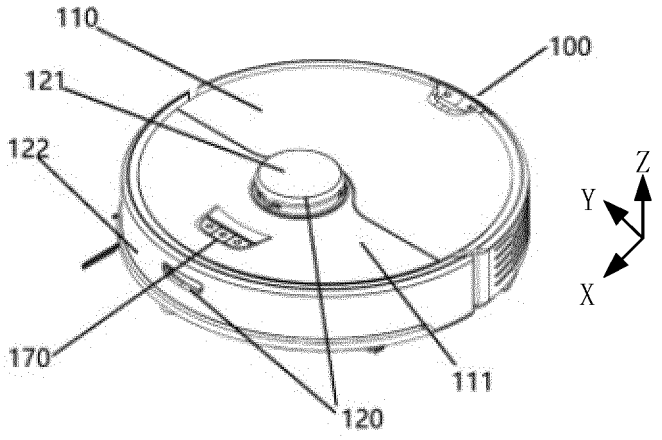
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FIG. 1

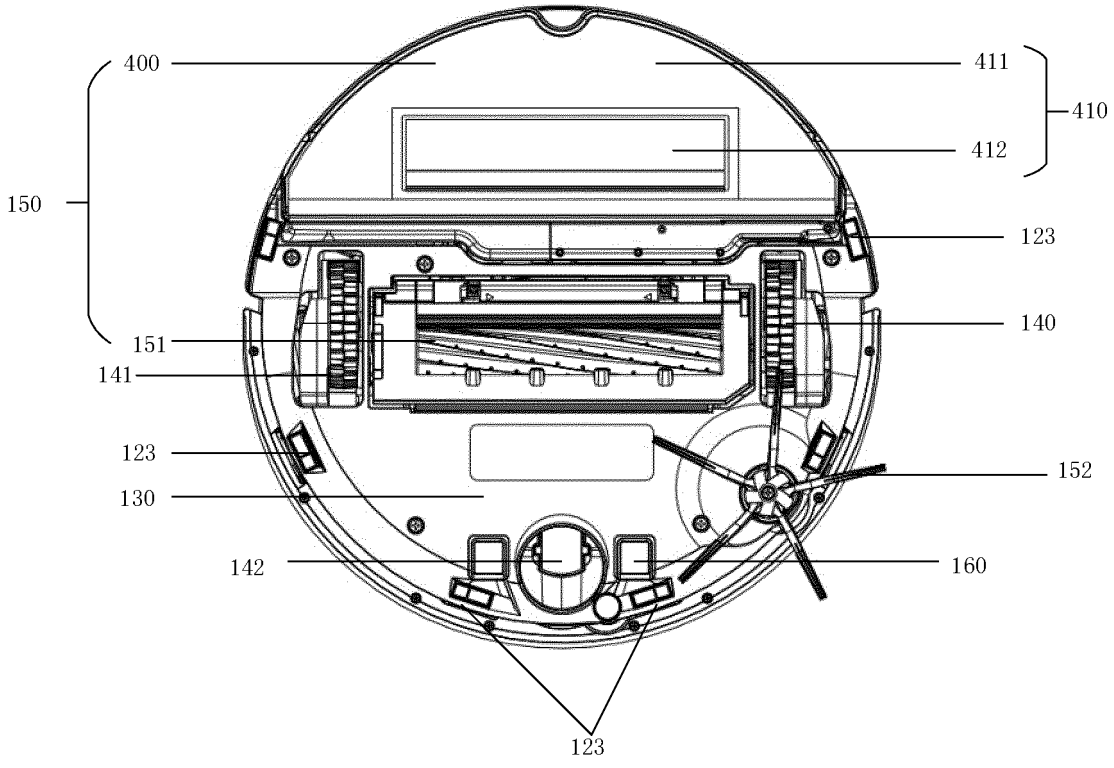
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FIG. 2

