

TITLE OF INVENTION: A SYSTEM AND METHOD FOR MAKING A FLUID CONNECTION BETWEEN A CLEANING ROBOT AND A BASE STATION

TECHNICAL FIELD

[0001] This invention relates to a system and method for making a fluid connection between a cleaning robot and a base station. More particularly, this invention relates to a system and method for connecting the cleaning robot to the base station for transferring fluid therebetween.

BACKGROUND

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

[0003] Cleaning robots are widely used these days. Some of these robots include a clean water tank and a dirty or waste water tank that require refilling and draining respectively during use. Consequently, to increase the level of automation, base stations are provided where the cleaning robot can move to dock at to have its clean water tank refilled and waste water tank drained. An example of such a cleaning robot and base station system is disclosed in Chinese Utility Model No. CN220024922U, Lee et al., entitled "Water changing base station, intelligent cleaning machine and system thereof". The disclosed base station includes ports for connecting to corresponding ports of the cleaning robot. The system uses blind docking between the cleaning robot and the base station, which is low in docking accuracy and there is also a risk of docking failure. The ports of the base station also protrude from an outer surface of a housing of the base station. As a result, these protruding ports increase the footprint of the base station. They are also a safety hazard. Furthermore, each port uses an elastic sealing member sleeved thereon to seal the connection between two ports. The two ports are forced to merely abut each other. There is a risk that water may leak out of where the two ports meet.

[0004] There is therefore a need for a system for transferring fluid between a cleaning robot and a base station which addresses, at least in part, one or more of the forgoing problems.

SUMMARY

[0005] According to an aspect of the present disclosure, there is provided a method for making a fluid connection between a cleaning robot and a base station. The method includes moving the cleaning robot to the base station and picking up a first connecting member from the base station using a robotic arm. The robotic arm may be on the cleaning robot or the base station. The method further includes connecting the first connecting member to a second connecting member of the cleaning robot to complete the fluid connection between the cleaning robot and the base station, and transferring fluid between the cleaning robot and the base station through the fluid connection.

[0006] In some embodiments of the method, the method further includes extending the second connecting member out of the cleaning robot before connecting the first connecting member to the second connecting member.

[0007] In some embodiments of the method, the second connecting member is extended through a trap door out of the cleaning robot.

[0008] In some embodiments of the method, the method further includes retracting the second connecting member into the cleaning robot after transferring fluid between the cleaning robot and the base station.

[0009] In some embodiments of the method, the method further includes detecting that the fluid connection is established before transferring fluid between the cleaning robot and the base station.

[0010] In some embodiments of the method, detecting that the fluid connection is established includes detecting an electrical signal at a first electrical contact of one of the cleaning robot and the base station.

[0011] In some embodiments of the method, the electrical signal is output through a second electrical contact by the cleaning robot and routed back by the base station to the cleaning robot to be detected at the first electrical contact of the cleaning robot.

[0012] In some embodiments of the method, the first and the second electrical contacts are located on the second connecting member of the cleaning robot.

[0013] According to another aspect of the present disclosure, there is provided a fluid transferring system. The fluid transfer system includes a base station having a first connecting member and a cleaning robot having a second connecting member. The cleaning robot is configured to move to the base station. Either the cleaning robot or the base station includes a robotic arm that is configured to pick up the first connecting member from the base station and connect it to the second connecting member of the cleaning robot to allow fluid to be transferred between the cleaning robot and the base station therethrough.

[0014] In some embodiments of the system, the cleaning robot is further configured to extend the second connecting member out of the cleaning robot before the robotic arm connects the first connecting member to the second connecting member.

[0015] In some embodiments of the system, the cleaning robot is further configured to retract the second connecting member into the cleaning robot after transferring fluid between the cleaning robot and the base station.

[0016] In some embodiments of the system, the cleaning robot is further configured to detect that the fluid connection is established before transferring fluid between the cleaning robot and the base station.

