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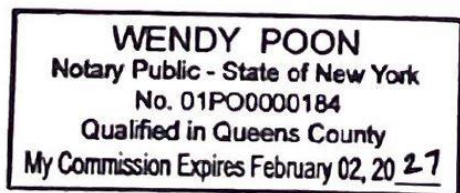


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(54) Title of the Invention

CONTROL METHOD AND DEVICE FOR A
SWIMMING POOL CLEANING ROBOT

(57) Abstract

A control method and device for a swimming pool cleaning robot are disclosed. In a bow-shaped cleaning mode, the swimming pool cleaning robot performs attitude calibration. During the attitude calibration process, the swimming pool cleaning robot is controlled to move to a first preset distance from the pool wall and rotate a preset angle in a clockwise or counterclockwise direction; the robot is then controlled to reverse until its rear is parallel to the pool wall, and the current IMU angle or ultrasonic ranging parameter of the robot is initialized. In the wall-climbing cleaning mode, the robot is controlled to move to a second preset distance from the pool wall, the power of the water pump motor is reduced to a preset multiple of the maximum power, and the robot is controlled to climb the wall. When the IMU angle exceeds a predetermined angle, it is determined that the robot is currently at the pool wall, and the water pump motor power is restored to the maximum power. The present invention improves the comprehensiveness and effectiveness of swimming pool cleaning.

Bow-Shaped Cleaning Mode	Wall-Climbing Cleaning Mode
The swimming pool cleaning robot performs attitude calibration. During the attitude calibration process, the robot is controlled to move to a first preset distance from the pool wall and rotate a preset angle in a clockwise or counterclockwise direction; the robot is then controlled to reverse until its rear is parallel to the pool wall, the current IMU angle or ultrasonic ranging parameter of the robot is initialized, and the bow-shaped cleaning is started.	The robot is controlled to move to a second preset distance from the pool wall, the power of the water pump motor is reduced to a preset multiple of the maximum power, and the robot is controlled to climb the wall. When the IMU angle of the robot exceeds a predetermined angle or the ultrasonic ranging parameter is less than a predetermined distance, it is determined that the robot is currently at the pool wall, and the water pump motor power is restored to the maximum power to start wall-climbing cleaning.

1. A control method for a swimming pool cleaning robot, characterized by comprising:
bow-shaped cleaning mode: the swimming pool cleaning robot performs attitude calibration; during the attitude calibration process, the robot is controlled to move to a first preset distance from the pool wall and rotate a preset angle in a clockwise or counterclockwise direction; the robot is then controlled to reverse until its rear is parallel to the pool wall, the current IMU angle or ultrasonic ranging parameter of the robot is initialized, and the bow-shaped cleaning is started;
wall-climbing cleaning mode: the robot is controlled to move to a second preset distance from the pool wall, the power of the water pump motor is reduced to a preset multiple of the maximum power, and the robot is controlled to climb the wall; when the IMU angle of the robot exceeds a predetermined angle or the ultrasonic ranging parameter is less than a predetermined distance, it is determined that the robot is currently at the pool wall, and the water pump motor power is restored to the maximum power to start wall-climbing cleaning.
2. The control method for a swimming pool cleaning robot according to Claim 1, characterized in that during the bow-shaped cleaning process, the robot is controlled to move forward to the first preset distance from the pool wall;
when the robot moves forward to the first preset distance from the pool wall, it is controlled to turn right or left by 90°, and after moving forward for a preset time, it is detected whether there is an obstacle in front of the robot; if there is an obstacle, it is marked as the first obstacle encounter.
3. The control method for a swimming pool cleaning robot according to Claim 2, characterized in that if there is no obstacle, the robot is controlled to turn right or left by 90° to continue cleaning, until the robot again reaches the first preset distance from the pool wall, then continues to turn right or left by 90°, moves forward for a preset time, and again detects whether there is an obstacle in front of the robot; if there is an obstacle, it is marked as the second obstacle encounter, at which time the robot is controlled to rotate 180° and clean in the opposite direction.
4. The control method for a swimming pool cleaning robot according to Claim 3, characterized in that, it is detected again whether there is an obstacle in front of the robot, and if there is no obstacle, continue to control the robot to turn right or left by 90° to continue cleaning.
5. The control method for a swimming pool cleaning robot according to Claim 4, characterized in that when the robot performs the bow-shaped cleaning mode for a predetermined period, the robot is controlled to move forward to the first preset distance from the pool wall for angle calibration.
6. The control method for a swimming pool cleaning robot according to Claim 1, characterized in that during the wall-climbing cleaning process, when the robot climbs to a third preset distance from the water surface, it is determined that the robot is about to leave the water surface, and after a delay of at least 2 seconds, the robot is controlled to perform a reverse action.
7. The control method for a swimming pool cleaning robot according to Claim 1, characterized in that during the wall-climbing cleaning process, when the robot leaves the pool water surface, after a delay of at least 2 seconds, the robot is controlled to perform a reverse action.
8. The control method for a swimming pool cleaning robot according to Claim 7, characterized in that during the wall-climbing cleaning process, when the robot encounters an obstacle, the robot is controlled to continue climbing for a preset time, then perform a reverse action;
when the IMU tilt angle of the robot is less than 30 degrees, it is determined that the robot is in the pool bottom area.
9. The control method for a swimming pool cleaning robot according to Claim 8, characterized in that after it is determined that the robot is in the pool bottom area, the distance between the robot and the side pool wall is judged; when the side distance is less than 300 mm, it is determined that the robot is at a right angle, and the robot is controlled to rotate to clean the other side pool wall;

if the side distance is greater than or equal to 300 mm, the robot is controlled to reverse and rotate before continuing wall-climbing cleaning.