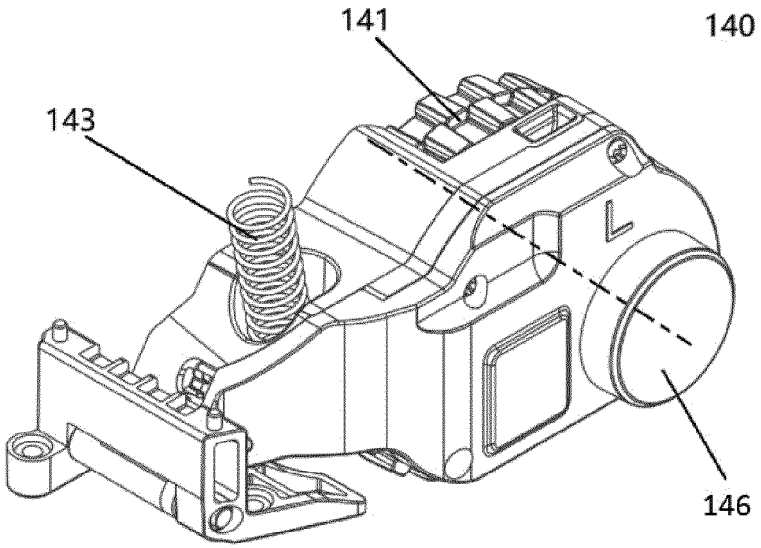


FIG. 3

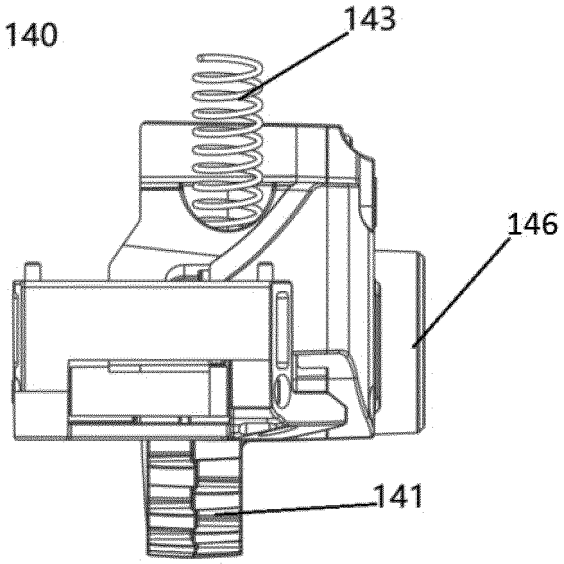


FIG. 4

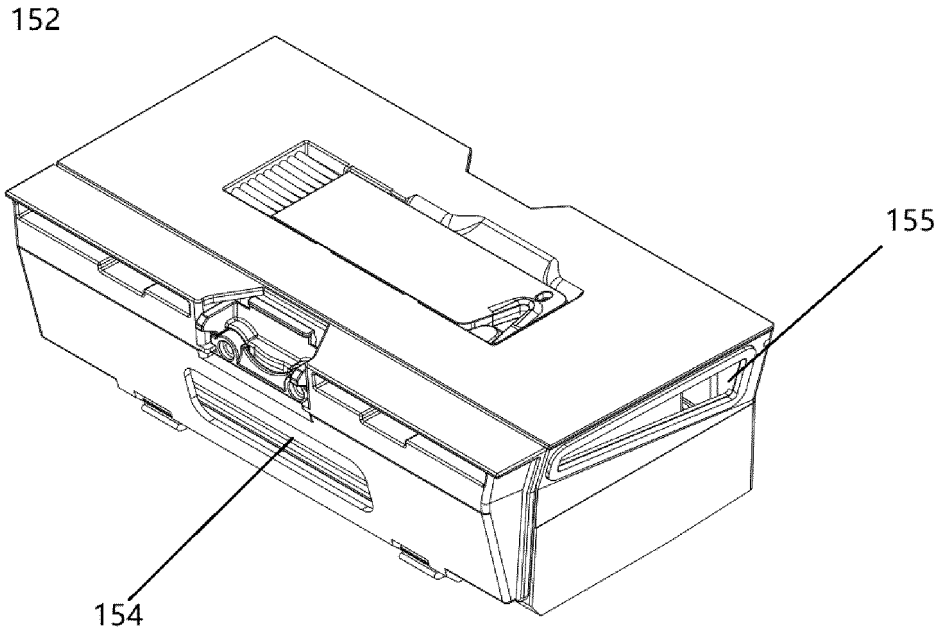


FIG. 5

