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(54) AUTOMATED SYSTEM FOR CLEANING A BUILDING

(57) The present invention relates to the construction of automatic room cleaning systems equipped with a parking module. A parking module and an automatic room cleaning system that comprises a robotic vacuum cleaner, a charging station, a control system and a parking module are provided. The parking module comprises a case that can accommodate at least the robotic vacuum cleaner, and a front cover with a controlled drive mechanism that opens and closes the said front cover. The provided parking module and its construction improve the ergonomics of the automatic room cleaning system, save the interior space in the room while preserving its appearance, and prevent undesirable contact of children and pets with the complex, expensive robotic equipment.

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Description

Prior Art

[0001] The proposed invention relates to automatic systems that perform room cleaning using robotic equipment.

[0002] A large number of automatic room cleaning systems that use robotic vacuum cleaners is known from the prior art.

[0003] Patent of the Russian Federation No. 2357644 published on June 10, 2009 describes a robotic cleaning system that is assumed to be the closest prior art. The known system comprises a robotic vacuum cleaner that performs cleaning while moving automatically over the target surface and a charging station designed so that it can be connected to the vacuum cleaner to charge its on-board battery. The system additionally allows the robotic vacuum cleaner to freely cross thresholds of any height.

[0004] Robotic vacuum cleaners and their charging stations can have different constructions and performance specifications. Charging stations can be stationary or mobile.

[0005] RU Patent No. 2350252 published on March 27, 2009 describes a robotic vacuum cleaner charging method that allows detecting incorrect connection between the contact terminals and the charging terminals and preventing wrong positioning of the robotic vacuum cleaner in relation to the charging device when the vacuum cleaner is charged manually.

[0006] RU Patent No. 2338639 published on November 20, 2008 describes a system and a method of returning the robotic vacuum cleaner to the charging device. The robotic vacuum cleaner return system includes a self-guidance signal transmitter, a self-guidance signal receiver and a control device. The self-guidance signal receiver is installed in the robotic vacuum cleaner and receives at least one signal transmitted by the self-guidance signal transmitter. The control device recognizes the signal and directs the robotic vacuum cleaner to the charging device. The robotic vacuum cleaner receives an infrared signal transmitted by the charging device, determines its location and docks with the charging device to charge its on-board battery.

[0007] RU Patent No. 2321879 published on April 10, 2008 proposes a mobile cleaning robot capable of image recognition and a robot guidance system including a charging device with a docking guidance image printed on it.

[0008] RU Patent No. 2311868 published on December 10, 2007 describes an automatic room cleaning system. The system includes video cameras and a garbage robot. The video cameras are installed in the upper corners of the room and are connected wirelessly through a video lock-in unit and the first transceiver with the second transceiver installed on the garbage robot. The garbage robot also includes a transceiver antenna, a microprocessor, batteries, chassis motors, a mechanical gripper with motors, and a garbage compartment. The video cameras are stationary, with the combined field of view covering the entire surface of the monitored floor, and the number of video cameras is selected so as to ensure full view of the floor surface.

[0009] RU Patent No. 2303387 published on July 27, 2007 describes an automatic cleaning system and a method of returning the cleaning robot to an external charging device. The system includes an external charging device with a charging stand and charging terminals, and a number of transmitting parts that send signals of different strength with different codes. The cleaning robot includes a battery, terminals for connection to the charging terminals in order to supply electric energy to the battery, a receiving part that receives signals from the transmitting parts, and a control part that controls the robotic cleaner movement using the signals received by the receiving part.

[0010] An automatic room cleaning system with a cleaning robot and a charging station is also known from application US 2009/0049640 published on February 26, 2009. The charging station additionally provides unloading of the garbage from the cleaning robot to a separate container.

[0011] Automatic room cleaning systems are also known from application EP 1842474 published on October 10, 2007, application GB 2414167 published on November 23, 2005, patent US 7332890 published on February 19, 2008, patent US 7555363 published on June 30, 2009, and application JP 2007-181656 published on July 19, 2007.