10. A swimming pool cleaning robot control device, using any of the control methods according to any one of Claims 1 to 9, characterized by comprising:

bow-shaped cleaning control module: configured to perform attitude calibration for the swimming pool cleaning robot; during the attitude calibration process, the robot is controlled to move to a first preset distance from the pool wall and rotate a preset angle in a clockwise or counterclockwise direction; the robot is then controlled to reverse until its rear is parallel to the pool wall, the current IMU angle or ultrasonic ranging parameter of the robot is initialized, and bow-shaped cleaning is started;

wall-climbing cleaning control module: configured to control the robot to move to a second preset distance from the pool wall, the power of the water pump motor is reduced to a preset multiple of the maximum power, and the robot is controlled to climb the wall; when the IMU angle of the robot exceeds a predetermined angle or the ultrasonic ranging parameter is less than a predetermined distance, it is determined that the robot is currently at the pool wall, and the water pump motor power is restored to the maximum power to start wall-climbing cleaning.

CONTROL METHOD AND DEVICE FOR A SWIMMING POOL CLEANING ROBOT

Technical Field

[0001] The present invention pertains to the technical field of swimming pool cleaning, and specifically relates to a control method and device for a swimming pool cleaning robot.

Prior Art

[0002] Water quality pollution in swimming pools is a major factor affecting the appearance of the pool, and mainly arises from the following three sources: First, natural sources: Such as dust, leaves, rainwater, insects, etc.; Second, artificial additives: In order to maintain the clarity and hygiene of swimming pool water, various chemical agents such as disinfectants, algacides, pH balancers, and clarifiers are typically added to the pool water. These chemicals can react with other substances in the water to produce new pollutants. Additionally, the pool structure itself may shed debris due to corrosion, which also becomes a pollutant; Third, pollutants brought in by swimmers: This is the primary source of pollution in swimming pools and can be divided into substances shed from the human body and substances excreted by the human body.

[0003] At present, underwater cleaning robots have been developed for cleaning debris in swimming pools. Conventional underwater cleaning robots fall into two categories: one type is connected to a control box via a cable and is powered by an AC power supply, dragging the cable underwater during operation. The process of handling the cable is cumbersome and inconvenient. The other type is a wireless robot that operates underwater, but must be manually retrieved for charging and has a long charging time, which reduces user experience and cleaning efficiency. Furthermore, since cleaning is performed underwater, it is not possible to monitor the working status of the cleaning robot in real time, making cleaning planning inconvenient.

[0004] To address these issues, the applicant has developed a swimming pool cleaning robot equipped with a charging assembly, a floating assembly, a power supply assembly, and a cleaning assembly. The charging assembly comprises a charging dock, which is provided with a first charging induction part and a first magnetic attraction group. The floating assembly comprises a floating body, with a second charging induction part and a second magnetic attraction group on its side. The floating assembly is magnetically coupled to the second magnetic attraction group of the charging assembly via the first magnetic attraction group. When the first and second charging induction parts are connected, the power supply assembly is charged. The floating assembly is provided with a first driving module to drive the floating assembly, and the cleaning assembly is provided with a second driving module to drive the cleaning assembly. The floating assembly is connected to the cleaning assembly via a power supply cable. The power supply assembly supplies power to the cleaning assembly, the first driving module, and the second driving module. This swimming pool cleaning robot is equipped with a rechargeable power supply assembly, eliminating the need for a long cable, thereby avoiding the cumbersome process of cable management and preventing cable entanglement during operation, which could otherwise affect normal functioning. It can be charged directly without manual retrieval, offering a better user experience and higher cleaning efficiency. However, in order to improve the cleaning effectiveness of the swimming pool cleaning robot, the control and planning of the cleaning path is crucial. How to reasonably control the cleaning path to enhance cleaning performance is of significant research value.

Summary of the Invention

[0005] In view of the above, the present invention provides a control method and device for a swimming pool cleaning robot, which enables control of the cleaning path of the swimming pool cleaning robot and improves cleaning effectiveness.

[0006] To achieve the above objectives, the present disclosure provides the following technical solutions: A control method for a swimming pool cleaning robot, comprising:

[0007] Bow-shaped cleaning mode: the swimming pool cleaning robot performs attitude calibration; during the attitude calibration process, the robot is controlled to move to a first preset distance from the pool wall and rotate a preset angle in a clockwise or counterclockwise direction; the robot is then controlled to reverse until its rear is parallel to the pool wall, the current IMU angle or ultrasonic ranging parameter of the robot is initialized, and the bow-shaped cleaning is started;

[0008] wall-climbing cleaning mode: the robot is controlled to move to a second preset distance from the pool wall, the power of the water pump motor is reduced to a preset multiple of the maximum power, and the robot is controlled to climb the wall; when the IMU angle of the robot exceeds a predetermined angle or the ultrasonic ranging parameter is less than a predetermined distance, it is determined that the robot is currently at the pool wall, and the water pump motor power is restored to the maximum power to start wall-climbing cleaning.

[0009] As a preferred embodiment of the control method, during bow-shaped cleaning, the swimming pool cleaning robot is controlled to move forward to the first preset distance from the pool wall;

[0010] when the robot moves forward to the first preset distance from the pool wall, it is controlled to turn right or left by 90°, and after moving forward for a preset time, it is detected whether there is an obstacle in front of the robot; if there is an obstacle, it is marked as the first obstacle encounter.