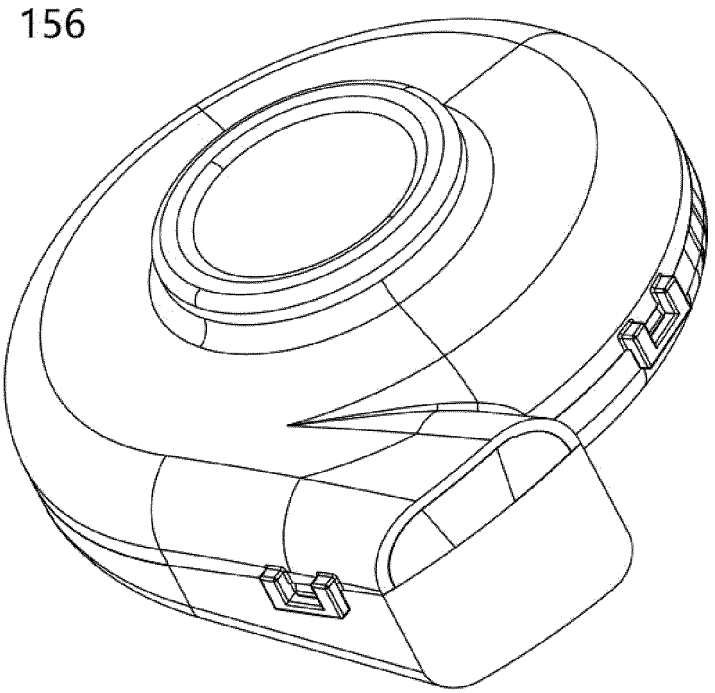


FIG. 6

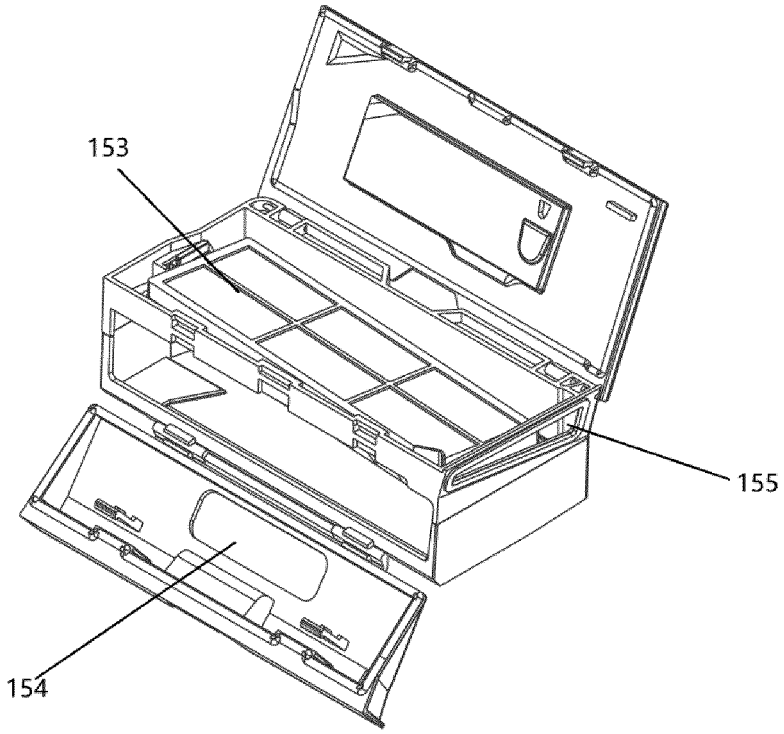


FIG. 7

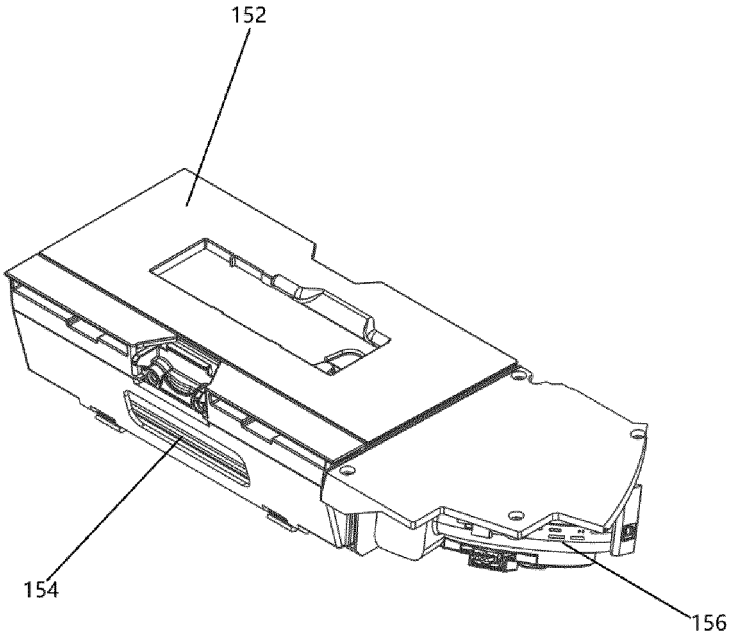