[0012] System described in RU patent No. 2357644 is assumed as the closest prior art to the provided system.

[0013] The common features of the known and the provided robotic room cleaning systems are the robotic vacuum cleaner, the charging station and the control system. The charging station can serve as a parking module.

[0014] All known automatic room cleaning systems with robotic vacuum cleaners have a considerable disadvantage (problem) of requiring additional space in the room as well as open arrangement of the charging station and the robotic vacuum cleaner.

Summary of the Invention

[0015] A parking module and an automatic room cleaning system that comprises a robotic vacuum cleaner, a charging station, a control system, and a parking module are provided. The parking module comprises a case (body) that can accommodate at least the robotic vacuum cleaner inside, and a front cover with a controlled drive mechanism that opens and closes the said front cover. The availability of the above parking module and its design improve the ergonomics of the automatic room cleaning system, save the interior space in the room while preserving its appearance, and prevent undesirable contact of children and pets with the complex, expensive

robotic equipment.

[0016] The object (purpose) of the proposed invention is to provide an automatic room cleaning system with a parking module that would ensure efficient use of the interior space, integration with the design of the room, and prevention of unauthorized and undesired contact of children and pets with the complex, expensive robotic equipment.

[0017] To solve the mentioned problem a design of a robotic vacuum cleaner parking module that comprises a case capable of accommodating at least the robotic vacuum cleaner, a front cover controlled by a drive mechanism that opens and closes the said front cover, a drive mechanism controller, and a power supply system is provided. Such parking module construction is not known from the prior art.

[0018] A design of an automatic room cleaning system with a robotic vacuum cleaner parking module that comprises a robotic vacuum cleaner, a charging station, and a parking module for the robotic vacuum cleaner integrated under a common control system that synchronizes the operation of the main elements is also provided. The provided system is distinguished (characterized) in that the parking module has a case enclosing the robotic vacuum cleaner and the charging station and a front cover with a controlled drive mechanism that opens and closes the cover in response to commands sent by the control system.

[0019] The size and materials of the parking module allow integrating it into the base (socle or dado part) of the furniture to preserve the appearance (design) of the room.

[0020] The control of the robotic vacuum cleaner and the drive mechanism (for example, an electromechanical drive) of the parking module front cover is provided by one common control system which makes the proposed system easier to use.

[0021] The control system consists of several elements and integrates all components of the proposed automatic room cleaning system with the parking module into a single circuit. Creation and programming of such a control system is based on the known means and methods and does not present any difficulties.

[0022] The robotic vacuum cleaner and the drive mechanism of the parking module front cover are designed so as to allow combined and/or separate sending of operating commands from the control system. Wherein the control system provides control the robotic vacuum cleaner and the drive mechanism together and/or separately.

[0023] The drive mechanism receives power from the controller and can be controlled over a wireless (radio) and/or conductive (galvanic) communication channel.

[0024] The control system comprises a programmable module that stores and processes control commands and provides synchronized control of the robotic vacuum cleaner, the charging station and the front cover drive mechanism; the above elements are usually equipped with the appropriate controllers, sensors and transceivers for this purpose. In any case the control system comprises modules that send control command signals to the robotic vacuum cleaner, the charging station and the controller of the parking module front cover drive mechanism, and the above devices comprise elements necessary to execute the control system commands.

[0025] The control system comprises at least one wireless (radio) remote control unit that can receive and transmit commands to the operating elements of the proposed automatic room cleaning system.

[0026] It is preferable for the control system to be integrated with the charging station and/or the robotic vacuum cleaner; however, it can also be designed as a separate unit.

[0027] The proposed system can additionally include an audio and/or LED module indicating the execution of the operating commands and/or the specified operating modes.

[0028] The advantages and variants of the proposed system are described in more detail below. However, they are not limited by the description and should be considered in the context of the prior art.

