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POOL ROBOT CONTROL METHOD AND APPARATUS, STORAGE MEDIUM, AND POOL ROBOT

CROSS-REFERNCE TO RELATED APPLICATIONS

[0001] The present disclosure is a continuation of International Patent Application No. PCT/CN2023/116834, filed with the World Intellectual Property Organization on September 4, 2023, which claims priority to Chinese patent application No. CN202310768678.3, filed on June 27, 2023 and entitled "POOL ROBOT CONTROL METHOD AND APPARATUS, STORAGE MEDIUM, AND POOL ROBOT", which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] Embodiments of the present disclosure relate to the field of computers, and specifically, to a pool robot control method and apparatus, a storage medium, and a pool robot.

BACKGROUND

[0003] A pool robot in a related technology can perform one or more tasks in a pool (for example, performing disinfection and performing cleaning). However, when the pool robot performs an operation on a specific object, the pool robot cannot quickly determine a position of the object, affecting efficiency in performing the operation.

[0004] In the related technology, an effective solution to resolve the above problem has not been proposed.

SUMMARY

[0005] Embodiments of the present disclosure provide a pool robot control method and apparatus, a storage medium, and a pool robot to at least resolve a problem of inefficiency of a pool robot in performing an operation on a specific object in a related technology.

[0006] According to an embodiment of the present disclosure, a pool robot control method is provided. The method includes: obtaining image information of a target water region captured by a pool robot, where the pool robot operates in the target water region; analyzing the image information to determine an analysis result; and determining a target position of a target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform a target operation corresponding to a type of the target object.

[0007] In an example embodiment, the obtaining image information of a target water region

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captured by a pool robot includes: obtaining the image information of the target water region captured by the pool robot when the pool robot operates in a first operation mode. The first operation mode is a mode in which the pool robot operates between a plurality of preset positions along a random route based on a preset time period.

[0008] In an example embodiment, the determining a target position of a target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform a target operation corresponding to a type of the target object includes: if the analysis result indicates that there is the target object in the target water region, determining the target position based on the image information; and controlling the pool robot to move to the target position and perform the target operation corresponding to the type of the target object.

[0009] In an example embodiment, after the obtaining image information of a target water region captured by a pool robot, the method further includes: determining a pixel coordinate of the target object in each of a plurality of frames of images to obtain a plurality of pixel coordinates, where the image information includes the plurality of frames of images; converting and mapping the plurality of pixel coordinates to a camera device coordinate system based on a first configuration parameter of a camera device of the pool robot to obtain a plurality of mapped coordinates, where the first configuration parameter includes a parameter existing when the image is captured; and determining the target position of the target object in the target water region based on the plurality of mapped coordinates and a second configuration parameter of the camera device. The second configuration parameter includes pose information existing when the camera device captures the image. The pose information includes a rotation matrix and a translation vector.

[0010] In an example embodiment, the converting and mapping the plurality of pixel coordinates to a camera device coordinate system based on a first configuration parameter of a camera device of the pool robot to obtain a plurality of mapped coordinates includes: converting and mapping the plurality of pixel coordinates to normalized coordinates in the camera device coordinate system to obtain the plurality of mapped coordinates; or converting and mapping the plurality of pixel coordinates to image plane coordinates in the camera device coordinate system to obtain the plurality of mapped coordinates.

[0011] In an example embodiment, the obtaining image information of a target water region captured by a pool robot includes: obtaining the image information of the target water region captured by the pool robot when the pool robot operates in a second operation mode. The second operation mode is a mode in which the pool robot operates between a plurality of

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preset positions along a fixed route based on a preset time period.

[0012] In an example embodiment, the determining a target position of a target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform a target operation corresponding to a type of the target object includes: when the pool robot operates in the second operation mode, determining the target position of the target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform the target operation corresponding to the type of the target object.

[0013] In an example embodiment, the determining a target position of a target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform a target operation corresponding to a type of the target object includes: after the pool robot operates in a second operation mode, marking positions of a plurality of target objects on a map if the analysis result indicates that there is the plurality of target objects in the target water region, where the map is constructed in a process in which the pool robot operates in the target water region; determining an operation route based on the positions of the plurality of target objects; and controlling the pool robot to move to the positions of the plurality of target objects along the operation route and perform a target operation corresponding to a type of each target object.

[0014] In an example embodiment, the determining an operation route based on the positions of the plurality of target objects includes: inputting the positions of the plurality of target objects to a target shortest route model to obtain the operation route. The operation route is a shortest operation route in which the pool robot passes through the positions of the plurality of target objects.

[0015] In an example embodiment, the target shortest route model is determined in the following manner: defining an objective function as a length of the operation route; taking a plurality of randomly combined operation routes as parents and a plurality of randomly re-combined operation routes as offspring; and determining the target shortest route model based on the parents and the offspring.

[0016] In an example embodiment, before the obtaining image information of a target water region captured by a pool robot, the method further includes: controlling the pool robot to perform the target operation along an edge in the target water region; and after it is determined that the pool robot completes the target operation along the edge, controlling the pool robot to perform a patrolling operation in the target water region. The patrolling operation includes controlling the pool robot to capture the image information in the target water region.

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[0017] In an example embodiment, before the obtaining image information of a target water region captured by a pool robot, the method further includes: controlling the pool robot to perform a task in the target water region, where the task includes performing the target operation along an edge of the target water region, performing the target operation in the target water region along a planned route, and performing the target operation along the edge of the target water region again; and after it is determined that the pool robot completes the task, controlling the pool robot to perform a patrolling operation in the target water region. The patrolling operation includes controlling the pool robot to capture the image information in the target water region.

[0018] In an example embodiment, the target object is determined in the following manner: inputting the image information to a target network model to obtain feature information of an object included in the image information output by the target network model, where the feature information includes a spatial feature and a semantic feature of the object; and determining the target object based on the feature information of the object.

[0019] In an example embodiment, the target network model is trained in the following manner: obtaining M frames of sample images, where each frame of sample image includes a preset object, and M is a natural number greater than or equal to one; marking the preset object in each frame of sample image to obtain M frames of marked sample images; and training an original network model based on the M frames of marked sample images to obtain the target network model.

[0020] According to another embodiment of the present disclosure, a pool robot control apparatus is provided. The apparatus includes: an obtaining module configured to obtain image information of a target water region captured by a pool robot, where the pool robot operates in the target water region; an analysis module configured to analyze the image information to determine an analysis result; and a determining module configured to determine a target position of a target object if the analysis result indicates that there is the target object in the target water region, and control the pool robot to move to the target position and perform a target operation corresponding to a type of the target object.

[0021] In an example embodiment, the obtaining module includes a first obtaining sub-module configured to obtain the image information of the target water region captured by the pool robot when the pool robot operates in a first operation mode. The first operation mode is a mode in which the pool robot operates between a plurality of preset positions along a random route based on a preset time period.

[0022] In an example embodiment, the determining module includes: a first determining sub-

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module configured to determine the target position based on the image information if the analysis result indicates that there is the target object in the target water region and a control sub-module configured to control the pool robot to move to the target position and perform the target operation corresponding to the type of the target object.

[0023] In an example embodiment, the obtaining module includes a second obtaining sub-module configured to obtain the image information of the target water region captured by the pool robot when the pool robot operates in a second operation mode. The second operation mode is a mode in which the pool robot operates between a plurality of preset positions along a fixed route based on a preset time period.

[0024] In an example embodiment, the determining module includes a second determining sub-module configured to: when the pool robot operates in the second operation mode, determine the target position of the target object if the analysis result indicates that there is the target object in the target water region, and control the pool robot to move to the target position and perform the target operation corresponding to the type of the target object.

[0025] In an example embodiment, the apparatus is further configured to: after obtaining the image information of the target water region captured by the pool robot, determine a pixel coordinate of the target object in each of a plurality of frames of images to obtain a plurality of pixel coordinates, where the image information includes the plurality of frames of images; convert and map the plurality of pixel coordinates to a camera device coordinate system based on a first configuration parameter of a camera device of the pool robot to obtain a plurality of mapped coordinates, where the first configuration parameter includes a parameter existing when the image is captured; and determine the target position of the target object in the target water region based on the plurality of mapped coordinates and a second configuration parameter of the camera device. The second configuration parameter includes pose information existing when the camera device captures the image. The pose information includes a rotation matrix and a translation vector.

[0026] In an example embodiment, the plurality of pixel coordinates are converted and mapped to the camera device coordinate system based on the first configuration parameter of the camera device of the pool robot in the following manner, to obtain the plurality of mapped coordinates: converting and mapping the plurality of pixel coordinates to normalized coordinates in the camera device coordinate system to obtain the plurality of mapped coordinates; or converting and mapping the plurality of pixel coordinates to image plane coordinates in the camera device coordinate system to obtain the plurality of mapped coordinates.

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[0027] In an example embodiment, the determining module further includes: a third determining sub-module configured to: after the pool robot operates in a second operation mode, mark positions of a plurality of target objects on a map if the analysis result indicates that there is the plurality of target objects in the target water region, where the map is constructed in a process in which the pool robot operates in the target water region; a fourth determining sub-module configured to determine an operation route based on the positions of the plurality of target objects; and a control sub-module configured to control the pool robot to move to the positions of the plurality of target objects along the operation route and perform a target operation corresponding to a type of each target object.

[0028] In an example embodiment, the operation route is determined based on the positions of the plurality of target objects in the following manner: inputting the positions of the plurality of target objects to a target shortest route model to obtain the operation route. The operation route is a shortest operation route in which the pool robot passes through the positions of the plurality of target objects.

[0029] In an example embodiment, the target shortest route model is determined in the following manner: defining an objective function as a length of the operation route; taking a plurality of randomly combined operation routes as parents and a plurality of randomly re-combined operation routes as offspring; and determining the target shortest route model based on the parents and the offspring.

[0030] In an example embodiment, the apparatus further includes: a first control module configured to: before the image information of the target water region captured by the pool robot is obtained, control the pool robot to perform the target operation along an edge in the target water region; and a second control module configured to: after it is determined that the pool robot completes the target operation along the edge, control the pool robot to perform a patrolling operation in the target water region. The patrolling operation includes controlling the pool robot to capture the image information in the target water region.

[0031] In an example embodiment, the apparatus is further configured to: before obtaining the image information of the target water region captured by the pool robot, control the pool robot to perform a task in the target water region, where the task includes performing the target operation along an edge of the target water region, performing the target operation in the target water region along a planned route, and performing the target operation along the edge of the target water region again; and after it is determined that the pool robot completes the task, control the pool robot to perform a patrolling operation in the target water region. The patrolling operation includes controlling the pool robot to capture the image information

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in the target water region.

[0032] In an example embodiment, the target object is determined in the following manner: inputting the image information to a target network model to obtain feature information of an object included in the image information output by the target network model, where the feature information includes a spatial feature and a semantic feature of the object; and determining the target object based on the feature information of the object.