[0011] As a preferred embodiment of the control method for a swimming pool cleaning robot, if there is no obstacle, the robot is controlled to turn right or left by 90° to continue cleaning, until the robot again reaches the first preset distance from the pool wall, then continues to turn right or left by 90°, moves forward for a preset time, and again detects whether there is an obstacle in front of the robot; if there is an obstacle, it is marked as the second obstacle encounter, at which time the robot is controlled to rotate 180° and clean in the opposite direction.

[0012] As a preferred embodiment of the control method for a swimming pool cleaning robot, it is detected again whether there is an obstacle in front of the robot, and if there is no obstacle, continue to control the robot to turn right or left by 90° to continue cleaning.

[0013] As a preferred embodiment of the control method for a swimming pool cleaning robot, when the robot performs the bow-shaped cleaning mode for a predetermined period, the robot is controlled to move forward to the first preset distance from the pool wall for angle calibration.

[0014] As a preferred embodiment of the control method for a swimming pool cleaning robot, during the wall-climbing cleaning process, when the robot climbs to a third preset distance from the water surface, it is determined that the robot is about to leave the water surface, and after a delay of at least 2 seconds, the robot is controlled to perform a reverse action.

[0015] As a preferred embodiment of the control method for a swimming pool cleaning robot, during the wall-climbing cleaning process, when the robot leaves the pool water surface, after a delay of at least 2 seconds, the robot is controlled to perform a reverse action.

[0016] As a preferred embodiment of the control method for a swimming pool cleaning robot, during the wall-climbing cleaning process, when the robot encounters an obstacle, the robot is controlled to continue climbing for a preset time, then perform a reverse action;

[0017] when the IMU tilt angle of the robot is less than 30 degrees, it is determined that the robot is in the pool bottom area.

[0018] As a preferred embodiment of the control method for a swimming pool cleaning robot, after it is determined that the robot is in the pool bottom area, the distance between the robot and the side pool wall is judged; when the side distance is less than 300 mm, it is determined that the robot is at a right angle, and the robot is controlled to rotate to clean the other side pool wall;

[0019] if the side distance is greater than or equal to 300 mm, the robot is controlled to reverse and rotate before continuing wall-climbing cleaning.

[0020] The present disclosure further provides a swimming pool cleaning robot control device, using the aforementioned swimming pool cleaning robot control method, comprising:

[0021] bow-shaped cleaning control module: configured to perform attitude calibration for the swimming pool cleaning robot; during the attitude calibration process, the robot is controlled to move to a first preset distance from the pool wall and rotate a preset angle in a clockwise or counterclockwise direction; the robot is then controlled to reverse until its rear is parallel to the pool wall, the current IMU angle or ultrasonic ranging parameter of the robot is initialized, and bow-shaped cleaning is started;

[0022] wall-climbing cleaning control module: configured to control the robot to move to a second preset distance from the pool wall, the power of the water pump motor is reduced to a preset multiple of the maximum power, and the robot is controlled to climb the wall; when the IMU angle of the robot exceeds a predetermined angle or the ultrasonic ranging parameter is less than a predetermined distance, it is determined that the robot is currently at the pool wall, and the water pump motor power is restored to the maximum power to start wall-climbing cleaning.

[0023] As a preferred embodiment of the control device for a swimming pool cleaning robot, the bow-shaped cleaning control module comprises a first obstacle detection submodule, configured to control the swimming pool cleaning robot to move forward to the first preset distance from the pool wall.

[0024] when the robot moves forward to the first preset distance from the pool wall, it is controlled to turn right or left by 90°, and after moving forward for a preset time, it is detected whether there is an obstacle in front of the robot; if there is an obstacle, it is marked as the first obstacle encounter.

[0025] As a preferred embodiment of the control device for a swimming pool cleaning robot, the bow-shaped cleaning control module comprises a second obstacle detection submodule, configured to, if there is no obstacle, control the robot to turn right or left by 90° to continue cleaning, until the robot again reaches the first preset distance from the pool wall, then continues to turn right or left by 90°, moves forward for a preset time, and again detects whether there is an obstacle in front of the robot; if there is an obstacle, it is marked as the second obstacle encounter, at which time the robot is controlled to rotate 180° and clean in the opposite direction.

[0026] As a preferred embodiment of the control device for a swimming pool cleaning robot, the bow-shaped cleaning control module comprises a subsequent obstacle detection submodule, configured to again detect whether there is an obstacle in front of the swimming pool cleaning robot, and if there is no obstacle, continue to control the swimming pool cleaning robot to continue turning right or left by 90° to continue cleaning.

[0027] As a preferred embodiment of the control device for a swimming pool cleaning robot, the bow-shaped cleaning control module comprises an angle calibration submodule, configured to, when the robot performs the bow-shaped cleaning mode for a predetermined period, control the robot to move forward to the first preset distance from the pool wall for angle calibration.

[0028] As a preferred embodiment of the control device for a swimming pool cleaning robot, the wall-climbing cleaning module comprises a water surface detection submodule, configured to, when the robot climbs to a third preset distance from the water surface, determine that the robot is about to leave the water surface, and after a delay of at least 2 seconds, the robot is controlled to perform a reverse action.

[0029] As a preferred embodiment of the control device for a swimming pool cleaning robot, the water surface detection submodule is further configured to, when the swimming pool cleaning robot leaves the pool water surface, after a delay of at least 2 seconds, control the swimming pool cleaning robot to perform a reverse action.

[0030] As a preferred embodiment of the control device for a swimming pool cleaning robot, the wall-climbing cleaning module comprises a wall-climbing obstacle detection submodule, configured to, when the swimming pool cleaning robot encounters an obstacle, control the swimming pool cleaning robot to continue climbing the wall for a predetermined period, and then perform a reverse action;

[0031] when the IMU tilt angle of the robot is less than 30 degrees, it is determined that the robot is in the pool bottom area.