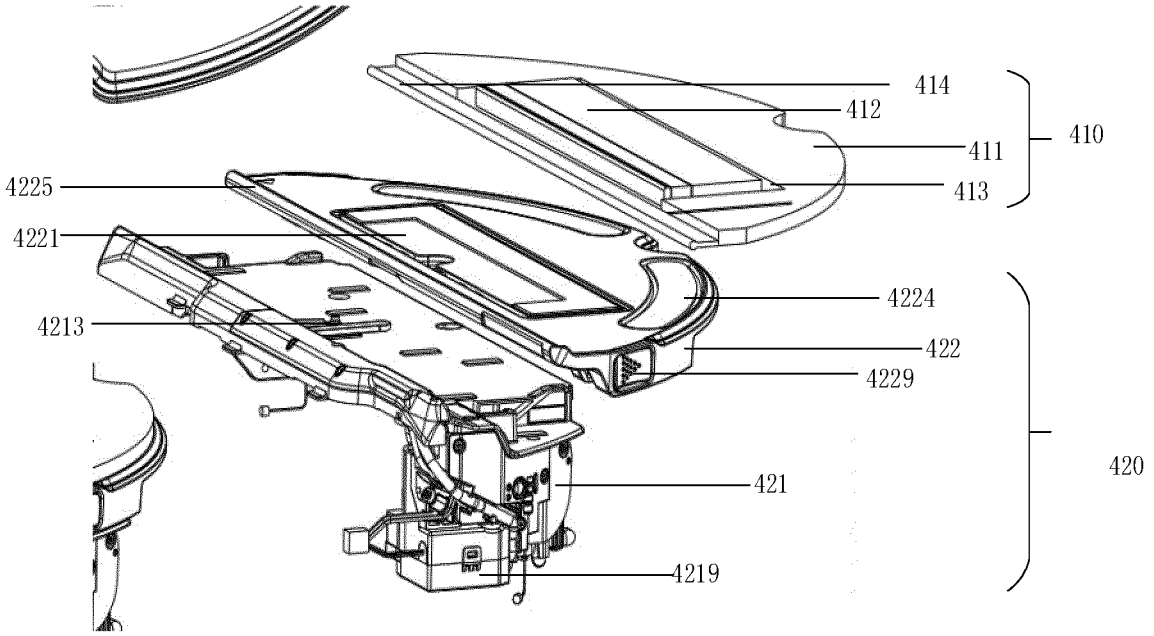


FIG. 8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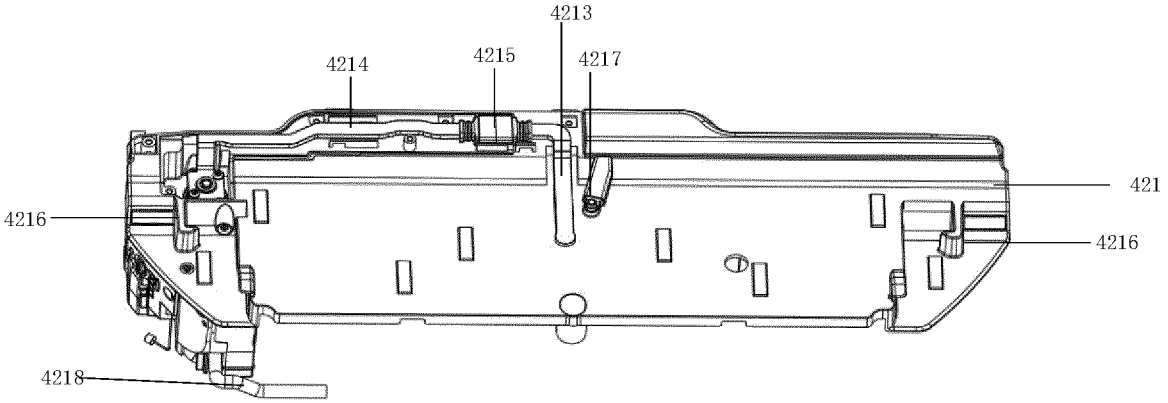
4229
420
421
4219