[0033] In an example embodiment, the target network model is trained in the following manner: obtaining M frames of sample images, where each frame of sample image includes a preset object, and M is a natural number greater than or equal to one; marking the preset object in each frame of sample image to obtain M frames of marked sample images; and training an original network model based on the M frames of marked sample images to obtain the target network model.

[0034] According to still another embodiment of the present disclosure, a computer-readable storage medium is further provided. The computer-readable storage medium stores a computer program. When the computer program is run, steps in any one of the method embodiments are performed.

[0035] According to still another embodiment of the present disclosure, a pool robot is further provided. The pool robot includes a memory and a processor. The memory stores a computer program. The processor is configured to: when executing the computer program, perform steps in any one of the method embodiments.

[0036] According to the present disclosure, the image information of the target water region captured by the pool robot is analyzed, so that the target object can be identified, and the position of the target object can be determined. Further, the pool robot can be controlled to directly move to the position of the target object and perform the target operation on the target object. In this way, the following case can be avoided: The pool robot cannot position the target object and therefore can only re-clean the entire target water region along a preset route.

BRIEF DESCRIPTION OF THE DRAWINGS

[0037] FIG. 1 is a block diagram of a hardware structure of a mobile terminal for performing a pool robot control method according to an embodiment of the present disclosure;

[0038] FIG. 2 is a flowchart of a pool robot control method according to an embodiment of the present disclosure; and

[0039] FIG. 3 is a block diagram of a structure of a pool robot control apparatus according to an embodiment of the present disclosure.

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DETAILED DESCRIPTION

[0040] Embodiments of the present disclosure are described in detail in the following with reference to the accompanying drawings.

[0041] It should be noted that in this specification, claims, and the accompanying drawings of the present disclosure, the terms "first", "second", and the like are intended to distinguish between similar objects but do not necessarily indicate a specific order or sequence.

[0042] The method provided in embodiments of the present disclosure may be performed by a mobile terminal, a computer terminal, or a similar computing apparatus. An example in which the method is performed by the mobile terminal is used. FIG. 1 is a block diagram of a hardware structure of a mobile terminal for performing a pool robot control method according to an embodiment of the present disclosure. As shown in FIG. 1, the mobile terminal may include one or more (only one processor is shown in FIG. 1) processors 102 (the processor 102 may include, but is not limited to, a processing apparatus such as a microprocessor unit or a field-programmable gate array FPGA) and a memory 104 configured to store data. The mobile terminal may further include a transmission device 106 with a communication function and an input/output device 108. A person skilled in the art may understand that the structure shown in FIG. 1 is only an example and does not constitute a limitation on the structure of the mobile terminal. For example, the mobile terminal may include more or fewer components than those shown in FIG. 1 or have a configuration different from that shown in FIG. 1.

[0043] The memory 104 may be configured to store a computer program, for example, a software program of an application software and modules, for example, a computer program corresponding to the pool robot control method in embodiments of the present disclosure. The processor 102 executes the computer program stored in the memory 104 to execute various functional applications and data processing, that is, to implement the above method. The memory 104 may include a high-speed random access memory, a non-volatile memory, for example, one or more magnetic storage apparatuses, a flash memory, or another non-volatile solid-state memory. In some examples, the memory 104 may further include memories that are remotely disposed relative to the processor 102, and these remote memories may be connected to the mobile terminal through a network. Examples of the foregoing network include, but are not limited to, the Internet, an enterprise intranet, a local area network, a mobile communication network, and a combination thereof.

[0044] The transmission device 106 is configured to receive or send data through one network. Specific examples of the network may include a wireless network provided by a

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communication provider of the mobile terminal. In one example, the transmission device 106 includes a network interface controller (Network Interface Controller, NIC for short) and may be connected to other network devices through a base station to communicate with the Internet. In one example, the transmission device 106 may be a radio frequency (Radio Frequency, RF for short) module configured to communicate with the Internet in a wireless manner.

[0045] An embodiment provides a pool robot control method. FIG. 2 is a schematic flowchart of the method according to an embodiment of the present disclosure. As shown in FIG. 2, the method may include the following steps.

[0046] Step S202: Obtain image information of a target water region captured by a pool robot, where the pool robot operates in the target water region.

[0047] Step S204: Analyze the image information to determine an analysis result.

[0048] Step S206: Determine a target position of a target object if the analysis result indicates that there is the target object in the target water region, and control the pool robot to move to the target position and perform a target operation corresponding to a type of the target object.

[0049] The above steps may be executed by a controller of the pool robot, a processor having data processing and signal interaction capabilities, or another processing device or processing unit having a similar processing capability. However, this is not limited thereto.

[0050] In the above embodiment, the device, of the pool robot, configured to perform capturing is a highly waterproofed camera. The camera may be disposed at a front end, a side surface, a top, or the like of the pool robot. A specific disposition position of the camera is not limited. The target water region is, but is not limited to, a swimming pool, an ornamental reservoir, a wild pool, or the like. The pool robot may be located on a water surface of the target water region or a bottom of the target water region, or suspended in the target water region, or located on a wall of a swimming pool when the target water region is the swimming pool. The image information may be analyzed in a manner of identifying the image information by using a pre-trained network model or identifying the image information by using other image analysis devices. The target object includes, but is not limited to, all types of debris, for example, a plastic bottle cap and a leaf. The image information may be a picture or a video including a plurality of frames of images. The image information is obtained in real time in a process in which the robot patrols the target water region. The target operation includes, but is not limited to, a cleaning operation, a disinfection operation, an alarm operation, and the like. For example, the pool robot may clean various types of debris (for example, a plastic bottle cap and a leaf), disinfect a region in which the target object is located and that needs to be disinfected, and send an alarm signal when detecting that the target object

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is a person or an animal that accidentally falls into the water.

[0051] Optionally, the analyzing the image information to determine an analysis result includes: inputting the image information to a target network model to obtain feature information of an object included in the image information output by the target network model, where the feature information includes a spatial feature and a semantic feature of the object included in each frame of image; and determining the target object based on the feature information of the object included in each frame of image. In this embodiment, the spatial feature is a shallow visual feature and includes a texture, a color, a shape, a spatial relationship, and the like, and the semantic feature includes a deep relationship between objects.

[0052] Optionally, a method for training the target network model includes: obtaining M frames of sample images, where each frame of sample image includes a preset object, and M is a natural number greater than or equal to one; marking the preset object in each frame of sample image to obtain M frames of marked sample images; and training an original network model based on the M frames of marked sample images to obtain the target network model. In this embodiment, the original network model may be YOLOv3 (a third version of a YOLO algorithm) or FasterRCNN (an optimized version of a FastRCNN algorithm, where a region of interest is generated by using a region proposal network). Certainly, the algorithm is only an example, and the original network model may be any model that can satisfy an identification requirement. The sample image may be a network resource, manually captured data, or an AI-generated training material. The target object in the sample image may be manually marked. Each sample image may include a plurality of target objects.

[0053] According to this embodiment of the present disclosure, the image information of the target water region captured by the pool robot is analyzed, so that the target object can be identified, and the position of the target object can be determined. Further, the pool robot can be controlled to directly move to the position of the target object and perform the target operation on the target object. In this way, the following case can be avoided: The pool robot cannot position the target object and therefore can only re-clean the entire target water region along a preset route.

[0054] In an example embodiment, the obtaining image information of a target water region captured by a pool robot includes: obtaining the image information of the target water region captured by the pool robot when the pool robot operates in a first operation mode. The first operation mode is a mode in which the pool robot operates between a plurality of preset positions along a random route based on a preset time period. In the above embodiment, the first operation mode is a mode of performing patrolling along a random path, and the preset

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time period may be 5 minutes, 6 minutes, or 10 minutes. Certainly, the above time period is only an example, and the preset time period may be any duration that can satisfy a patrolling requirement of the pool robot. For example, when there are three preset positions A, B, and C in the target water region, the first operation mode may be a mode in which the pool robot randomly performs patrolling between the three preset positions A, B, and C for 5 minutes. According to the above embodiment, the pool robot performs patrolling along the random path to determine that there are some target objects in the target water region. This can effectively improve efficiency of the pool robot in processing a specific object.

[0055] In an example embodiment, the determining a target position of a target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform a target operation corresponding to a type of the target object includes: if the analysis result indicates that there is the target object in the target water region, determining the target position based on the image information; and controlling the pool robot to move to the target position and perform the target operation corresponding to the type of the target object.

[0056] Optionally, a method for determining the target position based on the image information includes: determining a pixel coordinate of the target object in each frame of image to obtain N pixel coordinates, where the image information includes the image; converting and mapping the N pixel coordinates to a camera device coordinate system based on a first configuration parameter of a camera device of the pool robot to obtain N mapped coordinates, where the first configuration parameter includes a parameter existing when the image information is captured; and determining the target position based on the N mapped coordinates and a second configuration parameter of the camera device. The second configuration parameter includes pose information existing when the camera device captures the image information. The pose information includes a rotation matrix and a translation vector. In this embodiment, the converting and mapping the pixel coordinates to a camera device coordinate system may be converting the pixel coordinates to normalized coordinates in the camera device coordinate system (the pixel coordinates are converted to the normalized coordinates, so that subsequent calculation of the target position can be simplified), or converting the pixel coordinates to image plane coordinates in the camera device coordinate system (that is, the pixel coordinates are converted to the normalized coordinates based on a focal length of the camera device, and in this case, a distance between the image plane coordinates is a distance between corresponding pixel coordinates). According to the above embodiment, position information of the target object is determined based on the image

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information, so that some target objects in the target water region are quickly positioned. This can effectively improve the efficiency of the pool robot in processing a specific object.

[0057] In an example embodiment, the obtaining image information of a target water region captured by a pool robot includes: obtaining the image information of the target water region captured by the pool robot when the pool robot operates in a second operation mode. The second operation mode is a mode in which the pool robot operates between a plurality of preset positions along a fixed route based on a preset time period. In the above embodiment, the second operation mode is a mode of performing patrolling along a fixed path, and the preset time period may be 5 minutes, 6 minutes, or 10 minutes. Certainly, the above time period is only an example, and the preset time period may be any duration that can satisfy a patrolling requirement of the pool robot. For example, when there are three preset positions A, B, and C in the target water region, the second operation mode may be a mode in which the pool robot performs patrolling along a preset fixed path of A→B→C for 10 minutes. According to the above embodiment, the pool robot performs patrolling along the fixed path to determine that there are some target objects in the target water region. This can effectively improve efficiency of the pool robot in processing a specific object.

[0058] In an example embodiment, the determining a target position of a target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform a target operation corresponding to a type of the target object includes: when the pool robot operates in the second operation mode, determining the target position of the target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform the target operation corresponding to the type of the target object. According to the above embodiment, position information of the target object is determined based on the image information, so that some target objects in the target water region are quickly positioned. This can effectively improve the efficiency of the pool robot in processing a specific object.