[0032] As a preferred embodiment of the control device for a swimming pool cleaning robot, the wall-climbing cleaning module comprises a wall-climbing switching submodule, configured to, after it is determined that the swimming pool cleaning robot is in the pool bottom area, determine the distance between the swimming pool cleaning robot and the side pool wall. When the side distance is less than 300 mm, it is determined that the swimming pool cleaning robot is at a right angle, and at this time, the swimming pool cleaning robot is controlled to rotate and clean the other side pool wall;

[0033] if the side distance is greater than or equal to 300 mm, the robot is controlled to reverse and rotate before continuing wall-climbing cleaning.

[0034] The beneficial effects of the present disclosure are as follows: By providing a bow-shaped cleaning mode and a wall-climbing cleaning mode, in the bow-shaped cleaning mode, the swimming pool cleaning robot performs attitude calibration. During the attitude calibration process, the swimming pool cleaning robot is controlled to move to the first preset distance from the pool wall and rotate a preset angle clockwise or counterclockwise; the swimming pool cleaning robot is controlled to reverse until its rear is parallel to the pool wall, and the current IMU angle or ultrasonic ranging parameter of the swimming pool cleaning robot is initialized to start bow-shaped cleaning. In the wall-climbing cleaning mode, the swimming pool cleaning robot is controlled to move to a second preset distance from the pool wall, the power of the pump motor of the swimming pool cleaning robot is reduced to a preset multiple of the maximum power, and the swimming pool cleaning robot is controlled to climb the wall. When the IMU angle of the swimming pool cleaning robot is greater than a predetermined angle or the ultrasonic ranging parameter is less than a predetermined distance, it is determined that the swimming pool cleaning robot is currently at the pool wall position, and the pump motor power of the swimming pool cleaning robot is restored to the maximum power to start wall-climbing cleaning. The present disclosure can achieve reasonable control and planning of the cleaning path of the swimming pool cleaning robot, improve the comprehensiveness of cleaning by the swimming pool cleaning robot, and enhance the cleaning effect of the swimming pool.

Brief Description of the Drawings

[0035] In order to more clearly illustrate the embodiments of the present disclosure or the technical solutions in the prior art, a brief introduction to the drawings required for the description of the embodiments or the prior art is provided below. It is evident that the drawings described below are merely exemplary. For those of ordinary skill in the art, other illustrative drawings may be derived from the provided figures without any inventive effort.

[0036] The structures, proportions, sizes, and the like depicted in the present specification are solely for the purpose of facilitating understanding and reading of the disclosed content by those skilled in the art, and are not intended to limit the conditions under which the present disclosure may be implemented. Therefore, they do not have substantive technical significance. Any modifications to the structure, changes in proportional relationships, or adjustments in size, as long as they do not affect the efficacy and objectives achievable by the present disclosure, should still fall within the scope covered by the technical content disclosed herein.

[0037] FIG. 1 is a schematic diagram of the control method for a swimming pool cleaning robot provided in Embodiment 1 of the present disclosure;

[0038] FIG. 2 is a schematic diagram of the control device for a swimming pool cleaning robot provided in Embodiment 2 of the present disclosure.

Detailed Description

[0039] The following provides a detailed description of specific embodiments of the present disclosure. Those skilled in the art can readily understand other advantages and effects of the present invention based on the contents disclosed herein. Clearly, the embodiments described are part of the present invention and not exhaustive. Based on the embodiments in the present invention, all other embodiments obtained by one of ordinary skill in the art without creative work fall within the protection scope of the present invention.

[0040] In the related art, the applicant has developed and disclosed a swimming pool cleaning robot equipped with a charging assembly, a floating assembly, a power supply assembly, and a cleaning assembly. The charging assembly comprises a charging dock, which is provided with a first charging induction part and a first magnetic attraction group. The floating assembly comprises a floating body, with a second charging induction part and a second magnetic attraction group on its side. The floating assembly is magnetically coupled to the second magnetic attraction group of the charging assembly via the first magnetic attraction group. When the first and second charging induction parts are connected, the power supply assembly is charged. The floating assembly is provided with a first driving module to drive the floating assembly, and the cleaning assembly is provided with a second driving module to drive the cleaning assembly. The floating assembly is connected to the cleaning assembly via a power supply cable. The power supply assembly supplies power to the cleaning assembly, the first driving module, and the second driving module. In normal operation, the charging assembly is arranged at the edge of the swimming pool, with the charging bracket fixed to the poolside and the fixing part placed on the ground at the pool edge, while the adjustable base is positioned above the pool wall, i.e., above the water surface,