Detailed Description of the Invention

[0029] The provided technical solution involves installation of a parking space for automatic household cleaning systems - robotic vacuum cleaners with wireless control capabilities - primarily in the standard-size base niches of virtually any furniture set (preferably kitchen furniture).

[0030] The provided automatic parking module is an electronic/mechanical equipment that can be integrated into the standard base niches of furniture sets or other specially allocated spaces. It provides unique ergonomic placement and operation of a robotic vacuum cleaner in household conditions while preserving the appearance of the room, which is an important factor for the consumer.

[0031] The robotic vacuum cleaner with the charging station can be a product of any known manufacturer and is not an independent subject of this invention.

[0032] The parking module comprises the following basic modules and units:

- Case made of, for example, laminated chipboard, plastic or wood, with a hinged front cover, preferably opened vertically, made of, for example, aluminium or plastic. The standard external dimensions of the case are usually 600x540x120 mm or 600x540x150 mm.
- Drive mechanism for the hinged front cover - for example, a linear electric actuator (electromechanical drive).
- Cover drive mechanism controller; wherein control commands can be sent by a wireless (radio), galvanic (conductive) or any other possible method.

- Robotic vacuum cleaner charging base (can be the standard base supplied with the robotic vacuum cleaner or an additional base).
- Mains power supply unit - standard unit supplied with the robotic vacuum cleaner or an additional unit.
- Control system for the charging station, the robotic vacuum cleaner and the parking module front cover drive mechanism.
- Wireless keyring for independent control of the parking module controller (usually with an additional standalone wireless channel).
- Wireless remote control unit for the robot - the standard one may be used.

[0033] The mains adapter is the standard static power supply unit of the robotic vacuum cleaner. The floor-standing charging base is the standard robotic vacuum cleaner navigation and automatic charging device. The communication channel is wireless, and the navigation method is infrared. The method of contact between the charging station and the parked robotic vacuum cleaner is galvanic. The system can receive power from the standard mains adapter.

[0034] The wireless remote control unit is usually the standard device used to activate and control the robotic vacuum cleaner and program the individual weekly cleaning schedule.

[0035] The controller of the parking module front cover drive mechanism can be, for example, a modified standard car alarm unit with a power output for electric lock control and a function that allows programming the duration of the control pulses sent to the locks.

[0036] The electromechanical drive that opens and closes the front cover can be based on the solutions known from the prior art and presents no difficulties. In particular, the operating principle of the linear electromechanical drive is similar to automatic garage gates operated by a remote control unit.

[0037] The drive controller can be equipped with a secondary power source and/or connected directly to the standard robotic vacuum cleaner power source.

[0038] Wireless keyrings are an additional independent control channel for the drive controller and are necessary to force the opening/closing of the front cover remotely. When the robotic vacuum cleaner is at the charging base (the front cover is closed), the commands from the additional keyrings are blocked. This provides protection from possible electromechanical synchronization faults. The electromagnetic compatibility of the wireless keyrings is as per GOST R 50789-95 and GOST R 41.97 (Russian State Standards).

[0039] The independent wireless drive controller control channel is used in the following situations:

A) for initial synchronization of the parking module and robot during the installation of the system and its connection to the power mains.
B) if necessary, to open and close the module front door in abnormal situations (if the robot battery is discharged, if the robot loses the conductive connection to the charging base while inside, or when the robot is outside the parking space).

[0040] The galvanic (conductive) channel is always used when the robot is successfully parked at the charging base, and is essentially a channel for transmission of the module front door opening/closing commands over a cable. For example, the presence of +12V voltage at the output of the charging base means that the robot is "present" inside the parking module and generates a command to close the door, while 0V means that the robot is "absent" from the charging base and generates a command to open the door.