[0017] In some embodiments of the system, detecting that the fluid connection is established comprises detecting an electrical signal at a first electrical contact of one of the cleaning robot and the base station.

[0018] In some embodiments of the system, the electrical signal is output through a second electrical contact by the cleaning robot and routed back by the base station to the cleaning robot to be detected at the first electrical contact of the cleaning robot.

[0019] In some embodiments of the system, the first and the second electrical contacts are located on the second connecting member of the cleaning robot.

[0020] According to another aspect of the present disclosure, there is provided a cleaning robot. The cleaning robot includes a body and a retractable second connecting member that is extendable out of the body for connecting to a first connecting member of a base station to establish a fluid connection between the cleaning robot and the base station.

[0021] In some embodiments of the cleaning robot, the cleaning robot further includes an actuator that is coupled to the second connecting member. The actuator is

actuatable to extend the second connecting member out of the body and retract the second connecting member into the body.

[0022] In some embodiments of the cleaning robot, the cleaning robot further includes a pair of guide rails on which the second connecting member is slideable when being extended and retracted.

[0023] In some embodiments of the cleaning robot, the cleaning robot further includes a trap door on the body through which the second connecting member extends out of the body.

[0024] In some embodiments of the cleaning robot, the second connecting member includes a first electrical contact to which an electrical signal is applicable, a second electrical contact; and a controller coupled to the second electrical contact for reading an electrical signal thereon.

[0025] According to another aspect of the present disclosure, there is provided a base station. The base station includes a first connecting member, and a support for supporting the first connecting member. The first connecting member is removable from the support for connecting to a second connecting member of a cleaning robot for establishing a fluid connection therebetween.

[0026] In some embodiments of the base station, the first connecting member comprises a handle by which the first connecting member may be gripped to be removed from the support.

[0027] In some embodiments of the base station, the first connecting member comprises a locating means that is used by the cleaning robot to position a robotic arm over the first connecting member.

[0028] In some embodiments of the base station, the first connecting member comprises a first electrical contact and a second electrical contact electrically connected to the first electrical contact.

[0029] Other aspects and advantages of the invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

BRIEF DESCRIPTION OF DRAWINGS

[0030] The invention will be better understood with reference to the drawings, in which:

[Figure 1] is a flowchart showing a sequence of steps for making a fluid connection between a cleaning robot and a base station according to one embodiment of the invention;

[Figure 2A] is a drawing of a system including a cleaning robot and a base station according to another embodiment of the invention, wherein a second connecting member is shown extended out of a body of the cleaning robot;

[Figure 2B] is a drawing of the system in Figure 2A showing a robotic arm gripping onto a first connecting member picked up from the base station and connecting it to the second connecting member of the cleaning robot to establish a fluid connection between the cleaning robot and the base station;

[Figure 3] is an exploded isometric drawing of the second connecting member in Figures 2A and 2B;

[Figure 4] is a sectional side view drawing of the second connecting member in Figures 2A and 2B, showing the second connecting member in a retracted position within the body of the cleaning robot;

[Figure 5] is a side view drawing of the base station in Figures 2A and 2B showing the first connecting member supported on a support;

[Figure 6] is an isometric drawing of the first connecting member shown aligned with the second connecting member; and

[Figure 7] is an isometric drawing showing the first connecting member connected to the second connecting member that is extended out of the cleaning robot; and

[Figure 8] is a side view drawing of the first connecting member connected to the second connection member in Figure 7.

DESCRIPTION OF THE EMBODIMENTS

[0031] Throughout this document, unless otherwise indicated to the contrary, the terms “comprising”, “consisting of”, “having” and the like, are to be construed as non-exhaustive, or in other words, as meaning “including, but not limited to.”