[0059] In an example embodiment, the determining a target position of a target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform a target operation corresponding to a type of the target object includes: after the pool robot operates in a second operation mode, marking positions of a plurality of target objects on a map if the analysis result indicates that there is the plurality of target objects in the target water region, where the map is constructed in a process in which the pool robot operates in the target water region; determining an

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operation route based on the positions of the plurality of target objects; and controlling the pool robot to move to the positions of the plurality of target objects along the operation route and perform a target operation corresponding to a type of each target object. In the above embodiment, optionally, the determining an operation route based on the positions of the plurality of target objects includes: inputting the positions of the plurality of target objects to a target shortest route model to obtain the operation route. The operation route is a shortest operation route in which the pool robot passes through the positions of the plurality of target objects. According to the target shortest route model, the shortest operation route that traverses the plurality of positions is calculated based on a heuristic algorithm (for example, a genetic algorithm or an ant colony algorithm). For example, a method for determining a shortest route based on the genetic algorithm includes: defining an objective function as a length of the operation route; taking a plurality of randomly combined operation routes as parents and a plurality of randomly re-combined operation routes as offspring; choosing offspring with a better value of the objective function as a new parent; and performing iteration continuously and determining the offspring as the operation route when a value of the objective function of the offspring cannot significantly exceed that of the parent. The positions of the target objects are recorded in a process of performing patrolling along the fixed path, and route planning is performed after patrolling is completed. This can shorten processing distance and effectively improve cleaning efficiency of the pool robot.

[0060] In an example embodiment, before the obtaining image information of a target water region captured by a pool robot, the method further includes: controlling the pool robot to perform the target operation along an edge in the target water region; and after it is determined that the pool robot completes the target operation along the edge, controlling the pool robot to perform a patrolling operation in the target water region. The patrolling operation includes controlling the pool robot to capture the image information in the target water region. In the above embodiment, a task of the pool robot includes performing the target operation along an edge of the target water region, performing the target operation in the target water region along a planned route, and performing the target operation along the edge of the target water region again. Performing the target operation along the edge may correspond to performing the target operation along the edge of the target water region again in the task. In other words, the patrolling operation may be performed after the pool robot completes the task. According to the above embodiment, the pool robot performs patrolling after performing the task, so that supplementary cleaning can be performed on the target water region. This effectively improves a working effect of the pool robot.

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[0061] Based on the foregoing descriptions of the implementations, a person skilled in the art may clearly understand that the method in the above embodiment may be implemented by software in addition to a necessary universal hardware platform or by hardware only. In many cases, the former is a preferred implementation. Based on such understanding, the technical solutions of the present disclosure can be essentially or the part that contributes to the related technology can be embodied in a form of a software product. This computer software product is stored in a storage medium (for example, a ROM/RAM, a magnetic disk, or a compact disc), and includes several instructions for instructing a terminal device (which may be a mobile phone, a computer, a server, or a network device) to perform the method described in embodiments of the present disclosure.

[0062] An embodiment further provides a pool robot control apparatus. The apparatus is configured to implement the above embodiments and optional implementations. Some that have been described are not described in detail again. The term "module" used below may be a combination of software and/or hardware that implements a preset function. Although the apparatus described in the following embodiment is preferably implemented in software, it may be conceived that the apparatus is implemented in hardware or a combination of software and hardware.

[0063] FIG. 3 is a block diagram of a structure of a pool robot control apparatus according to an embodiment of the present disclosure. As shown in FIG. 3, the apparatus includes: an obtaining module 32 configured to obtain image information of a target water region captured by a pool robot, where the pool robot operates in the target water region; an analysis module 34 configured to analyze the image information to determine an analysis result; and a determining module 36 configured to determine a target position of a target object if the analysis result indicates that there is the target object in the target water region, and control the pool robot to move to the target position and perform a target operation corresponding to a type of the target object.

[0064] In an example embodiment, the obtaining module includes a first obtaining sub-module configured to obtain the image information of the target water region captured by the pool robot when the pool robot operates in a first operation mode. The first operation mode is a mode in which the pool robot operates between a plurality of preset positions along a random route based on a preset time period.

[0065] In an example embodiment, the determining module includes: a first determining sub-module configured to determine the target position based on the image information if the analysis result indicates that there is the target object in the target water region and a control

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sub-module configured to control the pool robot to move to the target position and perform the target operation corresponding to the type of the target object.

[0066] In an example embodiment, the obtaining module includes a second obtaining sub-module configured to obtain the image information of the target water region captured by the pool robot when the pool robot operates in a second operation mode. The second operation mode is a mode in which the pool robot operates between a plurality of preset positions along a fixed route based on a preset time period.

[0067] In an example embodiment, the determining module includes a second determining sub-module configured to: when the pool robot operates in the second operation mode, determine the target position of the target object if the analysis result indicates that there is the target object in the target water region, and control the pool robot to move to the target position and perform the target operation corresponding to the type of the target object.

[0068] In an example embodiment, the apparatus is further configured to: after obtaining the image information of the target water region captured by the pool robot, determine a pixel coordinate of the target object in each of a plurality of frames of images to obtain a plurality of pixel coordinates, where the image information includes the plurality of frames of images; convert and map the plurality of pixel coordinates to a camera device coordinate system based on a first configuration parameter of a camera device of the pool robot to obtain a plurality of mapped coordinates, where the first configuration parameter includes a parameter existing when the image is captured; and determine the target position of the target object in the target water region based on the plurality of mapped coordinates and a second configuration parameter of the camera device. The second configuration parameter includes pose information existing when the camera device captures the image. The pose information includes a rotation matrix and a translation vector.

[0069] In an example embodiment, the plurality of pixel coordinates are converted and mapped to the camera device coordinate system based on the first configuration parameter of the camera device of the pool robot in the following manner, to obtain the plurality of mapped coordinates: converting and mapping the plurality of pixel coordinates to normalized coordinates in the camera device coordinate system to obtain the plurality of mapped coordinates; or converting and mapping the plurality of pixel coordinates to image plane coordinates in the camera device coordinate system to obtain the plurality of mapped coordinates.

[0070] In an example embodiment, the determining module further includes: a third determining sub-module configured to: after the pool robot operates in a second operation

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mode, mark positions of a plurality of target objects on a map if the analysis result indicates that there is the plurality of target objects in the target water region, where the map is constructed in a process in which the pool robot operates in the target water region; a fourth determining sub-module configured to determine an operation route based on the positions of the plurality of target objects; and a control sub-module configured to control the pool robot to move to the positions of the plurality of target objects along the operation route and perform a target operation corresponding to a type of each target object.

[0071] In an example embodiment, the operation route is determined based on the positions of the plurality of target objects in the following manner: inputting the positions of the plurality of target objects to a target shortest route model to obtain the operation route. The operation route is a shortest operation route in which the pool robot passes through the positions of the plurality of target objects.

[0072] In an example embodiment, the target shortest route model is determined in the following manner: defining an objective function as a length of the operation route; taking a plurality of randomly combined operation routes as parents and a plurality of randomly re-combined operation routes as offspring; and determining the target shortest route model based on the parents and the offspring.

[0073] In an example embodiment, the apparatus further includes: a first control module configured to: before the image information of the target water region captured by the pool robot is obtained, control the pool robot to perform the target operation along an edge in the target water region; and a second control module configured to: after it is determined that the pool robot completes the target operation along the edge, control the pool robot to perform a patrolling operation in the target water region. The patrolling operation includes controlling the pool robot to capture the image information in the target water region.

[0074] In an example embodiment, the apparatus is further configured to: before obtaining the image information of the target water region captured by the pool robot, control the pool robot to perform a task in the target water region, where the task includes performing the target operation along an edge of the target water region, performing the target operation in the target water region along a planned route, and performing the target operation along the edge of the target water region again; and after it is determined that the pool robot completes the task, control the pool robot to perform a patrolling operation in the target water region. The patrolling operation includes controlling the pool robot to capture the image information in the target water region.

[0075] In an example embodiment, the target object is determined in the following manner:

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inputting the image information to a target network model to obtain feature information of an object included in the image information output by the target network model, where the feature information includes a spatial feature and a semantic feature of the object; and determining the target object based on the feature information of the object.

[0076] In an example embodiment, the target network model is trained in the following manner: obtaining M frames of sample images, where each frame of sample image includes a preset object, and M is a natural number greater than or equal to one; marking the preset object in each frame of sample image to obtain M frames of marked sample images; and training an original network model based on the M frames of marked sample images to obtain the target network model.

[0077] It should be noted that each module may be implemented by software or hardware, and for the latter, it may be implemented in the following manner: All modules are located in a same processor, or various modules are located in different processors respectively in a form of any combination. However, this is not limited thereto.

[0078] An embodiment of the present disclosure further provides a computer-readable storage medium. The computer-readable storage medium stores a computer program. When the computer program is run, steps in any one of the method embodiments are performed.

[0079] In an example embodiment, the computer-readable storage medium may include, but is not limited to, any medium that can store the computer program, for example, a USB flash drive, a read-only memory (Read-Only Memory, ROM for short), a random access memory (Random Access Memory, RAM for short), a removable hard disk, a magnetic disk, or a compact disc.

[0080] An embodiment of the present disclosure further provides a pool robot. The pool robot includes a memory and a processor. The memory stores a computer program. The processor is configured to: when executing the computer program, perform steps in any one of the method embodiments.

[0081] In an example embodiment, the pool robot may further include a transmission device and an input/output device. The transmission device is connected to the processor, and the input/output device is connected to the processor.

[0082] For details of specific examples in this embodiment, refer to the examples described in the above embodiments and example implementations. Details are not described in this embodiment again.

[0083] It is clear that a person skilled in the art should understand that the modules or steps in the present disclosure may be implemented by a general-purpose computing apparatus, and

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the modules may be integrated on a single computing apparatus or distributed on a network including a plurality of computing apparatuses, or may be implemented by program code executed by a computing apparatus. In this way, the program code can be stored in a storage apparatus and executed by the computing apparatus. In addition, in some cases, the shown or described steps may be performed in an order different from the above order, or the modules are respectively manufactured into various integrated circuit modules, or a plurality of modules are manufactured into a single integrated circuit module. In this way, the present disclosure is not limited to any particular combination of hardware and software.

[0084] The foregoing descriptions are merely optional embodiments of the present disclosure, but are not intended to limit the present disclosure. For a person skilled in the art, the present disclosure may have various modifications and variations. Any modification, equivalent replacement, improvement, or the like made without departing from the principle of the present disclosure shall fall within the protection scope of the present disclosure.

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CLAIMS

What is claimed is:

1. A pool robot control method, comprising:

obtaining image information of a target water region captured by a pool robot, wherein the pool robot operates in the target water region, wherein the image information comprises a frame of image or a plurality of frames of images;

analyzing the image information to determine an analysis result; and

determining a target position of a target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform a target operation corresponding to a type of the target object.

2. The method according to claim 1, wherein the obtaining image information of a target water region captured by a pool robot comprises:

obtaining the image information of the target water region captured by the pool robot when the pool robot operates in a first operation mode, wherein the first operation mode is a mode in which the pool robot operates between a plurality of preset positions along a random route based on a preset time period.