to facilitate charging of the power supply assembly. When the power supply assembly requires charging, the cleaning robot moves to the charging position, where the floating assembly and charging assembly are docked. The first and second magnetic attraction groups engage, enabling the first and second charging induction parts to conduct and thus charge the power supply assembly of the cleaning robot. Since the water level in the pool may fluctuate, to prevent the charging assembly from being submerged, the height of the charging dock can be adjusted via a sliding lug and a height adjustment slot. The purpose of the first driving module is to enable the floating assembly to move on the water surface. The impeller drive motor drives the walking impeller to rotate, which agitates the water surface, thereby propelling the floating assembly. The cleaning housing serves as a carrier for the cleaning assembly and the second driving module. During operation, the power supply assembly supplies power to the floating assembly and the first driving module via the power supply cable. The design of the drainage outlet and water guide port guides water flow during the operation of the drainage pump, allowing debris to be collected by the cleaning assembly into the debris collection box. The design of the avoidance mounting slot and edge mounting area makes the entire cleaning assembly more compact. Through the central cleaning roller brush and edge cleaning roller brush, cleaning of the central and front/rear sides is achieved, resulting in improved cleaning performance. The walking drive motor is powered by the power supply assembly. During operation, the walking drive motor drives the main drive wheel, which in turn drives the edge drive wheel via a transmission chain. The rotation of the transmission chain enables underwater movement of the cleaning assembly, while the rotation of the edge drive wheel drives the edge cleaning roller brush, thus achieving edge cleaning. Additionally, when the main drive wheel operates, it also drives the engaged intermediate drive wheel, which in turn drives the central cleaning roller brush, thereby achieving central cleaning. The design of the limiting wheel increases the stability of the transmission chain and facilitates adjustment of its tension. The balancing assembly may rotate relative to the cleaning housing. The handle facilitates lifting of the cleaning assembly, and the balancing groove on the handle achieves balance via the balanced float, ensuring the stability of the cleaning assembly underwater when driven by the second driving module. [0041] The technical solution of the present application is developed based on the above swimming pool cleaning robot. The specific structural design of the swimming pool cleaning robot can be found in related published applications and will not be repeated here. To implement the technical solution of the present application, ultrasonic sensors are arranged at the front and sides of the swimming pool cleaning robot, and an IMU (9-axis angle sensor) is also provided to enable distance and angle sensing control. Of course, ultrasonic distance measurement and IMU angle detection themselves are part of the prior art.

[0042] Embodiment 1

[0043] Referring to FIG. 1, Embodiment 1 of the present disclosure provides a control method for a swimming pool cleaning robot, comprising:

[0044] Bow-shaped cleaning mode: the swimming pool cleaning robot performs attitude calibration; during the attitude calibration process, the robot is controlled to move to a first preset distance from the pool wall and rotate a preset angle in a clockwise or counterclockwise direction; the robot is then controlled to reverse until its rear is parallel to the pool wall, the current IMU angle or ultrasonic ranging parameter of the robot is initialized, and the bow-shaped cleaning is started;

[0045] wall-climbing cleaning mode: the robot is controlled to move to a second preset distance from the pool wall, the power of the water pump motor is reduced to a preset multiple of the maximum power, and the robot is controlled to climb the wall; when the IMU angle of the robot exceeds a predetermined angle or the ultrasonic ranging parameter is less than a predetermined distance, it is determined that the robot is currently at the pool wall, and the water pump motor power is restored to the maximum power to start wall-climbing cleaning.

[0046] In this embodiment, during the bow-shaped cleaning process, the swimming pool cleaning robot is controlled to move forward to the first preset distance from the pool wall. When the robot moves forward to the first preset distance from the pool wall, it is controlled to turn right or left by 90°, and after moving forward for a preset time, it is detected whether there is an obstacle in front of the robot; if there is an obstacle, it is marked as the first obstacle encounter. If there is no obstacle, the robot is controlled to turn right or left by 90° to continue cleaning, until the robot again reaches the first preset distance from the pool wall, then continues to turn right or left by 90°, moves forward for a preset time, and again detects whether there is an obstacle in front of the robot; if there is an obstacle, it is marked as the second obstacle encounter, at which time the robot is controlled to rotate 180° and clean in the opposite direction. It is detected again whether there is an obstacle in front of the robot, and if there is no obstacle, continue to control the robot

to turn right or left by 90° to continue cleaning. When the robot performs the bow-shaped cleaning mode for a predetermined period, the robot is controlled to move forward to the first preset distance from the pool wall for angle calibration.

[0047] In one application process, under the bow-shaped cleaning mode, when the swimming pool cleaning robot enters bottom cleaning, it first enters calibration mode, moves forward until the front ultrasonic sensor detects a distance of 250 mm from the pool wall, then rotates clockwise by 160°, and then reverses until its rear is parallel to the pool wall. Record the IMU angle at this time as the initial value of 0 degrees. Begin bow-shaped cleaning: the swimming pool cleaning robot moves forward until it is 250 mm from the pool wall. At this point, the swimming pool cleaning robot turns right by 90°, advances for 1 second, and then detects whether there is an obstacle ahead. If an obstacle is detected, it is marked as the first obstacle encounter; if no obstacle is detected, the robot turns right by 90° and continues cleaning until it is again 250 mm from the pool wall. At this point, it turns right by 90°, advances for 1 second, and again detects whether there is an obstacle ahead. If an obstacle is detected, it is marked as the second obstacle encounter. The swimming pool cleaning robot then rotates 180° and proceeds to clean in the opposite direction; if no obstacle is detected, it turns right by 90° and continues cleaning, repeating this process. When the swimming pool cleaning robot has been operating for 10 minutes, it moves to the pool wall and re-enters calibration mode to calibrate the current angle.

[0048] In this embodiment, during the wall-climbing cleaning process, when the robot climbs to a third preset distance from the water surface, it is determined that the robot is about to leave the water surface, and after a delay of at least 2 seconds, the robot is controlled to perform a reverse action. Or, during the wall-climbing cleaning process, when the robot leaves the pool water surface, after a delay of at least 2 seconds, the robot is controlled to perform a reverse action. During the wall-climbing cleaning process, when the robot encounters an obstacle, the robot is controlled to continue climbing for a preset time, then perform a reverse action; when the IMU tilt angle of the robot is less than 30 degrees, it is determined that the robot is in the pool bottom area. After it is determined that the robot is in the pool bottom area, the distance between the robot and the side pool wall is judged; when the side distance is less than 300 mm, it is determined that the robot is at a right angle, and the robot is controlled to rotate to clean the other side pool wall; if the side distance is greater than or equal to 300 mm, the robot is controlled to reverse and rotate before continuing wall-climbing cleaning.