[0032] Furthermore, throughout the specification, unless the context requires otherwise, the word “include” or variations such as “includes” or “including” will be

understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

[0033] Throughout the description, it is to be appreciated that the term ‘processor/controller’ and its plural form include microcontrollers, microprocessors, programmable integrated circuit chips such as application specific integrated circuit chip (ASIC), computer servers, electronic devices, and/or combination thereof capable of processing one or more input electronic signals to produce one or more output electronic signals. The controller includes one or more input modules and one or more output modules for processing of electronic signals.

[0034] The following description refers to elements or nodes or features being “coupled” together. As used herein, unless expressly stated otherwise, “coupled” means that one element/node/feature/ is directly or indirectly joined to (or directly or indirectly communicates with) another element/node/feature, and does not necessarily connect a direct mechanical connection. Coupled elements/nodes/features are understood to exert mutual influence on one another. Thus, although the figures depicts one exemplary arrangement of elements, additional intervening elements, devices, features, or components may be present in an embodiment of the depicted subject matter.

[0035] In addition, certain terminology may also be used in the following description for the purpose of reference only, and thus are not intended to be limiting. For example, terms such as “upper”, “lower”, “above”, and “below” refer to directions in the drawings to which reference is made in a consistent but arbitrary frame of reference. Such terminology may include the words specifically mentioned above, derivatives thereof, and words of similar import. Similarly, the terms “first”, “second”, and other such numerical terms referring to structures do not imply a sequence or order unless clearly indicated by the context.

[0036] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as is commonly understood by a skilled person to which the subject matter herein belongs.

[0037] As shown in the drawings for purposes of illustration, the invention may be embodied in a versatile method for making a fluid connection between a cleaning robot and a base station. Existing methods tend to be more restrictive as far as robot design is concerned. Referring to Figure 1, the method includes moving the cleaning

robot to the base station and picking up a first connecting member from the base station using a robotic arm of the cleaning robot. The method further includes connecting the first connecting member to a second connecting member of the cleaning robot to define the fluid connection between the cleaning robot and the base station, and transferring fluid between the cleaning robot and the base station through the fluid connection.

[0038] Specifically, Figure 1 shows a sequence 2 of steps in the method for making a fluid connection between a cleaning robot 4 and a base station 6. As shown in Figures 2-8, the cleaning robot 4 includes a body 8 and a robotic arm 10 mounted to the top of the body 8. The robotic arm 10 may be any suitable robotic arm, such as those supplied by Elite Robots (Shanghai, China). Mounted to the robotic arm 10 is a camera 12. The cleaning robot 4 further includes a connecting member 20, referred to hereinafter as a second connecting member 20, that is housed inside the body 8. The second connecting member 20 is extendable through a trap door 22 on the body 8 to be outside the body 8. As shown in Figure 3, the second connecting member 20 includes a header block 24, three Y-shape sealing rings 26 and a cover plate 28. The header block 24 includes three cavities 30. Each Y-shape sealing ring 26 sits in a cavity 30. The cover plate 28 is fixedly attached to the header block 24 to retain the three Y-shape sealing rings 28 within the cavities 30. Extending from a lower edge of the cover plate 28 is a tongue member 32. The header block 24 further includes three tubes 36, each of which is in fluid communication with a respective one of the three cavities 30. In this embodiment, a first tube 36 is fluidly coupled via a first hose to a clean water tank (both not shown). A second tube is fluidly coupled via a second hose to a cleaning liquid or liquid detergent tank (both not shown). A third tube is fluidly coupled via a third hose to a waste water tank (both not shown). During a cleaning operation, the liquid detergent is drawn from the liquid detergent tank and sprayed onto a cleaning surface. The cleaning robot picks up a brush (not shown) with its robotic arm 10 and scrubs the cleaning surface with the brush. The cleaning robot 4 then draws water from the clean water tank and sprays it on the scrubbed surface to rinse off the liquid detergent. The cleaning robot 4 cleans the brush by spraying the liquid detergent and/or the clean water on the brush. This liquid detergent and/or clean water is then collected in the waste water tank. The header block 24 also includes a pair of panels 38 extending horizontally from both sides of the header block 24. The cleaning