3. The method according to claim 1, wherein the determining a target position of a target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform a target operation corresponding to a type of the target object comprises:

if the analysis result indicates that there is the target object in the target water region, determining the target position based on the image information; and

controlling the pool robot to move to the target position and perform the target operation corresponding to the type of the target object.

4. The method according to claim 1, wherein the obtaining image information of a target water region captured by a pool robot comprises:

obtaining the image information of the target water region captured by the pool robot when the pool robot operates in a second operation mode, wherein the second operation mode is a mode in which the pool robot operates between a plurality of preset positions along a fixed route based on a preset time period.

5. The method according to claim 4, wherein the determining a target position of a target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform a target operation

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corresponding to a type of the target object comprises:

when the pool robot operates in the second operation mode, determining the target position of the target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform the target operation corresponding to the type of the target object.

6. The method according to claim 4, wherein the determining a target position of a target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform a target operation corresponding to a type of the target object comprises:

after the pool robot operates in the second operation mode, marking positions of a plurality of target objects on a map if the analysis result indicates that there is the plurality of target objects in the target water region, wherein the map is constructed in a process in which the pool robot operates in the target water region;

determining an operation route based on the positions of the plurality of target objects; and

controlling the pool robot to move to the positions of the plurality of target objects along the operation route and perform a target operation corresponding to a type of each target object.

7. The method according to claim 1, wherein before the obtaining image information of a target water region captured by a pool robot, the method further comprises:

controlling the pool robot to perform the target operation along an edge in the target water region; and

after it is determined that the pool robot completes the target operation along the edge, controlling the pool robot to perform a patrolling operation in the target water region, wherein the patrolling operation comprises controlling the pool robot to capture the image information in the target water region.

8. The method according to claim 1, wherein before the obtaining image information of a target water region captured by a pool robot, the method further comprises:

controlling the pool robot to perform a task in the target water region, wherein the task comprises performing the target operation along an edge of the target water region, performing the target operation in the target water region along a planned route, and performing the target operation along the edge of the target water region again; and

after it is determined that the pool robot completes the task, controlling the pool robot to perform a patrolling operation in the target water region, wherein the patrolling operation comprises controlling the pool robot to capture the image information in the target water

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region.

9. A pool robot control method, wherein a pool robot is configured to perform a cleaning operation in a target water region, and a camera is disposed on the pool robot, wherein the method comprises:

controlling the pool robot to perform a patrolling operation in the target water region, enabling the camera to capture an image of the target water region in a process of performing the patrolling operation, wherein the image is used to determine whether there is a target object in the target water region, wherein the target object needs to be cleaned; and

controlling, if it is determined that there is the target object, the pool robot to move to a target position of the target object and perform the cleaning operation on the target object.

10. The method according to claim 9, further comprising:

controlling the pool robot to perform the cleaning operation in the target water region along an edge of the target water region; and

after the pool robot completes the cleaning operation along the edge of the target water region, controlling the pool robot to perform the patrolling operation in the target water region.

11. The method according to claim 9, wherein the patrolling operation is performed after the pool robot completes a task, wherein the task comprises performing the cleaning operation along an edge of the target water region, performing the cleaning operation in the target water region along a planned route, and performing the cleaning operation along the edge of the target water region again.

12. The method according to claim 9, comprising: if it is determined that there is the target object, controlling the pool robot to directly move to the target position of the target object and perform the cleaning operation on the target object.

13. The method according to claim 9, wherein the controlling the pool robot to perform a patrolling operation in the target water region comprises:

controlling the pool robot to perform the patrolling operation in a first operation mode, wherein the first operation mode is a mode of performing the patrolling operation along a random route.

14. The method according to claim 13, wherein the controlling the pool robot to perform a patrolling operation in the target water region comprises:

controlling the pool robot to perform the patrolling operation in the first operation mode, wherein the first operation mode is a mode in which the pool robot operates between a plurality of preset positions along the random route based on a preset time period.

15. The method according to claim 9, wherein the controlling the pool robot to perform

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a patrolling operation in the target water region comprises:

controlling the pool robot to perform the patrolling operation in a second operation mode, wherein the second operation mode is a mode of performing the patrolling operation along a fixed route.

16. The method according to claim 15, wherein the controlling the pool robot to perform a patrolling operation in the target water region comprises:

controlling the pool robot to perform the patrolling operation in the second operation mode, wherein the second operation mode is a mode in which the pool robot operates between a plurality of preset positions along the fixed route based on a preset time period.

17. The method according to claim 15, wherein the controlling, if it is determined that there is the target object, the pool robot to move to a target position of the target object and perform the cleaning operation on the target object comprises:

when the pool robot is controlled to perform the patrolling operation in the second operation mode, controlling, if it is determined that there is the target object, the pool robot to move to the target position of the target object and perform the cleaning operation on the target object.

18. The method according to claim 15 comprising: in a process of controlling the pool robot to perform the patrolling operation in the second operation mode, if it is determined that there is the target object, recording the target position of the target object, or after the pool robot is controlled to perform the patrolling operation in the second operation mode, if it is determined that there is a plurality of target objects, marking target positions of the plurality of target objects on a map, wherein the map is constructed in a process in which the pool robot operates in the target water region; and

the controlling, if it is determined that there is the target object, the pool robot to move to a target position of the target object and perform the cleaning operation on the target object comprises: after the patrolling operation is completed, controlling the pool robot to move to the target positions of the plurality of target objects along an operation route and perform the cleaning operation on each target object.

19. The method according to claim 9, comprising: when the pool robot performs the cleaning operation at a water surface or a bottom of the target water region, controlling the pool robot to perform the patrolling operation in the target water region.

20. The method according to claim 9, comprising: if it is determined that there is the target object, determining the target position of the target object and controlling the pool robot to move to the target position of the target object, wherein the image is used to determine the

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target position of the target object.

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ABSTRACT

Embodiments of the present disclosure provide a pool robot control method and apparatus, a storage medium, and a pool robot. The method includes: obtaining image information of a target water region captured by a pool robot, where the pool robot operates in the target water region; analyzing the image information to determine an analysis result; and determining a target position of a target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform a target operation corresponding to a type of the target object.

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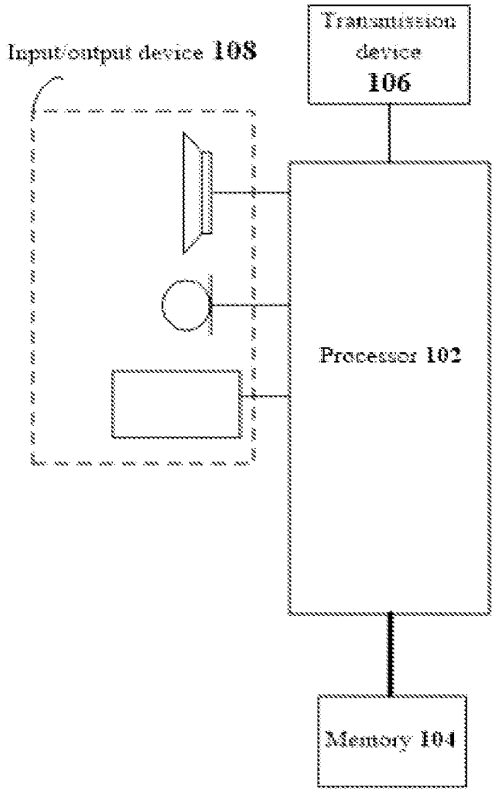


FIG. 1

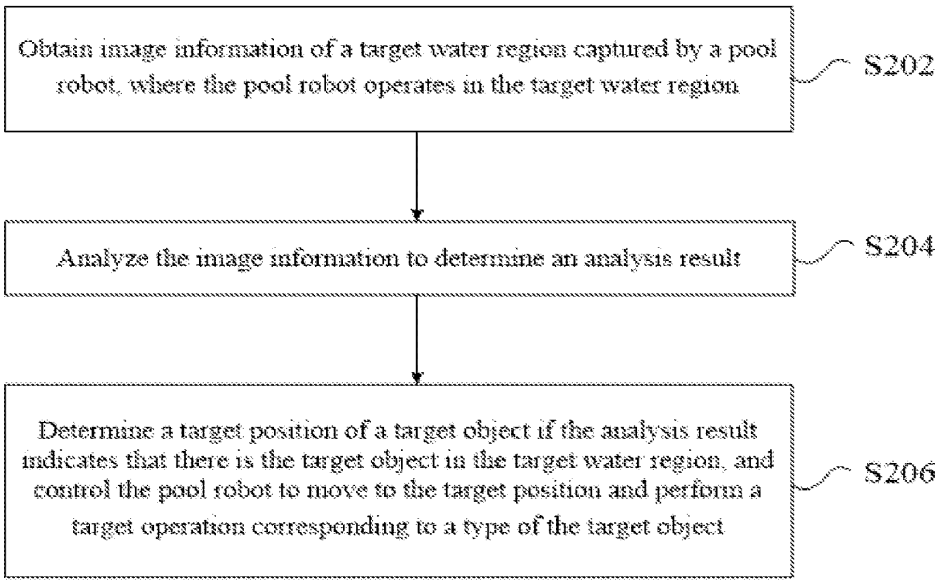


FIG. 2

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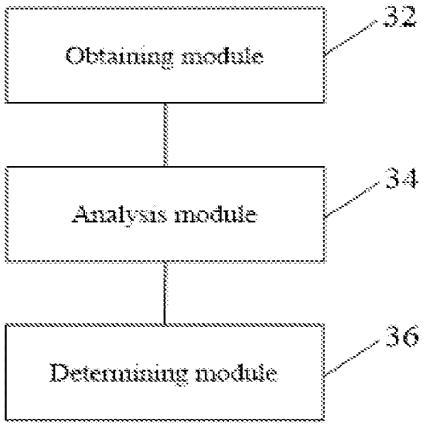


FIG. 3

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ELECTRONIC PAYMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
19/342,629	**09/28/2025 08:04:14 PM Z ET**	**2024009-016**

Title of Invention

POOL ROBOT CONTROL METHOD AND APPARATUS, STORAGE MEDIUM, AND POOL ROBOT

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	7873	FILED BY	Wanying Li
PATENT CENTER #	72489205	AUTHORIZED BY	-
CUSTOMER #	204084	FILING DATE	-
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Shilei ZHANG

Payment Information

PAYMENT METHOD	PAYMENT TRANSACTION ID	PAYMENT AUTHORIZED BY
CARD / 8009	**E20259RK05298402**	**Wanying Li**

PRE-AUTHORIZED ACCOUNT	PRE-AUTHORIZED CATEGORY
606842	**37 CFR 1.16 (National application filing, search, and examination fees); 37 CFR 1.17 (Patent application and reexamination processing fees); 37 CFR 1.19 (Document supply fees); 37 CFR 1.20 (Post Issuance fees); 37 CFR 1.21 (Miscellaneous fees and charges)**

FEE CODE	DESCRIPTION	ITEM PRICE($)	QUANTITY	ITEM TOTAL($)
4011	BASIC FILING FEE- UTILITY	70.00	1	70.00
2111	UTILITY PATENT APPL. SEARCH FEE	308.00	1	308.00
2311	EXAMINATION OF ORIGINAL PATENT APPLICATION	352.00	1	352.00
2830	PROCESSING FEE, EXCEPT IN PROVISIONAL APPLICATIONS	60.00	1	60.00
2817	REQUEST FOR PRIORITIZED EXAMINATION	1806.00	1	1806.00

TOTAL AMOUNT:	**¤2,596.00**

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	Pool robot control method and apparatus, storage medium, and pool robot

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [x] The attached application, or
- [ ] United States application or PCT international application number _____ filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

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LEGAL NAME OF INVENTOR

Inventor: Shilei Zhang Date (Optional): _____

Signature: ZHANG Shilei

Note: An application data sheet (PTO/AIA/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	2024009-016
	Application Number	
Title of Invention	POOL ROBOT CONTROL METHOD AND APPARATUS, STORAGE MEDIUM, AND POOL ROBOT	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

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☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

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Prefix	Given Name	Middle Name	Family Name	Suffix
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All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

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For further information see 37 CFR 1.33(a).