FIG. 9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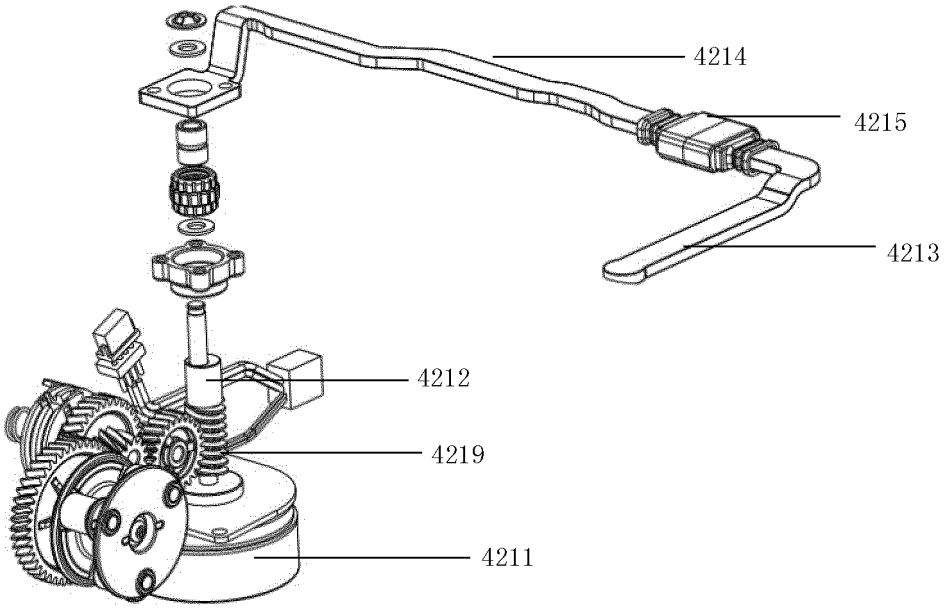
421
4216
4216
4218

FIG. 10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4215
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4212
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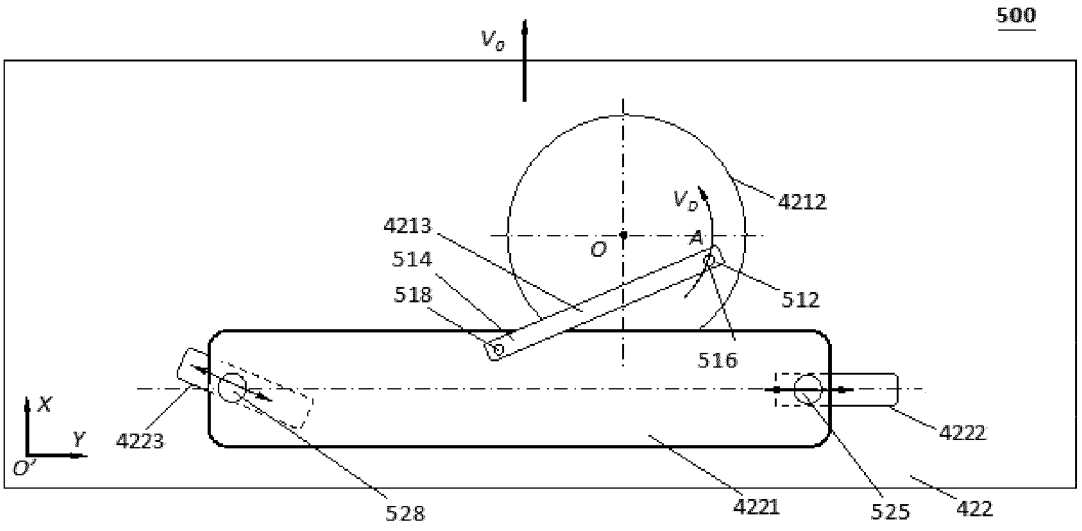
4211

FIG. 11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V_0
V_D
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4213
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O
A
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X
Y
O'
4223
4222
528
4221
525
422