[0049] In one application process, under the wall-climbing cleaning mode, after entering the pool wall cleaning, the swimming pool cleaning robot moves toward the pool wall. When ultrasonic detection identifies that the distance between the swimming pool cleaning robot and the wall is approximately 300 mm, the pump power is reduced to 50% of the maximum power, and the swimming pool cleaning robot begins wall climbing. When the IMU detects that the angle of the swimming pool cleaning robot exceeds 60 degrees, it is determined that the swimming pool cleaning robot is at the wall position, and the pump power is adjusted to 100%, allowing the swimming pool cleaning robot to climb up the wall. When the swimming pool cleaning robot ascends to a distance of 300 mm from the water surface, ultrasonic detection determines that the swimming pool cleaning robot is about to leave the water surface. At this time, after a delay of 2 seconds, the swimming pool cleaning robot performs a reverse action; or, if the ultrasonic detection identifies that the swimming pool cleaning robot has left the water surface, after a delay of 2 seconds, the reverse procedure is executed.

[0050] Specifically, when the swimming pool cleaning robot encounters an obstacle while climbing the wall, it continues to climb for 40 seconds. If it still has not passed the obstacle, it performs a reverse action. The robot reverses until the IMU detects that the tilt angle of the swimming pool cleaning robot is less than 30 degrees, at which point it is determined that the swimming pool cleaning robot has reached the pool bottom. The swimming pool cleaning robot then detects the distance between the side ultrasonic sensor and the side wall. If the side ultrasonic distance is less than 300 mm, it is determined that the swimming pool cleaning robot is at a right angle, and the robot rotates counterclockwise by 65° to clean the other wall surface. If the side ultrasonic data is greater than or equal to 300 mm, the swimming pool cleaning robot reverses for 1 second and then rotates clockwise by 20°, continuing wall-climbing cleaning.

[0051] In summary, the present disclosure provides both a bow-shaped cleaning mode and a wall-climbing cleaning mode. Under the bow-shaped cleaning mode, when the swimming pool cleaning robot enters bottom cleaning, it first enters calibration mode, moves forward until the front ultrasonic sensor detects a distance of 250 mm from the pool wall, then rotates clockwise by 160°, and then reverses until its rear is parallel to the pool wall. Record the IMU angle at this time as the initial value of 0 degrees. Begin bow-

shaped cleaning: the swimming pool cleaning robot moves forward until it is 250 mm from the pool wall. At this point, the swimming pool cleaning robot turns right by 90°, advances for 1 second, and then detects whether there is an obstacle ahead. If an obstacle is detected, it is marked as the first obstacle encounter; if no obstacle is detected, the robot turns right by 90° and continues cleaning until it is again 250 mm from the pool wall. At this point, it turns right by 90°, advances for 1 second, and again detects whether there is an obstacle ahead. If an obstacle is detected, it is marked as the second obstacle encounter. The swimming pool cleaning robot then rotates 180° and proceeds to clean in the opposite direction; if no obstacle is detected, it turns right by 90° and continues cleaning, repeating this process. Under the wall-climbing cleaning mode, after entering the pool wall cleaning, the swimming pool cleaning robot moves toward the pool wall. When ultrasonic detection identifies that the distance between the swimming pool cleaning robot and the wall is approximately 300 mm, the pump power is reduced to 50% of the maximum power, and the swimming pool cleaning robot begins wall climbing. When the IMU detects that the angle of the swimming pool cleaning robot exceeds 60 degrees, it is determined that the swimming pool cleaning robot is at the wall position, and the pump power is adjusted to 100%, allowing the swimming pool cleaning robot to climb up the wall. When the swimming pool cleaning robot ascends to a distance of 300 mm from the water surface, ultrasonic detection determines that the swimming pool cleaning robot is about to leave the water surface. At this time, after a delay of 2 seconds, the swimming pool cleaning robot performs a reverse action; or, if the ultrasonic detection identifies that the swimming pool cleaning robot has left the water surface, after a delay of 2 seconds, the reverse procedure is executed. When the swimming pool cleaning robot encounters an obstacle while climbing the wall, it continues to climb for 40 seconds. If it still has not passed the obstacle, it performs a reverse action. The robot reverses until the IMU detects that the tilt angle of the swimming pool cleaning robot is less than 30 degrees, at which point it is determined that the swimming pool cleaning robot has reached the pool bottom. The swimming pool cleaning robot then detects the distance between the side ultrasonic sensor and the side wall. If the side ultrasonic distance is less than 300 mm, it is determined that the swimming pool cleaning robot is at a right angle, and the robot rotates counterclockwise by 65° to clean the other wall surface. If the side ultrasonic data is greater than or equal to 300 mm, the swimming pool cleaning robot reverses for 1 second and then rotates clockwise by 20°, continuing wall-climbing cleaning. When the swimming pool cleaning robot has been operating for 10 minutes, it moves to the pool wall and re-enters calibration mode to calibrate the current angle. The present disclosure can achieve reasonable control and planning of the cleaning path of the swimming pool cleaning robot, improve the comprehensiveness of cleaning by the swimming pool cleaning robot, and enhance the cleaning effect of the swimming pool.

[0052] It should be noted that the method according to the embodiments of the present disclosure may be executed by a single device, such as a computer or server. The method of this embodiment may also be applied in distributed scenarios, wherein multiple devices cooperate with each other to complete the process. In such distributed scenarios, one of the multiple devices may execute only one or more steps of the method according to the embodiments of the present disclosure, and these devices interact with each other to accomplish the method.