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Customer Number	204084		
Email Address	contact@soleadolaw.com	Add Email	Remove Email

Application Information:

Title of the Invention	POOL ROBOT CONTROL METHOD AND APPARATUS, STORAGE MEDIUM, AND POOL ROBOT		
Attorney Docket Number	2024009-016	**Small Entity Status Claimed**	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	2	**Suggested Figure for Publication (if any)**	

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	2024009-016
	Application Number	
Title of Invention	POOL ROBOT CONTROL METHOD AND APPARATUS, STORAGE MEDIUM, AND POOL ROBOT	

Filing By Reference:

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For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

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Customer Number	204084		

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Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	PCT/CN2023/116834	2024-09-04

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	2024009-016
	Application Number	
Title of Invention	POOL ROBOT CONTROL METHOD AND APPARATUS, STORAGE MEDIUM, AND POOL ROBOT	

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)
2023107686783	CN	2023-06-27	0402

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

PTO/AIA/14 (01-22)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	2024009-016
	Application Number	
Title of Invention	POOL ROBOT CONTROL METHOD AND APPARATUS, STORAGE MEDIUM, AND POOL ROBOT	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	2024009-016
	Application Number	
Title of Invention	POOL ROBOT CONTROL METHOD AND APPARATUS, STORAGE MEDIUM, AND POOL ROBOT	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1 Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

◉ Assignee	○ Legal Representative under 35 U.S.C. 117	○ Joint Inventor
○ Person to whom the inventor is obligated to assign.	○ Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	XINGMAI INNOVATION TECHNOLOGY (SUZHOU) CO., LTD.		
Mailing Address Information For Applicant:			
Address 1	12F, Bldg. 5, Tianyun Square, 111 Wusongjiang Ave		
Address 2	Guoxiang Sub-district, Wuzhong District		
City	Suzhou	**State/Province**	JS
Country	CN	Postal Code	215124
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button. Add

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	2024009-016
	Application Number	
Title of Invention	POOL ROBOT CONTROL METHOD AND APPARATUS, STORAGE MEDIUM, AND POOL ROBOT	

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

Remove

If the Assignee or Non-Applicant Assignee is an Organization check here. ☒

Organization Name	XINGMAI INNOVATION TECHNOLOGY (SUZHOU) CO., LTD.

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1	12F, Bldg. 5, Tianyun Square, 111 Wusongjiang Ave		
Address 2	Guoxiang Sub-district, Wuzhong District		
City	Suzhou	**State/Province**	
Country i	CN	Postal Code	215124
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add

Signature:

Remove

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/WANYING LI/			Date (YYYY-MM-DD)	2025-09-28
First Name	WANYING	Last Name	LI	Registration Number	81,553

Additional Signature may be generated within this form by selecting the Add button. Add

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Approved for use through 05/31/2024. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	2024009-016
	Application Number	
Title of Invention	POOL ROBOT CONTROL METHOD AND APPARATUS, STORAGE MEDIUM, AND POOL ROBOT	

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1 The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3 A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent CooperationTreaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Doc Code: TRACK1.REQ
Document Description: TrackOne Request

PTO/AIA/424 (04-14)

CERTIFICATION AND REQUEST FOR PRIORITIZED EXAMINATION UNDER 37 CFR 1.102(e) (Page 1 of 1)

First Named Inventor:	Shilei ZHANG	Nonprovisional Application Number (if known):	
Title of Invention:	Pool robot control method and apparatus, storage medium, and pool robot		

APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS PRIORITIZED EXAMINATION FOR THE ABOVE-IDENTIFIED APPLICATION.

1. The processing fee set forth in 37 CFR 1.17(i)(1) and the prioritized examination fee set forth in 37 CFR 1.17(c) have been filed with the request. The publication fee requirement is met because that fee, set forth in 37 CFR 1.18(d), is currently $0. The basic filing fee, search fee, and examination fee are filed with the request or have been already been paid. I understand that any required excess claims fees or application size fee must be paid for the application.

2. I understand that the application may not contain, or be amended to contain, more than four independent claims, more than thirty total claims, or any multiple dependent claims, and that any request for an extension of time will cause an outstanding Track I request to be dismissed.

3. The applicable box is checked below:

I. ☑ Original Application (Track One) - Prioritized Examination under § 1.102(e)(1)

i. (a) The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a). This certification and request is being filed with the utility application via EFS-Web.

---OR---

(b) The application is an original nonprovisional plant application filed under 35 U.S.C. 111(a). This certification and request is being filed with the plant application in paper.

ii. An executed inventor's oath or declaration under 37 CFR 1.63 or 37 CFR 1.64 for each inventor, **or** the application data sheet meeting the conditions specified in 37 CFR 1.53(f)(3)(i) is filed with the application.

II. ☐ Request for Continued Examination - Prioritized Examination under § 1.102(e)(2)

i. A request for continued examination has been filed with, or prior to, this form.
ii. If the application is a utility application, this certification and request is being filed via EFS-Web.
iii. The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a), or is a national stage entry under 35 U.S.C. 371.
iv. This certification and request is being filed prior to the mailing of a first Office action responsive to the request for continued examination.
v. No prior request for continued examination has been granted prioritized examination status under 37 CFR 1.102(e)(2).

Signature /Wanying Li/	Date 2025-09-29
Name (Print/Typed) Wanying Li	Practitioner Registration Number 81,553

Note: *This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required.**

☑ *Total of 1 forms are submitted.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Doc Code: PA..
Document Description: Power of Attorney

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TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed. In accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA/82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	
Filing Date	
First Named Inventor	Shilei ZHANG
Title	Pool robot control method and apparatus, storage medium, and pool robot
Art Unit	
Examiner Name	
Attorney Docket Number	2024009-016

SIGNATURE of Applicant or Patent Practitioner

Signature	/Wanying Li/	Date (Optional)	
Name	Wanying Li	Registration Number	81,553
Title (if Applicant is a juristic entity)	Patent Attorney		
Applicant Name (if Applicant is a juristic entity)	XINGMAI INNOVATION TECHNOLOGY (SUZHOU) CO., LTD.		

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82B (07-13)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☑ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 204084

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☑ The address associated with the above-mentioned Customer Number

OR

☐ The address associated with Customer Number:

OR

☐ Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

XINGMAI INNOVATION TECHNOLOGY (SUZHOU) CO., LTD.

☐ Inventor or Joint Inventor (title not required below)

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☑ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature	YAN Yadong	Date (Optional)	
Name	YAN, Yadong		
Title	IP Director		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.31, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/AIA/15 (10-17)
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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	2024009-016
First Named Inventor	Shilei ZHANG
Title	POOL ROBOT CONTROL METHOD AND APPARATUS, STORAGE MEDIUM, AND P
Priority Mail Express® Label No.	

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. ☐ **Fee Transmittal Form** (PTO/SB/17 or equivalent)
2. ☑ **Applicant asserts small entity status.** See 37 CFR 1.27
3. ☐ **Applicant certifies micro entity status.** See 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.
4. ☑ **Specification** [*Total Pages* 23] Both the claims and abstract must start on a new page. *(See MPEP § 608.01(a) for information on the preferred arrangement)*
5. ☑ **Drawing(s)** (35 U.S.C. 113) [*Total Sheets* 2]
6. **Inventor's Oath or Declaration** [*Total Pages* 1] *(including substitute statements under 37 CFR 1.64 and assignments serving as an oath or declaration under 37 CFR 1.63(e))*
   a. ☑ Newly executed (original or copy)
   b. ☐ A copy from a prior application (37 CFR 1.63(d))
7. ☑ **Application Data Sheet** ** See note below.* See 37 CFR 1.76 (PTO/AIA/14 or equivalent)
8. **CD-ROM or CD-R** in duplicate, large table, or Computer Program (*Appendix*)
   ☐ Landscape Table on CD
9. **Nucleotide and/or Amino Acid Sequence Submission** (*if applicable, items a. – c. are required*)
   a. ☐ Computer Readable Form (CRF)
   b. ☐ Specification Sequence Listing on:
      i. ☐ CD-ROM or CD-R (2 copies); or
      ii. ☐ Paper
   c. ☐ Statements verifying identity of above copies

ADDRESS TO: **Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450**

ACCOMPANYING APPLICATION PAPERS

10. ☑ **Assignment Papers** (cover sheet & document(s)) Name of Assignee XINGMAI INNOVATION TECHNOLOGY (SUZHOU) CO., LTD.
11. ☑ **37 CFR 3.73(c) Statement** (*when there is an assignee*) ☑ **Power of Attorney**
12. ☐ **English Translation Document** (*if applicable*)
13. ☐ **Information Disclosure Statement** (PTO/SB/08 or PTO-1449)
    ☐ Copies of citations attached
14. ☐ **Preliminary Amendment**
15. ☐ **Return Receipt Postcard** (*MPEP § 503*) (*Should be specifically itemized*)
16. ☐ **Certified Copy of Priority Document(s)** (*if foreign priority is claimed*)
17. ☐ **Nonpublication Request** Under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent.
18. ☑ **Other:** Request for Prioritized examination (Track One)

***Note**: (1) Benefit claims under 37 CFR 1.78 and foreign priority claims under 1.55 **must** be included in an Application Data Sheet (ADS).
(2) For applications filed under 35 U.S.C. 111, the application must contain an ADS specifying the applicant if the applicant is an assignee, person to whom the inventor is under an obligation to assign, or person who otherwise shows sufficient proprietary interest in the matter. See 37 CFR 1.46(b).