robot 4 further includes a pair of guide rails 40, each having a longitudinal groove 42 therein. The panels 38 of the header block 24 sit in the longitudinal grooves 42 of the guide rails 40 to allow the header block 24 to be slidable along the length of the guide rails 40. The cleaning robot 4 further includes a linear actuator 50 having a lead screw and a nut (both not shown). Fixedly attached to the nut is a slider 52. Connected to the slider 52 is one end of a push plate 54. The other end of the push plate 54 is connected to the header block 24. The linear actuator 50 is actuatable to rotate the lead screw so that the nut moves along the length of the lead screw. This in turn causes the header block 24 coupled thereto to be pushed and pulled along the guide rails 40 by the linear actuator 50. The assembly of the linear actuator 50, guide rails 40 and second connecting member 20 is mounted to an undersurface of a mounting plate 55. The mounting plate 55 is mounted to an undersurface of the top the body 8. The trap door 22 is hinged to the body 8 and faces the header block 24. The trap door 22 is biased by a torsion spring 56 to cover an opening 58 (Figure 7) in the body 8. When the header block 24 is moved towards an extended position thereof, the tongue member 32 pushes the trap door 22 against the force exerted thereon by the torsion spring 56 to tilt the trap door 22 outwards as shown in Figures 7 and 8. In the extended position, the header block 24 emerges from the opening 58 in the body 8 to be outside the body 8. Mounted to the cover plate 28 is an electrical connector 60 having a first electrical contact and a second electrical contact. An electrical signal, such as a +5V voltage, can be applied to the first electrical contact. The cleaning robot 4 further includes a battery (not shown).

[0039] The base station 6 is next described. The base station 6 includes a housing 70. Inside the housing 70 is a clean water supply tank and a liquid detergent supply tank (both not shown). The base station 6 further includes another connecting member 72, hereinafter referred to as a first connecting member 72, for mating with the second connecting member 20 of the cleaning robot 4. The first connecting member 72 includes three ganged tubes 74 and a handle 76. Two of the ganged tubes 74 are coupled to the clean water supply tank and liquid detergent supply tank. The third tube 74 is coupled by a hose to a drainage pipe (both not shown). The handle 76 has a panel 78 with a bulbous edge 80 distal from the ganged tubes 74. The handle 76 further includes a pillar 82 that intersects the panel 78 to protrude from both sides of the panel 78 and also a top of the bulbous edge 80. Such a handle design allows

clamping jaws of the robotic arm 10 to clamp on the handle 76 to firmly grip it without slippage in any direction. The first connecting member 72 is securely supported on a support 73 within the housing 70 via any means, including but not limited to, a magnetic means. The first connecting member 72 is accessible via a cover 77 on the housing 70. The base station 6 further includes two charging terminals 90 (Figures 2A and 2B).

[0040] Returning to the sequence 2 in Figure 1, the sequence 2 starts in a MOVE ROBOT TO BASE STATION step 100, wherein the autonomous cleaning robot 4 returns to a base station 6 for one or more reasons during operation. The cleaning robot 4 may return to the base station 6 in the step 100 for example when the battery is low, when it is low on clean water or liquid detergent, or when the waste water tank is full. As known to those skilled in the art, the location of and the path to the base station from where the cleaning robot's current location is stored in a memory (not shown) of the cleaning robot 4. The cleaning robot 4 is configured to move to the base station 6 based on the information stored thereon. When the cleaning robot 4 is adjacent the base station 6, it uses its camera 12 mounted to the robotic arm 10 and a vision system implemented therein to locate a first indicium (not shown) on the base station 6. The first indicium may include but not limited to a QR code. The cleaning robot 4 is further configured to determine its exact location with respect to the first indicium and therefore the base station 6. The cleaning robot 4 then aligns itself with the base station 6 and moves towards the base station 6 such that it docks at the base station 6 with the charging terminals 90 of the base station 6 inserted into corresponding charging ports of the cleaning robot 4 to initiate charging of the battery as shown in Figure 2A.