[0053] It should be noted that the above describes some embodiments of the present disclosure. Other embodiments are within the scope of the appended Claims. In some cases, actions or steps described in the Claims can be performed in a different order than that of the embodiments and still achieve the desired results. Additionally, the processes depicted in the drawings do not necessarily require specific or continuous sequences to achieve the desired results. In some embodiments, multitasking and parallel processing are also possible or advantageous.

[0054] Embodiment 2

[0055] Referring to FIG. 2, Embodiment 2 of the present disclosure provides a control device for a swimming pool cleaning robot, using the swimming pool cleaning robot control method of the aforementioned embodiments, comprising:

[0056] bow-shaped cleaning control module 1: configured to perform attitude calibration for the swimming pool cleaning robot; during the attitude calibration process, the robot is controlled to move to a first preset distance from the pool wall and rotate a preset angle in a clockwise or counterclockwise direction; the robot is then controlled to reverse until its rear is parallel to the pool wall, the current IMU angle or ultrasonic ranging parameter of the robot is initialized, and bow-shaped cleaning is started;

[0057] wall-climbing cleaning control module 2: configured to control the robot to move to a second preset distance from the pool wall, the power of the water pump motor is reduced to a preset multiple of the

maximum power, and the robot is controlled to climb the wall; when the IMU angle of the robot exceeds a predetermined angle or the ultrasonic ranging parameter is less than a predetermined distance, it is determined that the robot is currently at the pool wall, and the water pump motor power is restored to the maximum power to start wall-climbing cleaning.

[0058] In this embodiment, the bow-shaped cleaning control module 1 comprises a first obstacle detection submodule 11, configured to control the swimming pool cleaning robot to move forward to the first preset distance from the pool wall.

[0059] when the robot moves forward to the first preset distance from the pool wall, it is controlled to turn right or left by 90°, and after moving forward for a preset time, it is detected whether there is an obstacle in front of the robot; if there is an obstacle, it is marked as the first obstacle encounter.

[0060] In this embodiment, the bow-shaped cleaning control module comprises a second obstacle detection submodule, configured to, if there is no obstacle, control the robot to turn right or left by 90° to continue cleaning, until the robot again reaches the first preset distance from the pool wall, then continues to turn right or left by 90°, moves forward for a preset time, and again detects whether there is an obstacle in front of the robot; if there is an obstacle, it is marked as the second obstacle encounter, at which time the robot is controlled to rotate 180° and clean in the opposite direction.

[0061] In this embodiment, the bow-shaped cleaning control module comprises a subsequent obstacle detection submodule, configured to again detect whether there is an obstacle in front of the swimming pool cleaning robot, and if there is no obstacle, continue to control the swimming pool cleaning robot to continue turning right or left by 90° to continue cleaning.

[0062] In this embodiment, the bow-shaped cleaning control module comprises an angle calibration submodule, configured to, when the robot performs the bow-shaped cleaning mode for a predetermined period, control the robot to move forward to the first preset distance from the pool wall for angle calibration.

[0063] In this embodiment, the wall-climbing cleaning module 2 comprises a water surface detection submodule 21, configured to, when the robot climbs to a third preset distance from the water surface, determine that the robot is about to leave the water surface, and after a delay of at least 2 seconds, the robot is controlled to perform a reverse action.

[0064] In this embodiment, the water surface detection submodule 21 is further configured to, when the swimming pool cleaning robot leaves the pool water surface, after a delay of at least 2 seconds, control the swimming pool cleaning robot to perform a reverse action.

[0065] In this embodiment, the wall-climbing cleaning module 2 comprises a wall-climbing obstacle detection submodule 22, configured to, when the swimming pool cleaning robot encounters an obstacle, control the swimming pool cleaning robot to continue climbing the wall for a predetermined period, and then perform a reverse action;

[0066] when the IMU tilt angle of the robot is less than 30 degrees, it is determined that the robot is in the pool bottom area.

[0067] In this embodiment, the wall-climbing cleaning module 2 comprises a wall-climbing switching submodule 23, configured to, after it is determined that the swimming pool cleaning robot is in the pool bottom area, determine the distance between the swimming pool cleaning robot and the side pool wall. When the side distance is less than 300 mm, it is determined that the swimming pool cleaning robot is at a right angle, and at this time, the swimming pool cleaning robot is controlled to rotate and clean the other side pool wall;

[0068] if the side distance is greater than or equal to 300 mm, the robot is controlled to reverse and rotate before continuing wall-climbing cleaning.

[0069] It should be noted that the information interaction and execution process among the modules of the above device are based on the same concept as the method embodiment 1 of this application, and thus achieve the same technical effects as the method embodiment of this application. For specific details, please refer to the descriptions in the foregoing method embodiments of this application, which will not be repeated here.

[0070] Embodiment 3

[0071] Embodiment 3 of the present disclosure provides a non-transitory computer-readable storage medium, wherein the computer-readable storage medium stores program code for the control method of a swimming pool cleaning robot, and the program code includes instructions for executing the control method of a swimming pool cleaning robot according to Embodiment 1 or any possible implementation thereof.

[0072] The computer-readable storage medium may be any available medium accessible by a computer, or a data storage device such as a server or data center integrating one or more available media. The available media may be magnetic media (e.g., floppy disk, hard disk, magnetic tape), optical media (e.g., DVD), or semiconductor media (e.g., solid state disk (SSD)), etc.

[0073] Embodiment 4

[0074] Embodiment 4 of the present disclosure provides an electronic device, comprising: a memory and a processor;

[0075] The processor and the memory communicate with each other via a bus; the memory stores program instructions executable by the processor, and the processor, by invoking the program instructions, is capable of executing the control method for a swimming pool cleaning robot according to Embodiment 1 or any possible implementation thereof.