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APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
19/342,629	**09/28/2025 08:04:14 PM Z ET**	**2024009-016**

Title of Invention

POOL ROBOT CONTROL METHOD AND APPARATUS, STORAGE MEDIUM, AND POOL ROBOT

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	7873	FILED BY	Wanying Li
PATENT CENTER #	72489205	FILING DATE	-
CUSTOMER #	204084	FIRST NAMED INVENTOR	Shilei ZHANG
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	-

Documents

TOTAL DOCUMENTS: 7

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
ADS_aia0014_2024009-016.pdf	8	Application Data Sheet	2174 KB
2024009-016_track ONE.pdf	2	Track One Request	122 KB
2024009-016_Power of Attorney_F.pdf	2	Power of Attorney	1576 KB
2024009-016_Declaration-Shilei ZHANG_F.pdf	1	Oath or Declaration filed	1201 KB
aia0015-tran letter_2024009-016.pdf	2	Transmittal of New Application	418 KB
FINAL_2024009-016_APP TEXT_US-20230133WO4-APP.TEXT.docx	23	Application body structured text document	43 KB

Warning: Document has [Balance SBCS characters and DBCS characters] option enabled and may result in reduction of pages, however, no data or text has been modified. Bookmarks were found and have been removed.

FINAL_2024009-016_Drawings-20230133WO4.pdf	2	Drawings-only black and white line drawings	40 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
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New International Application Filed with the USPTO as a Receiving Office

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证　明

本证明之附件是向本局提交的下列专利申请文件副本。

申　　请　　号：202310768678.3

申　请　类　型：发明专利

发明 创造 名称：水池机器人的控制方法、装置、存储介质及水池机器人

申　　请　　日：2023年06月27日

申　　请　　人：星迈创新科技（苏州）有限公司

发明人或设计人：张石磊

局长

申长雨

2023 年 09 月 05 日

说 明 书 附 图

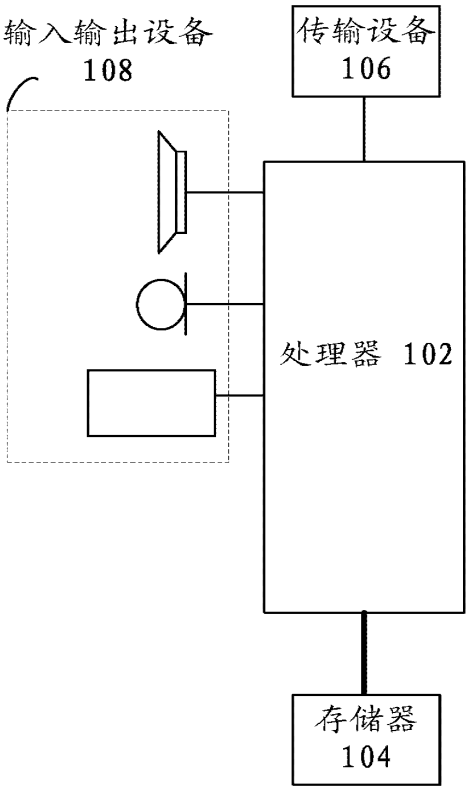


图 1

PN211113

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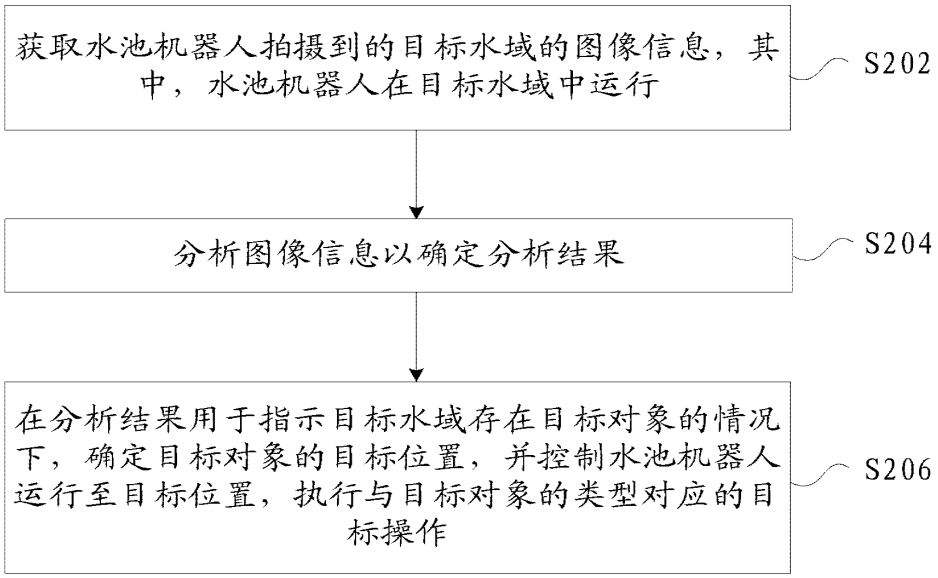


图 2

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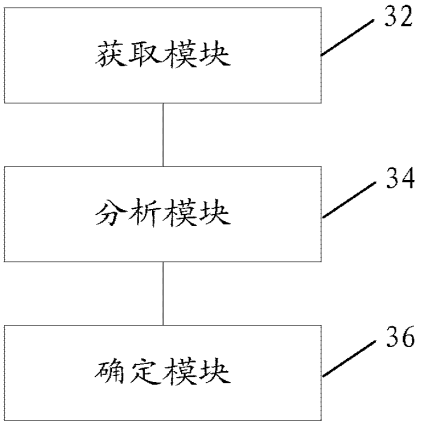


图 3

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说明书

水池机器人的控制方法、装置、存储介质及水池机器人

技术领域

本申请实施例涉及计算机领域，具体而言，涉及一种水池机器人的控制方法、装置、存储介质及水池机器人。

背景技术

相关技术中的水池机器人可以在水池中执行一种或多种工作任务（例如，消毒、清洁等），但水池机器人在对特定的对象执行操作时，并不能快速的确定出对象所在的位置，从而影响执行操作的效率。

针对上述问题，相关技术尚未提出有效的解决方案。

发明内容

本申请实施例提供了一种水池机器人的控制方法、装置、存储介质及水池机器人，以至少解决相关技术中水池机器人对特定对象的操作效率低下的问题。

根据本申请的一个实施例，提供了一种水池机器人的控制方法，包括：获取水池机器人拍摄到的上述目标水域的图像信息，其中，上述水池机器人在上述目标水域中运行；分析上述图像信息以确定分析结果；在上述分析结果用于指示上述目标水域存在目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作。

在一个示例性实施例中，获取水池机器人拍摄到的上述目标水域的图像信息，包括：获取上述水池机器人在按照第一运行模式运行时，拍摄到的上述目标水域的图像信息，其中，第一运行模式包括上述水池机器人按照预设时间周期在多个预设位置间的随机路线中运行的模式。

在一个示例性实施例中，在上述分析结果用于指示上述目标水域存在目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器

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人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作，包括：在上述分析结果用于指示上述目标水域中存在目标对象的情况下，根据上述图像信息确定上述目标位置；控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作。

在一个示例性实施例中，获取水池机器人拍摄到的上述目标水域的图像信息，包括：获取上述水池机器人在按照第二运行模式运行时，拍摄到的上述目标水域的图像信息，其中，第二运行模式包括上述水池机器人按照预设时间周期在多个预设位置间的固定路线中运行的模式。

在一个示例性实施例中，在上述分析结果用于指示上述目标水域存在目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作，包括：在上述水池机器人在按照第二运行模式运行时，从上述分析结果中确定上述目标水域中包括上述目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作。

在一个示例性实施例中，在上述分析结果用于指示上述目标水域存在目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作，包括：在上述水池机器人在按照第二运行模式运行之后，从上述分析结果中确定上述目标水域中包括多个上述目标对象的情况下，在上述地图中标记多个上述目标对象的位置，其中，上述地图是上述水池机器人在上述目标水域中运行的过程中构建的；按照多个上述目标对象的位置确定运行路线；控制上述水池机器人按照运行路线运行至多个上述目标对象的多个位置处，执行与每个上述目标对象的类型对应的目标操作。

在一个示例性实施例中，获取水池机器人拍摄到的上述目标水域的图像信息之前，上述方法还包括：控制上述水池机器人在上述目标水域中沿边执行上述目标操作；在确定上述水池机器人沿边执行上述目标操作之后，

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控制上述水池机器人在上述目标水域中执行巡视操作，其中，上述巡视操作包括控制上述水池机器人在上述目标水域中拍摄上述图像信息。

根据本申请的另一个实施例，提供了一种水池机器人的控制装置，包括：获取模块，用于获取水池机器人拍摄到的上述目标水域的图像信息，其中，上述水池机器人在上述目标水域中运行；分析模块，用于分析上述图像信息以确定分析结果；确定模块，用于在上述分析结果用于指示上述目标水域存在目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作。

在一个示例性实施例中，上述获取模块包括：第一获取子模块，用于获取上述水池机器人在按照第一运行模式运行时，拍摄到的上述目标水域的图像信息，其中，第一运行模式包括上述水池机器人按照预设时间周期在多个预设位置间的随机路线中运行的模式。

在一个示例性实施例中，上述确定模块包括：第一确定子模块，用于在上述分析结果用于指示上述目标水域中存在目标对象的情况下，根据上述图像信息确定上述目标位置；控制子模块，用于控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作。

在一个示例性实施例中，上述获取模块包括：第二获取子模块，用于获取上述水池机器人在按照第二运行模式运行时，拍摄到的上述目标水域的图像信息，其中，第二运行模式包括上述水池机器人按照预设时间周期在多个预设位置间的固定路线中运行的模式。

在一个示例性实施例中，上述确定模块包括：第二确定子模块，用于在上述水池机器人在按照第二运行模式运行时，从上述分析结果中确定上述目标水域中包括上述目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作。

在一个示例性实施例中，上述确定模块还包括：第三确定子模块，用

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于在上述水池机器人在按照第二运行模式运行之后，从上述分析结果中确定上述目标水域中包括多个上述目标对象的情况下，在上述地图中标记多个上述目标对象的位置，其中，上述地图是上述水池机器人在上述目标水域中运行的过程中构建的；第四确定子模块，用于按照多个上述目标对象的位置确定运行路线；控制子模块，用于控制上述水池机器人按照运行路线运行至多个上述目标对象的多个位置处，执行与每个上述目标对象的类型对应的目标操作。

在一个示例性实施例中，上述装置还包括：第一控制模块，用于获取水池机器人拍摄到的上述目标水域的图像信息之前，控制上述水池机器人在上述目标水域中沿边执行上述目标操作；第二控制模块，用于在确定上述水池机器人沿边执行上述目标操作之后，控制上述水池机器人在上述目标水域中执行巡视操作，其中，上述巡视操作包括控制上述水池机器人在上述目标水域中拍摄上述图像信息。根据本申请的又一个实施例，还提供了一种计算机可读存储介质，上述计算机可读存储介质中存储有计算机程序，其中，上述计算机程序被设置为运行时执行上述任一项方法实施例中的步骤。

根据本申请的又一个实施例，还提供了一种水池机器人，包括存储器和处理器，上述存储器中存储有计算机程序，上述处理器被设置为运行上述计算机程序以执行上述任一项方法实施例中的步骤。