FIG. 12

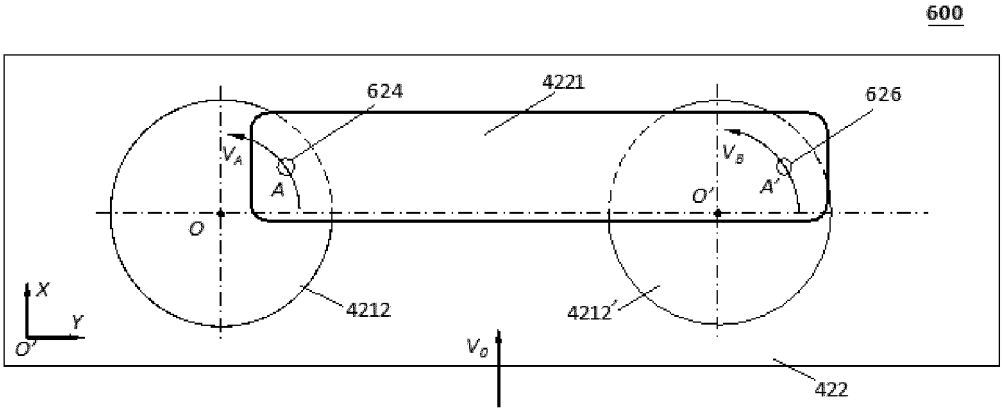

FIG. 13

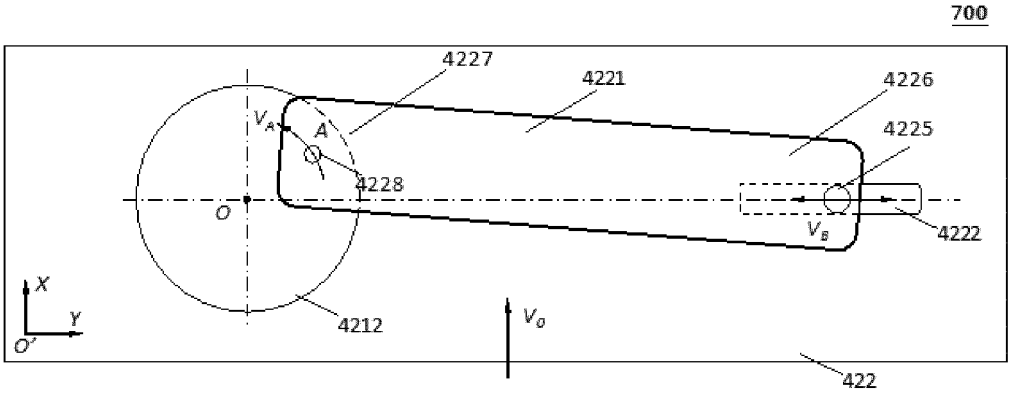

FIG. 14

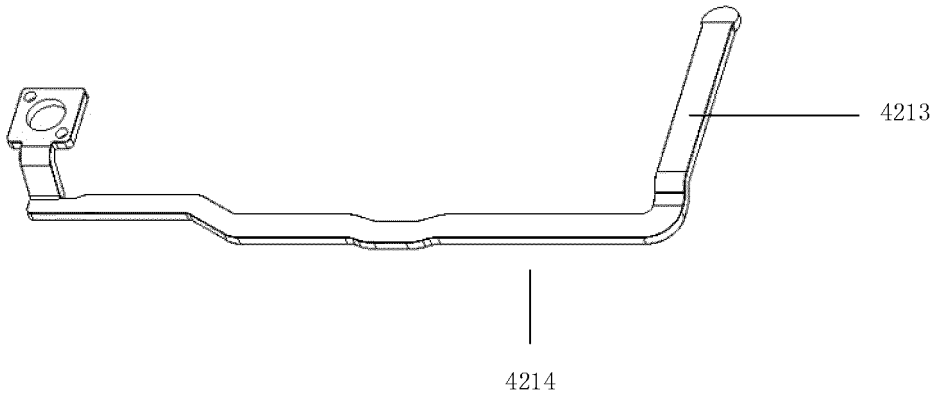

FIG. 15

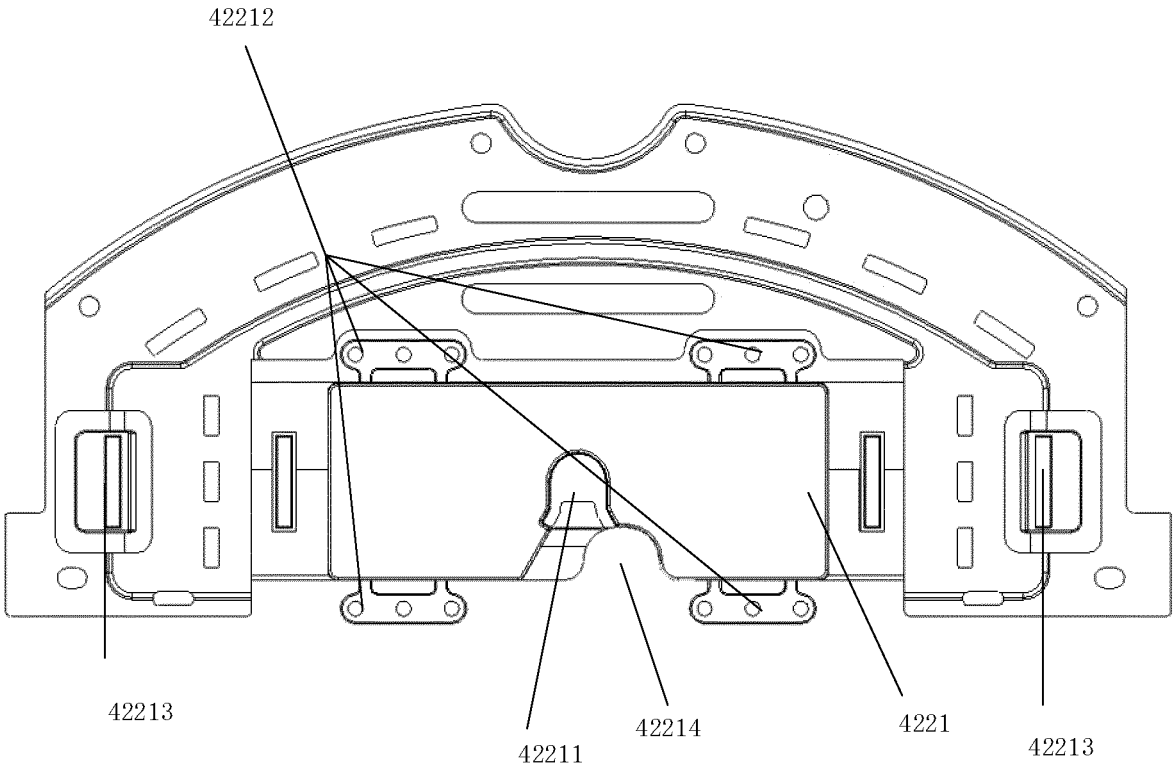

FIG. 16

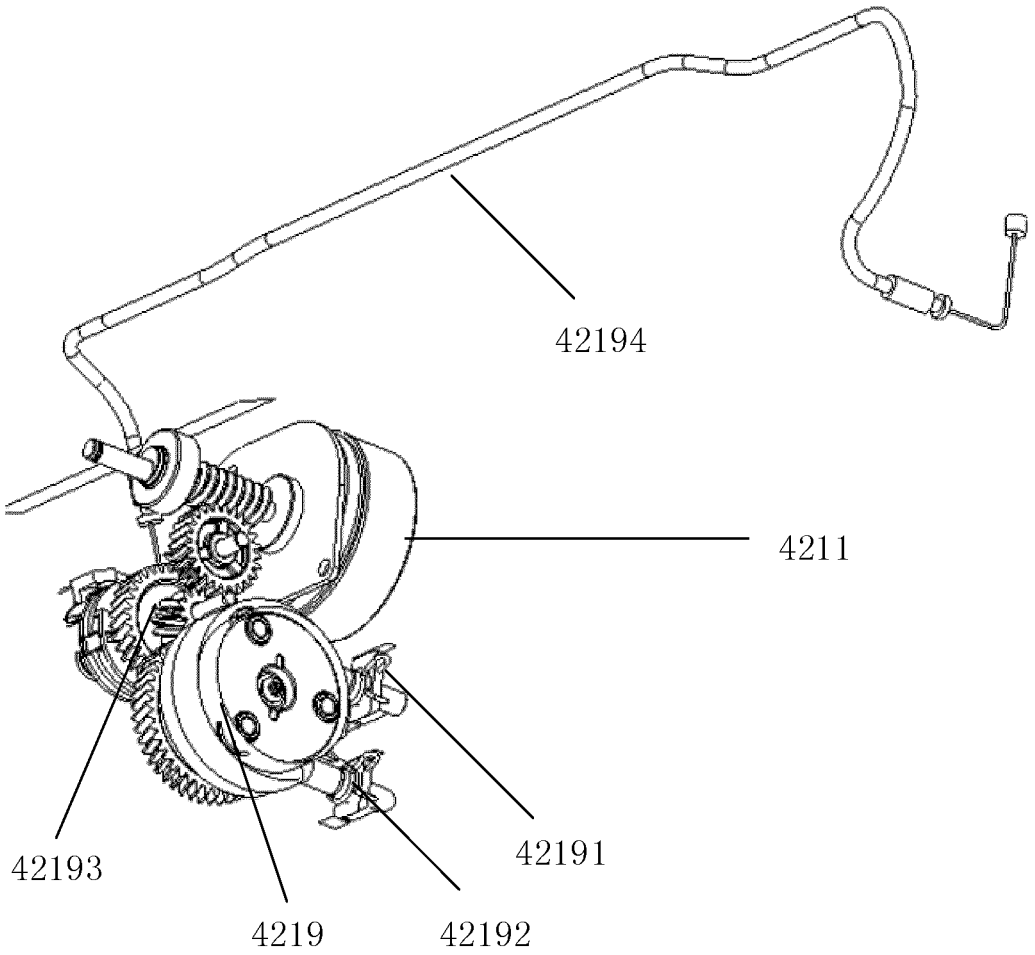

FIG. 17

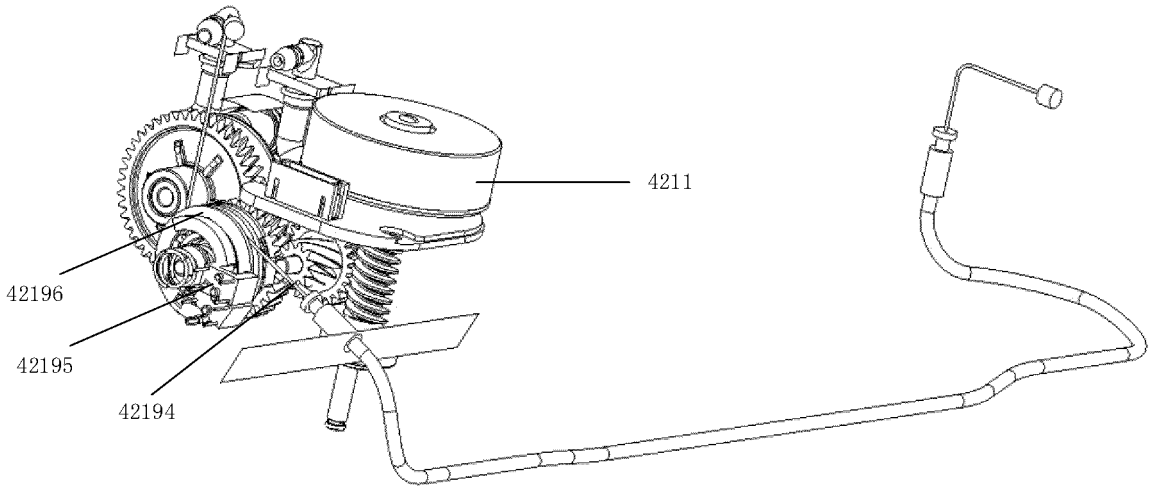

FIG. 18

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/099231

A. CLASSIFICATION OF SUBJECT MATTER

A47L 11/24(2006.01)i; A47L 11/284(2006.01)i; A47L 11/40(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A47L11/-

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

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

CNPAT, CNKI, EPODOC, WPI: 自动, 机器人, 拖, 擦, 干式, 抹布, 湿式, 来回, 往复, 摆动, 偏心, 凸轮, 曲柄, 拆卸, 拆装, 按钮, 按压, 升降, 浮动, auto+, robot, mop+, scrap+, wip+, duster cloth, dry, wet, reciprocat+, eccentric+, cam, crank, button, press, float+, fluctuat+, lift+, elevat+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 112806916 A (BEIJING STONE CENTURY TECHNOLOGY CO., LTD.) 18 May 2021 (2021-05-18) description, paragraphs [0083]-[0147], and figures 1-28	1-19