[0076] Specifically, the processor may be implemented by hardware or software. When implemented by hardware, the processor may be a logic circuit, integrated circuit, etc.; when implemented by software, the processor may be a general-purpose processor, which implements the function by reading software code stored in the memory. The memory may be integrated within the processor or may be located outside the processor and exist independently.

[0077] In the above embodiments, the implementation may be entirely or partially realized by software, hardware, firmware, or any combination thereof. When implemented by software, it may be realized entirely or partially in the form of a computer program product. The computer program product includes one or more computer instructions. When the computer program instructions are loaded and executed on a computer, all or part of the processes or functions described in the embodiments of the present disclosure are generated. The computer may be a general-purpose computer, a dedicated computer, a computer network, or other programmable device. The computer instructions may be stored in a computer-readable storage medium or transmitted from one computer-readable storage medium to another, for example, the computer instructions may be transmitted from a website, computer, server, or data center to another website, computer, server, or data center via wired (e.g., coaxial cable, optical fiber, digital subscriber line (DSL)) or wireless (e.g., infrared, wireless, microwave, etc.) means.

[0078] Obviously, those skilled in the art should understand that the above modules or steps of the present disclosure may be implemented by general computing devices, which may be centralized on a single computing device or distributed over a network composed of multiple computing devices. Optionally, they may be implemented by program code executable by a computing device, so that they can be stored in a storage device and executed by the computing device. In some cases, the steps shown or described herein may be performed in an order different from that described herein, or they may be made as separate integrated circuit modules, or multiple modules or steps may be made as a single integrated circuit module. Thus, the present disclosure is not limited to any specific hardware and software combination.

[0079] Although the present disclosure has been described in detail with general description and specific embodiments above, modifications or improvements may be made based on the present disclosure, which are apparent to those skilled in the art. Therefore, such modifications or improvements made without departing from the spirit of the present disclosure shall fall within the scope of protection claimed by the present disclosure.

Bow-Shaped Cleaning Mode	Wall-Climbing Cleaning Mode
The swimming pool cleaning robot performs attitude calibration. During the attitude calibration process, the robot is controlled to move to a first preset distance from the pool wall and rotate a preset angle in a clockwise or counterclockwise direction; the robot is then controlled to reverse until its rear is parallel to the pool wall, the current IMU angle or ultrasonic ranging parameter of the robot is initialized, and the bow-shaped cleaning is started.	The robot is controlled to move to a second preset distance from the pool wall, the power of the water pump motor is reduced to a preset multiple of the maximum power, and the robot is controlled to climb the wall. When the IMU angle of the robot exceeds a predetermined angle or the ultrasonic ranging parameter is less than a predetermined distance, it is determined that the robot is currently at the pool wall, and the water pump motor power is restored to the maximum power to start wall-climbing cleaning.

FIG. 1

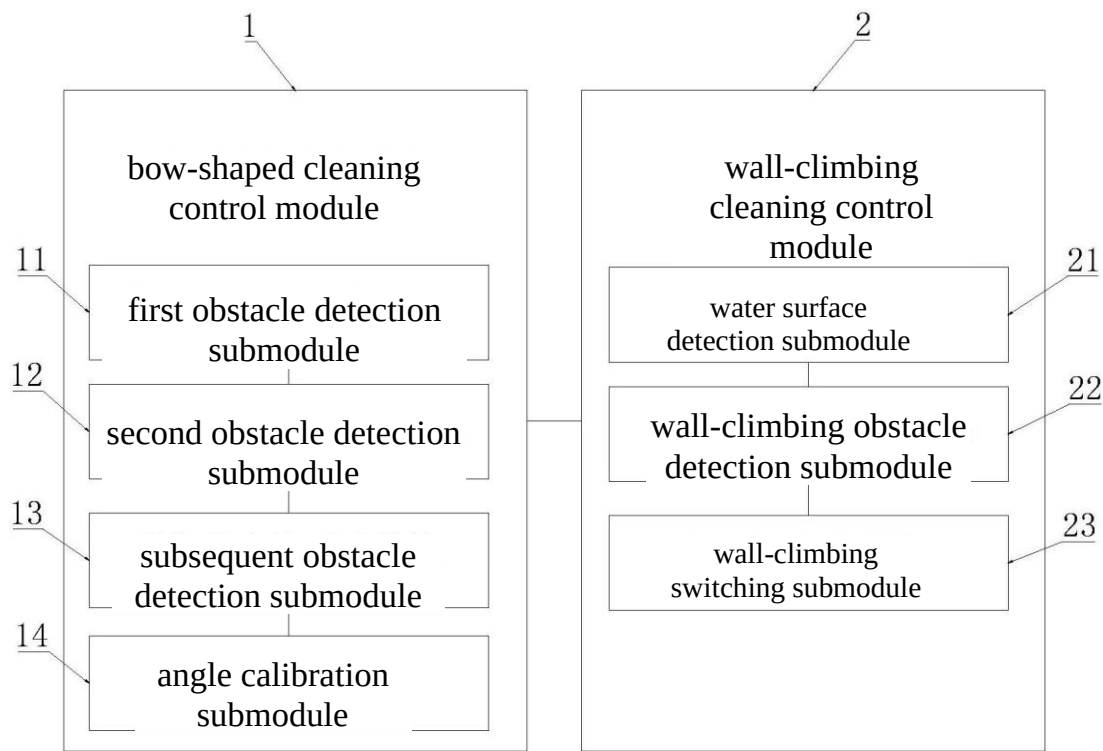


FIG. 2