通过本申请，通过分析水池机器人拍摄的目标水域图像信息，可以识别出目标对象并且确认目标对象的位置，进而可以控制机器人直接前往目标对象的位置并对目标对象执行目标操作，避免出现水池机器人无法定位目标对象，只能按照预设路线重新清理整个目标水域的情况，有效解决了相关技术中水池机器人对特定对象的操作效率低下的问题，达到了提高操作效率的效果。

附图说明

图1是根据本申请实施例的水池机器人的控制方法的移动终端的硬件

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结构框图；

图 2 是根据本申请实施例的水池机器人的控制方法的流程图；

图 3 是根据本申请实施例的水池机器人的控制装置的结构框图。

具体实施方式

下文中将参考附图并结合实施例来详细说明本申请的实施例。

需要说明的是，本申请的说明书和权利要求书及上述附图中的术语“第一”、“第二”等是用于区别类似的对象，而不必用于描述特定的顺序或先后次序。

本申请实施例中所提供的方法实施例可以在移动终端、计算机终端或者类似的运算装置中执行。以运行在移动终端上为例，图 1 是本申请实施例的一种水池机器人控制方法的移动终端的硬件结构框图。如图 1 所示，移动终端可以包括一个或多个（图 1 中仅示出一个）处理器 102（处理器 102 可以包括但不限于微处理器 MCU 或可编程逻辑器件 FPGA 等的处理装置）和用于存储数据的存储器 104，其中，上述移动终端还可以包括用于通信功能的传输设备 106 以及输入输出设备 108。本领域普通技术人员可以理解，图 1 所示的结构仅为示意，其并不对上述移动终端的结构造成限定。例如，移动终端还可包括比图 1 中所示更多或者更少的组件，或者具有与图 1 所示不同的配置。

存储器 104 可用于存储计算机程序，例如，应用软件的软件程序以及模块，如本申请实施例中的水池机器人控制方法对应的计算机程序，处理器 102 通过运行存储在存储器 104 内的计算机程序，从而执行各种功能应用以及数据处理，即实现上述的方法。存储器 104 可包括高速随机存储器，还可包括非易失性存储器，如一个或者多个磁性存储装置、闪存、或者其他非易失性固态存储器。在一些实例中，存储器 104 可进一步包括相对于处理器 102 远程设置的存储器，这些远程存储器可以通过网络连接至移动终端。上述网络的实例包括但不限于互联网、企业内部网、局域网、移动通信网及其组合。

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传输设备 106 用于经由一个网络接收或者发送数据。上述的网络具体实例可包括移动终端的通信供应商提供的无线网络。在一个实例中，传输设备 106 包括一个网络适配器（NetworkInterfaceController，简称为 NIC），其可通过基站与其他网络设备相连从而可与互联网进行通讯。在一个实例中，传输设备 106 可以为射频（RadioFrequency，简称为 RF）模块，其用于通过无线方式与互联网进行通讯。

在本实施例中提供了一种水池机器人控制方法，图 2 是根据本申请实施例的流程图，如图 2 所示，该流程包括如下步骤：

步骤 S202，获取水池机器人拍摄到的上述目标水域的图像信息，其中，上述水池机器人在上述目标水域中运行；

步骤 S204，分析上述图像信息以确定分析结果；

步骤 S206，在上述分析结果用于指示上述目标水域存在目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作。

其中，上述步骤的执行主体可以为水池机器人的控制器，或者是具备数据处理、信号交互能力的处理器，或者还可以是其他的具备类似处理能力的处理设备或处理单元等但不限于此。

在上述实施例中，上述水池机器人用于拍摄的设备是防水等级较高的摄像头，该摄像头可以置于水池机器人的前端，侧面，顶端等位置，具体设置位置不限。上述目标水域包括但不限于泳池、观赏型水库、野外水池等。上述水池机器人可以位于目标水域水面，也可以位于目标水域水底，或者悬浮与目标水域内，在上述目标水域是泳池的情况下还可以位于泳池池壁。对上述图像信息进行分析可以采用通过预先训练的网络模型对图像信息进行识别，或者是利用其他的图像分析设备对图像信息进行识别的方式。上述目标对象包括但不限于各类水域垃圾，例如塑料瓶盖、树叶等。上述图像信息可以是图片，可以是包括多帧图像的视频，上述图像信息是机器人在目标水域中进行巡视的过程中实时获取的。上述目标操作包括但

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不限于清洁操作、消毒操作、报警操作等，例如，水池机器人可以对各类水域垃圾（如塑料瓶盖、树叶等）进行清洁，水池机器人还可以对需要消毒的目标对象所在区域进行消毒，水池机器人还可以在检测到目标对象为意外落水的人或动物时发出报警信号。

可选的，分析上述图像信息以确定分析结果包括：将上述图像信息输入至目标网络模型，得到上述目标网络模型输出的上述图像信息中包括的对象的特征信息，其中，上述特征信息包括每帧上述图像中包括的对象的空间特征和语义特征；从每帧上述图像中包括的对象的特征信息中确定上述目标对象。在本实施例中，上述空间特征也即浅层视觉特征，包括纹理、颜色、形状、空间关系等，上述语义特征包括深层的对象与对象间的关系。

可选的，上述目标网络模型的一种训练方法包括：获取 M 帧样本图像，其中，每帧上述样本图像中均包括预设对象，其中，上述 M 是大于或等于 1 的自然数；在每帧上述样本图像中对上述预设对象进行标记，得到 M 帧标记后的样本图像；利用 M 帧上述标记后的样本图像训练原始网络模型，得到上述目标网络模型。在本实施例中，上述原始网络模型可以是 yolov3（YOLO 算法的第三个版本），还可以是 FasterRcnn（FastRcnn 算法的优化版本，感兴趣区域的生成方法采用 RegionProposal 网络）。当然，上述算法仅仅是一种说明性的示例，原始网络模型可以是任一能够满足识别需求的模型。上述样本图像可以是网络资源，也可以是人工拍摄的数据，还可以是 AI 生成的训练素材，对样本图像中的目标对象进行标记可以采取人工标记的方式，每个样本图像可以包括多个目标对象。

通过本申请实施例，通过分析水池机器人拍摄的目标水域图像信息，可以识别出目标对象并且确认目标对象的位置，进而可以控制机器人直接前往目标对象的位置，并对目标对象执行目标操作，避免出现水池机器人无法定位目标对象只能按照预设路线重新清理整个目标水域的情况。

在一个示例性实施例中，获取水池机器人拍摄到的上述目标水域的图像信息，包括：获取上述水池机器人在按照第一运行模式运行时，拍摄到

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的上述目标水域的图像信息，其中，第一运行模式包括上述水池机器人按照预设时间周期在多个预设位置间的随机路线中运行的模式。在上述实施例中，上述第一运行模式包括沿随机路径巡视的模式，上述预设时间周期可以是 5 分钟，可以是 6 分钟，还可以是 10 分钟，当然，上述时间仅仅是一种说明性的示例，预设时间周期可以是能够满足水池机器人巡视需求的任一时长。示例性地，在目标水域包括 A、B、C 三个预设位置的情况下，第一运行模式可以是上述水池机器人在 A、B、C 三个预设位置间随机迅游 5 分钟。通过上述实施例，通过随机路径巡视的方式，确定目标水域中存在的个别目标对象，能够有效提高水池机器人对特定对象的处理效率。

在一个示例性实施例中，在上述分析结果用于指示上述目标水域存在目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作，包括：在上述分析结果用于指示上述目标水域中存在目标对象的情况下，根据上述图像信息确定上述目标位置；控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作。

可选的，上述根据图像信息确定目标位置的方法包括：确定上述目标对象在每帧图像中的像素坐标，得到 N 个像素坐标，其中，上述图像信息包括上述图像；利用水池机器人摄像设备的第一配置参数将 N 个上述像素坐标转化映射至摄像设备坐标系中，得到 N 个映射坐标，其中，上述第一配置参数包括拍摄上述图像信息时的参数；利用 N 个上述映射坐标和上述摄像设备的第二配置参数确定上述目标位置，其中，上述第二配置参数包括上述摄像设备拍摄上述图像信息时的位姿信息，上述位姿信息包括旋转矩阵和平移向量。在本实施例中，在上述实施例中，上述将像素坐标转化映射到摄像设备坐标系中可以是将上述像素坐标转化为摄像设备坐标系下的归一化坐标（转化为归一化坐标的形式能够简化后续对目标位置的计算），也可以是将上述像素坐标转化为摄像设备坐标系下的成像面坐标（也即归焦距化坐标，这种情况下成像面坐标间的距离就是对应的像素坐标间

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的距离)。通过上述实施例，通过图像信息确定目标对象位置信息，快速定位目标水域中存在的个别目标对象，能够有效提高水池机器人对特定对象的处理效率。

在一个示例性实施例中，获取水池机器人拍摄到的上述目标水域的图像信息，包括：获取上述水池机器人在按照第二运行模式运行时，拍摄到的上述目标水域的图像信息，其中，第二运行模式包括上述水池机器人按照预设时间周期在多个预设位置间的固定路线中运行的模式。在上述实施例中，上述第二运行模式包括沿固定路径巡视的模式，上述预设时间周期可以是 5 分钟，可以是 6 分钟，还可以是 10 分钟，当然，上述时间仅仅是一种说明性的示例，预设时间周期可以是能够满足水池机器人巡视需求的任一时长。示例性地，在目标水域包括 A、B、C 三个预设位置的情况下，第二运行模式可以是上述水池机器人沿 A→B→C 的预设固定路径迅游 10 分钟。通过上述实施例，通过固定路径巡视的方式，确定目标水域中存在的个别目标对象，能够有效提高水池机器人对特定对象的处理效率。

在一个示例性实施例中，在上述分析结果用于指示上述目标水域存在目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作，包括：在上述水池机器人在按照第二运行模式运行时，从上述分析结果中确定上述目标水域中包括上述目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作。通过上述实施例，通过图像信息确定目标对象位置信息，快速定位目标水域中存在的个别目标对象，能够有效提高水池机器人对特定对象的处理效率。

在一个示例性实施例中，在上述分析结果用于指示上述目标水域存在目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作，包括：在上述水池机器人在按照第二运行模式运行之后，从上述分析结果中确定上述目标水域中包括多个上述目标对象的情况下，在上述地图中标记

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多个上述目标对象的位置，其中，上述地图是上述水池机器人在上述目标水域中运行的过程中构建的；按照多个上述目标对象的位置确定运行路线；控制上述水池机器人按照运行路线运行至多个上述目标对象的多个位置处，执行与每个上述目标对象的类型对应的目标操作。在上述实施例中，可选的，按照多个上述目标对象的位置确定运行路线包括：将多个上述目标对象的位置输入目标最短路模型以得到上述运行路线。上述目标最短路模型可以通过启发式算法（例如遗传算法、蚁群算法等）计算遍历上述多个位置的最短运行路线。示例性地，一种通过遗传算法确定最短路的方法包括：定义目标函数为运行路线长度，将随机组合的多个运行路线作为父代，再次随机组合的多个运行路线作为子代，选择目标函数值较优秀的子代作为新的父代，持续迭代，在子代目标函数值不能明显超过父代的情况下，确定子代为上述运行路线。通过在固定路径巡视过程过程中记录目标对象位置，并在巡视完成后规划路线处理，能够节省处理距离，有效提高水池机器人清洁效率。