[0041] There are following possible ways to control the robotic vacuum cleaner:

A) Manual parking mode activation - by pressing the corresponding button on the control unit (when the robot is outside the parking module);
B) Parking and exit mode activation using the wireless control unit;
C) Automatic parking mode activation when the battery is discharged in the process of cleaning with mandatory use of the standard movement coordinators for accurate navigation of the robot to the charging base - for example, if several rooms are being cleaned.
D) Cleaning mode activation by a built-in timer signal according to an individual cleaning schedule pre-set by the user.

[0042] The proposed system operates as follows.

[0043] The parking module case is installed in a prepared base niche - for example, of a kitchen furniture set - suitable in terms of the useful volume. For example, this may require cutting an opening in the base of the furniture to provide the necessary clearance on the right and on the left side so that the parking module front cover would open freely and covering the edges of the material with plastic edge trimming caps.

[0044] The mains adapter is connected through a socket on the back wall of the parking module and is installed in the base space of the furniture. The presence and lighting of a signal LED on the front cover can serve as a power and mains adapter status indicator.

[0045] The front cover is opened using the wireless control unit or the additional keyring to allow the robot to navigate to and park at the charging base located inside the parking module.

[0046] It is practical to use an infrared channel for the navigation and parking of the robot, since it is the most accurate and noise-resistant communication channel. Since an infrared signal works efficiently only if a direct line of sight is available, it is preferable to provide free space in a 1 m radius in front of the module for the robot to manoeuvre during the parking.

[0047] Standard robotic vacuum cleaner navigation facilities installed in the rooms in accordance with the manufacturer's recommendations should be used to ensure successful parking of the robot from a room adjacent to the one in which the base is located.

[0048] The robotic vacuum cleaner, the charging station, the parking module and the control system need to be synchronized with each other before the vacuum cleaner can be activated remotely.

[0049] The parking command can be sent from the standard control unit or directly from the robotic vacuum cleaner keyboard.

[0050] In the process of work the robotic vacuum cleaner receives and processes signals from movement coordinators (if they are available and activated) and the floor-standing charging base, and adjusts its movement path optically to ensure accurate docking with the parking module. Successful parking of the robot at the charging station can be confirmed by audible and light signals.

[0051] In several seconds after the galvanic contact between the robot and the charging base is established the parking module front cover closes automatically in a smooth motion, ensuring concealed ergonomic storage and continuously monitored charging of the robotic vacuum cleaner.

[0052] The robotic vacuum cleaner leaves the parking module when it receives a command from the built-in timer (according to a pre-programmed cleaning schedule) or from a wireless control unit.

[0053] The robotic vacuum cleaner's exit from the parking module is preceded by the synchronous opening of the front door and can be accompanied with an audible and a light signal (such as a melody).

[0054] When the cleaning cycle for one or several rooms is complete or when the battery is discharged to a specified level, the robotic vacuum cleaner automatically returns to the charging base in the parking module without human interference, and the door is automatically closed behind it, preventing unauthorized contact with the equipment.

[0055] The owner of such an automatic house cleaning system only needs to periodically empty the dust container and clean the brushes from hairs and garbage. The dust container can also be emptied automatically; in this case the user is only required to perform regular servicing of the system.

[0056] As a result, children and pets have no access to the robotic vacuum cleaner during the charging. The robotic vacuum cleaner cleans the entire visible area of the apartment since there is no blind zone around the charging device. The robotic vacuum cleaner occupies no space in the visible area (which is important for small apartments) and does not disrupt the stylistic interior solution.

[0057] The procedure of synchronization between the robotic vacuum cleaner and the parking module consists of several simple operations and is performed when the parking module is installed, for example, in a furniture set. This procedure may need to be repeated in the process of system operation in case of abnormal situations related to power failures, robotic vacuum cleaner faults, or replacement of the remote control unit batteries. The synchronization can be automatic (programmed) or semiautomatic (requiring the user to input the necessary commands).