PX	CN 112806915 A (BEIJING STONE CENTURY TECHNOLOGY CO., LTD.) 18 May 2021 (2021-05-18) description, paragraphs [0082]-[0159], and figures 1-24	1-19
PX	CN 112690713 A (BEIJING STONE CENTURY TECHNOLOGY CO., LTD.) 23 April 2021 (2021-04-23) description, paragraphs [0091]-[0141], and figures 1-18	1-19
PX	CN 112806917 A (BEIJING STONE CENTURY TECHNOLOGY CO., LTD.) 18 May 2021 (2021-05-18) description, paragraphs [0079]-[0143], and figures 1-20	1-19
X	CN 109549573 A (ZHEJIANG DIMEI INTELLIGENT TECHNOLOGY CO., LTD.) 02 April 2019 (2019-04-02) description paragraphs [0042]-[0050], [0055]-[0058], figures 1-8	1-9, 11-19

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 September 2021	**28 September 2021**

Name and mailing address of the ISA/CN	Authorized officer
China National Intellectual Property Administration (ISA/CN) **No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088, China**	
Facsimile No. **(86-10)62019451**	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/099231

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	CN 110934545 A (SHENZHEN SILVER STAR INTELLIGENT TECHNOLOGY CO., LTD.) 31 March 2020 (2020-03-31) description, paragraphs [0043]-[0056], and figures 1-10	10
X	CN 211324758 U (GUANGZHOU COAYU ROBOT CO., LTD.) 25 August 2020 (2020-08-25) description, paragraphs [0038]-[0046], and figures 1-12	1-9, 11-18
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X	CN 211559965 U (QFEELTECH (BEIJING) CO., LTD.) 25 September 2020 (2020-09-25) description paragraphs [0041]-[0081], figures 1a-7b	1-2
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
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Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
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CN 112806915 A	18 May 2021	None	
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		EP 3031376 B1	06 June 2018

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REFERENCES CITED IN THE DESCRIPTION

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- CN 202110004713 **[0001]**
- CN 202110138563 **[0001]**