[0041] The sequence 2 proceeds next to a PICK UP 1ST CONNECTING MEMBER step 102 when the clean water tank and/or the liquid detergent tank needs to be refilled or the waste water tank needs to be drained. The cleaning robot 4 communicates with the base station 6 through a wireless communication channel established therebetween to inform the base station 6 that there is such a need. The base station 6 then opens the cover 77. Figure 2B shows the base station 6 with the cover 77 in an open position. The cleaning robot 4 next moves its robotic arm 10 with the camera 12 mounted thereon to search for a second indicium on the first connecting member 72. The second indicium may also include but not limited to a QR code. Once located, the cleaning robot 4 knows the exact location of the first connecting member 72 relative

thereto and is able to move its robotic arm 10 to grip its handle 76, lift the first connecting member 72 off the support 73 and move it towards the cleaning robot 4. As the cleaning robot 4 does that, the sequence 2 proceeds to an EXTEND 2ND CONNECTING MEMBER step 106, wherein the cleaning robot 4 actuates the linear actuator 50 to push the second connecting member 20 outwards. The tongue member 32 will come into contact with the trap door 22 and push it outwards as the second connecting member 20 extends outwards of the body 8. Figures 7 and 8 show the second connecting member in its extended position.

[0042] The sequence 2 next proceeds to a CONNECT 1ST AND 2ND CONNECTING MEMBERS step 108, wherein the cleaning robot 4 moves the robotic arm 10 towards the extended second connecting member 20 and connects the first connecting member 72 to the second connecting member 20. When properly connected, the end sections 110 of the tubes of the first connecting member 72 will be inserted through openings 112 in the cover plate 28 and the Y-shape sealing rings 26 in the cavities 30 of the header block 24 as shown in Figures 7 and 8. In this manner, fluid connection between the first connecting member 72 and the second connecting member 20 is made. The Y-shape sealing rings 26 prevent water leakage at this interconnection. The first electrical contact and the second electrical contact of the second connecting member 20 are also connected to the third electrical contact and fourth electrical contact of the first connecting member 72 respectively.

[0043] The sequence 2 next proceeds to an PROPERLY CONNECTED? decision step 114, wherein the cleaning robot 4 reads the voltage on the second electrical contact to determine if the first connecting member 72 is properly connected to the second connecting member 20. If the first connecting member 72 is properly connected to the second connecting member 20, the voltage applied to the first electrical contact will be detected on the second electrical contact having been routed through the shorted third electrical contact and fourth electrical contact of the first connecting member 72. If it is determined in this decision step 114 that the first connecting member 72 and the second connecting member 20 are not properly connected, the sequence 2 proceeds to a RETURN 1ST CONNECTING MEMBER step 115, wherein the cleaning robot 4 moves its robotic arm 10 to return the first connecting member 72 to the base station by placing it back on the support 73. The robot 4 next locates the second indicium on the first connecting member 72 to align the robotic arm

10 thereto and picks up the first connecting member 72 once again. The sequence 2 then returns to the CONNECT 1ST AND 2ND CONNECTING MEMBERS step 108 in another attempt to connect the first connecting member 72 to the second connecting member 20. The cleaning robot 4 keeps a count of the number of attempts to connect the first connecting member 72 to the second connecting member 20. If the cleaning robot 4 determines that the number of attempts has exceeded a predetermined number, such as but not limited to two, it will abort the operation and send an appropriate error message to an operator.