[0058] An example of the sequence of the synchronization operations:

1. The necessary system components need to be charged and connected to a power source and the proper interfacing between the standard robotic vacuum cleaner devices needs to be ensured before the installation of the parking module.
2. Install the parking module into the prepared base niche of the furniture set, connect the adapter to the power mains, and make sure the adapter LED indicator is on.
3. Open the module front cover using the wireless keyring or remote control unit to allow free parking of the robot at the charging base inside the case.
4. Place the robotic vacuum cleaner in front of the open parking module, making sure there is enough space for the manoeuvring. Activate the robotic vacuum cleaner and then send a parking command from the remote control unit or enter it manually.
5. When the robot is successfully parked at the charging station, a tone will sound and the front cover will close in a smooth motion. Brightly lit LED on the front cover indicates that the module power is on and that the robot is at the charging station inside the parking module.

[0059] After this the synchronization procedure is considered successfully completed. If necessary, an individual weekly cleaning schedule can be programmed so that the vacuum cleaner will perform the cleaning when it is convenient for the user.

[0060] The proposed automatic room cleaning system with the robotic vacuum cleaner parking module has definite advantages over similar systems existing in the world.

Drawing

[0061] Fig. 1 shows the logic of the system operation.

[0062] List of the basic parking module components:

case; front door electromechanical drive; electromechanical drive controller with two control command transmission channels - wireless and conductive; floor-standing charging base; connecting cables; status indicator LEDs; wireless keyrings; wireless remote control unit; mains charging device.

[0063] The proposed design of the parking module front door drive that makes use of a linear electric actuator

is characterized by simplicity, reliability and precise command execution. However, its relatively high cost and substantial noise produced during the operation can be viewed as disadvantages.

[0064] The following alternative examples of the parking module front door opening methods deserve consideration:

1. A pneumatic piston drive used as the actuator. This method has benefits in terms of the noise produced by the mechanics; however, the vacuum pump also creates noise comparable to that of the electromechanical drive during the operation, which negates its advantages. Besides, the pneumatic drive cannot provide the same level of precision as the linear electric actuator while having a roughly equivalent cost.
2. A design option that makes use of a step motor with cable linkage and roller mechanisms. It is a less reliable design than the linear electric actuator and therefore cannot be given preference. Its only advantage is the relatively low cost.
3. A design option that makes use of a gas spring furniture damper combined with an electric solenoid (for example, from a car alarm) that acts as an electric lock. Smooth mechanical opening is provided by the spring mechanism of the damper.

[0065] This technical solution is characterized by a relatively low cost, but allows implementing only one automatic operation - smooth opening of the module front cover. The cover is closed manually in this case, which does not meet all the objectives. Therefore, the front cover drive option with a linear electric actuator selected by the developer is the optimum solution that meets all the objectives and ensures that all operations are performed reliably.

[0066] The provided parking module and its design improve the ergonomics of the automatic room cleaning system, save the interior space in the room while preserving its appearance, and prevent undesirable contact of children and pets with the complex, expensive robotic equipment.

Claims

1. A robotic vacuum cleaner parking module comprising a case accommodating at least the robotic vacuum cleaner, a front cover controlled by a drive mechanism that opens and closes the said front cover, a drive mechanism controller, and a power supply system.

2. Parking module according to Claim 1 **characterized in that** the drive mechanism is designed as a linear electromechanical drive.

3. Parking module according to Claim 1 **characterized in that** the drive mechanism provides its control over a wireless and/or conductive communication channel.

4. Parking module according to Claim 1 **characterized in that** the parking module design allows installing it in the base part of the furniture.

5. An automatic room cleaning system comprising a robotic vacuum cleaner, a charging station, a control system, and a robotic vacuum cleaner parking module, **characterized in that** the parking module comprises a case accommodating at least the robotic vacuum cleaner and a front cover with a controlled drive mechanism that opens and closes the said front cover in response to commands sent by the control system to the drive mechanism controller.

6. System according to Claim 5 **characterized in that** the parking module design allows installing it in the base part of the furniture.

7. System according to Claim 5 **characterized in that** the robotic vacuum cleaner, the charging station and the parking module front cover drive mechanism are controlled by a common control system.