[0044] If, however, it is determined in the decision step 114 that the connection between the first connecting member 72 and the second connecting member 20 is proper, the sequence 2 proceeds to a TRANSFER FUIDL step 116. In this step 116, if the clean water tank needs refilling, the cleaning robot 4 will instruct the base station 6 via the wireless communication to pump clean water from its clean water supply tank through the fluid connection into the clean water tank of the cleaning robot 4. Similarly, if the liquid detergent tank needs refilling, the cleaning robot 4 will instruct the base station 6 via the wireless communication to pump liquid detergent from its liquid detergent supply tank through the fluid connection into the liquid detergent tank of the cleaning robot 4. And if waste water needs to be drained, the cleaning robot 4 pumps waste water in its waste water tank out through the fluid connection. In this manner, fluid can be transferred between the cleaning robot 4 and the base station 6 either sequentially or simultaneously.

[0045] The sequence 2 next proceeds to a CONTINUE OPERATION step 118, wherein the cleaning robot 4 disconnects the first connecting member 72 from the second connecting member 20 and returns it to the base station 6 by placing it back on the support 73. In this step 118, the cleaning robot 4 also actuates the linear actuator 50 to retract the second connecting member 20 into the body 8 of the cleaning robot 4 to return it back to its retracted position as shown in Figure 4. As a result, the trap door 22 closes behind the retracting second connecting member 20. The cleaning robot 4 can then continue with its operation where it left off earlier to return to the base station 6.

[0046] Advantageously, the method allows the first connecting member 72 to be connected to the second connecting member 20 that may be located anywhere on the cleaning robot 4 within reach of the robotic arm 10. As a result, positioning of the

second connecting member 20 on a robot becomes less critical. The first connecting member 72 is also stored within the housing 70 of the base station 6 and does not protrude therefrom. This allows the base station 6 to have a smaller footprint and makes it safer to operate. With the vision system and robotic arm 10, a docking accuracy of about 0.02mm may be achieved. The structure of the header block 24 and Y-shape sealing rings 26 receiving end portions 110 of the tubes 74 of the first connecting member 72 allows for effective sealing to prevent liquid leakage therefrom. The ganged tubes 74 of the first connecting member 74 also allows the connection of the various tubes 74 to the cleaning robot 4 to be made simultaneously.

[0047] Although the present invention is described as implemented in the above described embodiment, it is not to be construed to be limited as such. It is to be appreciated that modifications and improvements may be made without departing from the scope of the present invention.

[0048] For example, although the robotic arm is described to be that of the cleaning robot, the robotic arm may be one that is mounted to the base station in some embodiments. In other embodiments, the robotic arm may be a standalone robotic arm that is independent of the cleaning robot and base station.

[0049] As another example, a check is carried out to determine that the first connecting member is properly connected to the second connecting member. However, such a step may not be necessary if it is determined that the connection between the two can be consistently made with the cleaning robot's vision and positioning system. And even if the check is necessary, it is not limited to the specific embodiment described above. The check may be carried out by the base station instead of the cleaning robot in a manner similar to that described above. Alternatively, the cleaning robot or the base station may output the voltage for reading by the other.

[0050] As yet a further example, it is described that the second connecting member of the cleaning robot is hidden within the body of the cleaning robot and extended out of the body only when connecting with the first connecting member of the base station. The second connecting member may alternatively be fixed in position either inside or outside and the body.

[0051] It should be further appreciated by the person skilled in the art that one or more of the above modifications or improvements, not being mutually exclusive, may be further combined to form yet further embodiments of the present invention.

CLAIMS

[Claim 1] A method for making a fluid connection between a cleaning robot and a base station, the method comprising:

- moving the cleaning robot to the base station;
- picking up a first connecting member from the base station using a robotic arm of one of the cleaning robot and the base station;
- connecting the first connecting member to a second connecting member of the cleaning robot to define the fluid connection between the cleaning robot and the base station; and
- transferring fluid between the cleaning robot and the base station through the fluid connection.

[Claim 2] The method according to Claim 1, further comprising extending the second connecting member out of the cleaning robot before connecting the first connecting member to the second connecting member.

[Claim 3] The method according to Claim 2, wherein the second connecting member is extended through a trap door out of the cleaning robot.

[Claim 4] The method according to Claim 2 or Claim 3, further comprising retracting the second connecting member into the cleaning robot after transferring fluid between the cleaning robot and the base station.

[Claim 5] The method according to any one of the preceding claims, further comprising detecting that the fluid connection is established before transferring fluid between the cleaning robot and the base station.

[Claim 6] The method according to Claim 5, wherein detecting that the fluid connection is established comprises detecting an electrical signal at a first electrical contact of one of the cleaning robot and the base station.

[Claim 7] The method according to Claim 6, wherein the electrical signal is output through a second electrical contact by the cleaning robot and routed back by the base station to the cleaning robot to be detected at the first electrical contact of the cleaning robot.

[Claim 8] The method according to Claim 7, wherein the first and the second electrical contacts are location on the second connecting member of the cleaning robot.

[Claim 9] A fluid transferring system comprising:

a base station having a first connecting member; and

a cleaning robot having a second connecting member;

wherein the cleaning robot is configured to move to the base station, and wherein one of the cleaning robot and the base station further includes a robotic arm that is configured to pick up the first connecting member from the base station and connect the first connecting member to the second connecting member to allow fluid to be transferred between the cleaning robot and the base station therethrough.

[Claim 10] The fluid transferring system according to Claim 9, wherein the cleaning robot is further configured to extend the second connecting member out of the cleaning robot before the robotic arm connects the first connecting member to the second connecting member.

[Claim 11] The fluid transferring system according to Claim 10, wherein the cleaning robot is further configured to retract the second connecting member into the cleaning robot after transferring fluid between the cleaning robot and the base station.

[Claim 12] The fluid transferring system according to any one of Claims 9-11, wherein the cleaning robot is further configured to detect that the fluid connection is established before transferring fluid between the cleaning robot and the base station.

[Claim 13] The fluid transferring system according to Claim 12, wherein detecting that the fluid connection is established comprises detecting an electrical signal at a first electrical contact of one of the cleaning robot and the base station.

[Claim 14] The fluid transferring system according to Claim 13, wherein the electrical signal is output through a second electrical contact by the cleaning robot and routed back by the base station to the cleaning robot to be detected at the first electrical contact of the cleaning robot.

[Claim 15] The method according to Claim 14, wherein the first and the second electrical contacts are located on the second connecting member of the cleaning robot.

[Claim 16] A cleaning robot comprising:

- a body;

- a retractable second connecting member that is extendable out of the body for connecting to a first connecting member of a base station to establish a fluid connection between the cleaning robot and the base station.

[Claim 17] The cleaning robot according to Claim 16, further comprising an actuator that is coupled to the second connecting member, the actuator being actuatable to extend the second connecting member out of the body and retract the second connecting member into the body.

[Claim 18] The cleaning robot according to Claim 17, further comprising a pair of guide rails on which the second connecting member is slideable when being extended and retracted.

[Claim 19] The cleaning robot according to any one of Claims 16-18, further comprising a trap door on the body through which the second connecting member extends out of the body.

[Claim 20] The cleaning robot according to any one of Claims 16-19, wherein the second connecting member comprises:

a first electrical contact to which an electrical signal is applicable;
a second electrical contact; and
a controller coupled to the second electrical contact for reading any electrical signal thereon.

[Claim 21] A base station comprising:

a first connecting member; and
a support for supporting the first connecting member;
wherein the first connecting member is removable from the support for connecting to a second connecting member of a cleaning robot for establishing a fluid connection therebetween.

[Claim 22] A base station according to Claim 21, wherein the first connecting member comprises a handle by which the first connecting member may be gripped to be removed from the support.

[Claim 23] A base station according to Claim 21 or Claim 22, wherein the first connecting member comprises a locating means that is used by the cleaning robot to position a robotic arm over the first connecting member.

[Claim 24] A base station according to any one of Claims 21-23, wherein the first connecting member comprises a first electrical contact and a second electrical contact electrically connected to the first electrical contact.