8. System according to Claim 5 **characterized in that** the parking module front cover drive mechanism can be controlled over a wireless and/or conductive communication channel.

9. System according to Claim 5 **characterized in that** the control system comprises a programmable module that stores and processes control commands.

10. System according to Claim 5 **characterized in that** the control system comprises modules that transmit and receive control command signals to and from the robotic vacuum cleaner, the charging station and the controller of the parking module front cover drive mechanism.

11. System according to Claim 5 **characterized in that** the control system comprises at least one wireless remote control unit.

12. System according to Claim 5 **characterized in that** the control system is integrated with the charging station and/or the robotic vacuum cleaner.

13. System according to Claim 5 **characterized in that** it comprises an additional audio and/or LED module indicating the execution of the operating commands and/or the specified operating modes.

14. System according to Claim 5 **characterized in that**

the drive mechanism is designed as a linear electro-mechanical drive.

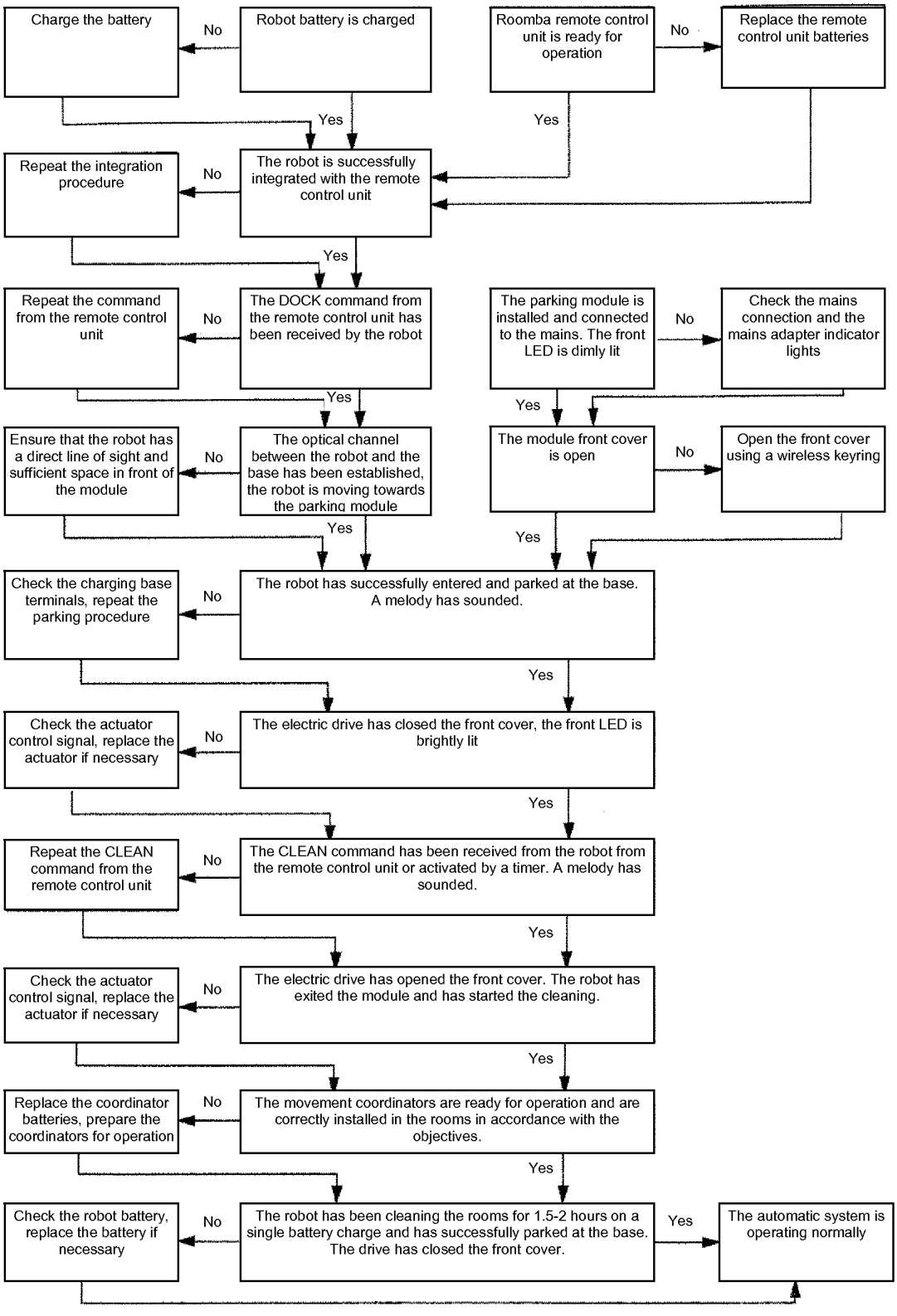
Charge the battery
No
Robot battery is charged
Roomba remote control unit is ready for operation
No
Replace the remote control unit batteries
Yes
Yes
Repeat the integration procedure
No
The robot is successfully integrated with the remote control unit
Yes
Repeat the command from the remote control unit
No
The DOCK command from the remote control unit has been received by the robot
The parking module is installed and connected to the mains. The front LED is dimly lit
No
Check the mains connection and the mains adapter indicator lights
Yes
Yes
Ensure that the robot has a direct line of sight and sufficient space in front of the module
No
The optical channel between the robot and the base has been established, the robot is moving towards the parking module
The module front cover is open
No
Open the front cover using a wireless keyring
Yes
Yes
Check the charging base terminals, repeat the parking procedure
No
The robot has successfully entered and parked at the base. A melody has sounded.
Yes
Check the actuator control signal, replace the actuator if necessary
No
The electric drive has closed the front cover, the front LED is brightly lit
Yes
Repeat the CLEAN command from the remote control unit
No
The CLEAN command has been received from the robot from the remote control unit or activated by a timer. A melody has sounded.
Yes
Check the actuator control signal, replace the actuator if necessary
No
The electric drive has opened the front cover. The robot has exited the module and has started the cleaning.
Yes
Replace the coordinator batteries, prepare the coordinators for operation
No
The movement coordinators are ready for operation and are correctly installed in the rooms in accordance with the objectives.
Yes
Check the robot battery, replace the battery if necessary
No
The robot has been cleaning the rooms for 1.5-2 hours on a single battery charge and has successfully parked at the base. The drive has closed the front cover.
Yes
The automatic system is operating normally

Fig. 1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/RU 2011/000382

A. CLASSIFICATION OF SUBJECT MATTER

A47L 9/00 (2006.01)

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)

A47L 9/00, 9/28, 5/00

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)

Esp@cenet, DWPI, PAJ, USPTO, RUPTO

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2004/004534 A1 (ALFRED KARCHER GMBH & CO. KG et al.) 15.01.2004, pages 11-14	1-14
Y	RU 18416 U1 (PODYMOV OLEG VLADIMIROVICH) 20.06.2001, pages 3-5	1-14
Y	SU 698076 A1 (PREDPRIYATIE P/YA G-4173) 15.11.1979	2, 14
Y	RU 2357644 C2 (SAMSUNG GUANDZHU ELEKTRONICKS CO. LTD.) 10.06.2009, line 5-p.11, line 25, figures 1, 4	10, 12

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

* Special categories of cited documents:

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Date of the actual completion of the international search	Date of mailing of the international search report
04 October 2011 (04.10.2011)	17 November 2011 (17.11.2011)
Name and mailing address of the ISA/	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1998)

REFERENCES CITED IN THE DESCRIPTION

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- RU 2350252 **[0005]**
- RU 2338639 **[0006]**
- RU 2321879 **[0007]**
- RU 2311868 **[0008]**
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- JP 2007181656 A **[0011]**