在一个示例性实施例中，获取水池机器人拍摄到的上述目标水域的图像信息之前，上述方法还包括：控制上述水池机器人在上述目标水域中沿边执行上述目标操作；在确定上述水池机器人沿边执行上述目标操作之后，控制上述水池机器人在上述目标水域中执行巡视操作，其中，上述巡视操作包括控制上述水池机器人在上述目标水域中拍摄上述图像信息。在上述实施例中，水池机器人工作任务包括沿目标水域边界执行目标操作、按照规划路线在目标水域中执行目标操作、再次沿目标水域边界执行目标操作，上述沿边执行目标操作对应于工作任务中再次沿目标水域边界执行目标操作，也即，巡视操作可以在水池机器人完成工作任务后执行。通过上述实施例，在水池机器人执行工作任务后进行巡视，能够对目标水域进行补充清洁，有效改善了水池机器人工作效果。

通过以上的实施方式的描述，本领域的技术人员可以清楚地了解到根据上述实施例的方法可借助软件加必需的通用硬件平台的方式来实现，当然也可以通过硬件，但很多情况下前者是更佳的实施方式。基于这样的理

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解，本申请的技术方案本质上或者说对现有技术做出贡献的部分可以以软件产品的形式体现出来，该计算机软件产品存储在一个存储介质（如ROM/RAM、磁碟、光盘）中，包括若干指令用以使得一台终端设备（可以是手机，计算机，服务器，或者网络设备等）执行本申请各个实施例上述的方法。

在本实施例中还提供了一种水池机器人的控制装置，该装置用于实现上述实施例及优选实施方式，已经进行过说明的不再赘述。如以下所使用的，术语“模块”可以实现预定功能的软件和/或硬件的组合。尽管以下实施例所描述的装置较佳地以软件来实现，但是硬件，或者软件和硬件的组合的实现也是可能并被构想的。

图 3 是根据本申请实施例的水池机器人的控制装置的结构框图，如图 3 所示，该装置包括：获取模块 32，用于获取水池机器人拍摄到的上述目标水域的图像信息，其中，上述水池机器人在上述目标水域中运行；分析模块 34，用于分析上述图像信息以确定分析结果；确定模块 36，用于在上述分析结果用于指示上述目标水域存在目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作。

在一个示例性实施例中，上述获取模块 32 包括：第一获取子模块，用于获取上述水池机器人在按照第一运行模式运行时，拍摄到的上述目标水域的图像信息，其中，第一运行模式包括上述水池机器人按照预设时间周期在多个预设位置间的随机路线中运行的模式。

在一个示例性实施例中，上述确定模块 36 包括：第一确定子模块，用于在上述分析结果用于指示上述目标水域中存在目标对象的情况下，根据上述图像信息确定上述目标位置；控制子模块，用于控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作。

在一个示例性实施例中，上述获取模块 32 包括：第二获取子模块，用于获取上述水池机器人在按照第二运行模式运行时，拍摄到的上述目标

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水域的图像信息，其中，第二运行模式包括上述水池机器人按照预设时间周期在多个预设位置间的固定路线中运行的模式。

在一个示例性实施例中，上述确定模块 36 包括：第二确定子模块，用于在上述水池机器人在按照第二运行模式运行时，从上述分析结果中确定上述目标水域中包括上述目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作。

在一个示例性实施例中，上述确定模块 36 还包括：第三确定子模块，用于在上述水池机器人在按照第二运行模式运行之后，从上述分析结果中确定上述目标水域中包括多个上述目标对象的情况下，在上述地图中标记多个上述目标对象的位置，其中，上述地图是上述水池机器人在上述目标水域中运行的过程中构建的；第四确定子模块，用于按照多个上述目标对象的位置确定运行路线；控制子模块，用于控制上述水池机器人按照运行路线运行至多个上述目标对象的多个位置处，执行与每个上述目标对象的类型对应的目标操作。

在一个示例性实施例中，上述装置还包括：第一控制模块，用于获取水池机器人拍摄到的上述目标水域的图像信息之前，控制上述水池机器人在上述目标水域中沿边执行上述目标操作；第二控制模块，用于在确定上述水池机器人沿边执行上述目标操作之后，控制上述水池机器人在上述目标水域中执行巡视操作，其中，上述巡视操作包括控制上述水池机器人在上述目标水域中拍摄上述图像信息。

需要说明的是，上述各个模块是可以通过软件或硬件来实现的，对于后者，可以通过以下方式实现，但不限于此：上述模块均位于同一处理器中；或者，上述各个模块以任意组合的形式分别位于不同的处理器中。

本申请的实施例还提供了一种计算机可读存储介质，该计算机可读存储介质中存储有计算机程序，其中，该计算机程序被设置为运行时执行上述任一项方法实施例中的步骤。

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在一个示例性实施例中，上述计算机可读存储介质可以包括但不限于：U盘、只读存储器（Read-OnlyMemory，简称为ROM）、随机存取存储器（RandomAccessMemory，简称为RAM）、移动硬盘、磁碟或者光盘等各种可以存储计算机程序的介质。

本申请的实施例还提供了一种水池机器人，包括存储器和处理器，该存储器中存储有计算机程序，该处理器被设置为运行计算机程序以执行上述任一项方法实施例中的步骤。

在一个示例性实施例中，上述水池机器人还可以包括传输设备以及输入输出设备，其中，该传输设备和上述处理器连接，该输入输出设备和上述处理器连接。

本实施例中的具体示例可以参考上述实施例及示例性实施方式中所描述的示例，本实施例在此不再赘述。

显然，本领域的技术人员应该明白，上述的本申请的各模块或各步骤可以用通用的计算装置来实现，它们可以集中在单个的计算装置上，或者分布在多个计算装置所组成的网络上，它们可以用计算装置可执行的程序代码来实现，从而，可以将它们存储在存储装置中由计算装置来执行，并且在某些情况下，可以以不同于此处的顺序执行所示出或描述的步骤，或者将它们分别制作成各个集成电路模块，或者将它们中的多个模块或步骤制作成单个集成电路模块来实现。这样，本申请不限制于任何特定的硬件和软件结合。

以上上述仅为本申请的优选实施例而已，并不用于限制本申请，对于本领域的技术人员来说，本申请可以有各种更改和变化。凡在本申请的原则之内，所作的任何修改、等同替换、改进等，均应包含在本申请的保护范围之内。

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权利要求书

1. 一种水池机器人的控制方法，其特征在于，包括：

获取水池机器人拍摄到的所述目标水域的图像信息，其中，所述水池机器人在所述目标水域中运行；

分析所述图像信息以确定分析结果；

在所述分析结果用于指示所述目标水域存在目标对象的情况下，确定所述目标对象的目标位置，并控制所述水池机器人运行至所述目标位置，执行与所述目标对象的类型对应的目标操作。

2. 根据权利要求1所述的方法，其特征在于，获取水池机器人拍摄到的所述目标水域的图像信息，包括：

获取所述水池机器人在按照第一运行模式运行时，拍摄到的所述目标水域的图像信息，其中，第一运行模式包括所述水池机器人按照预设时间周期在多个预设位置间的随机路线中运行的模式。

3. 根据权利要求2所述的方法，其特征在于，在所述分析结果用于指示所述目标水域存在目标对象的情况下，确定所述目标对象的目标位置，并控制所述水池机器人运行至所述目标位置，执行与所述目标对象的类型对应的目标操作，包括：

在所述分析结果用于指示所述目标水域中存在目标对象的情况下，根据所述图像信息确定所述目标位置；

控制所述水池机器人运行至所述目标位置，执行与所述目标对象的类型对应的目标操作。

4. 根据权利要求1所述的方法，其特征在于，获取水池机器人拍摄到的所述目标水域的图像信息，包括：

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获取所述水池机器人在按照第二运行模式运行时，拍摄到的所述目标水域的图像信息，其中，第二运行模式包括所述水池机器人按照预设时间周期在多个预设位置间的固定路线中运行的模式。

5. 根据权利要求 4 所述的方法，其特征在于，在所述分析结果用于指示所述目标水域存在目标对象的情况下，确定所述目标对象的目标位置，并控制所述水池机器人运行至所述目标位置，执行与所述目标对象的类型对应的目标操作，包括：

在所述水池机器人在按照第二运行模式运行时，从所述分析结果中确定所述目标水域中包括所述目标对象的情况下，确定所述目标对象的目标位置，并控制所述水池机器人运行至所述目标位置，执行与所述目标对象的类型对应的目标操作。

6. 根据权利要求 3 所述的方法，其特征在于，在所述分析结果用于指示所述目标水域存在目标对象的情况下，确定所述目标对象的目标位置，并控制所述水池机器人运行至所述目标位置，执行与所述目标对象的类型对应的目标操作，包括：

在所述水池机器人在按照第二运行模式运行之后，从所述分析结果中确定所述目标水域中包括多个所述目标对象的情况下，在地图中标记多个所述目标对象的位置，其中，所述地图是所述水池机器人在所述目标水域中运行的过程中构建的；

按照多个所述目标对象的位置确定运行路线；

控制所述水池机器人按照运行路线运行至多个所述目标对象的多个位置处，执行与每个所述目标对象的类型对应的目标操作。

7. 根据权利要求 1-6 任一项所述的方法，其特征在于，获取水池机器人拍摄到的所述目标水域的图像信息之前，所述方法还包括：

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控制所述水池机器人在所述目标水域中沿边执行所述目标操作；

在确定所述水池机器人沿边执行所述目标操作之后，控制所述水池机器人在所述目标水域中执行巡视操作，其中，所述巡视操作包括控制所述水池机器人在所述目标水域中拍摄所述图像信息。

8. 一种水池机器人的控制装置，其特征在于，包括：

获取模块，用于获取水池机器人拍摄到的所述目标水域的图像信息，其中，所述水池机器人在所述目标水域中运行；

分析模块，用于分析所述图像信息以确定分析结果；

确定模块，用于在所述分析结果用于指示所述目标水域存在目标对象的情况下，确定所述目标对象的目标位置，并控制所述水池机器人运行至所述目标位置，执行与所述目标对象的类型对应的目标操作。

9. 一种计算机可读存储介质，其特征在于，所述计算机可读存储介质中存储有计算机程序，其中，所述计算机程序被处理器执行时实现所述权利要求1至7任一项中所述的方法的步骤。

10. 一种水池机器人，包括存储器、处理器以及存储在所述存储器上并可在所述处理器上运行的计算机程序，其特征在于，所述处理器执行所述计算机程序时实现所述权利要求1至7任一项中所述的方法的步骤。

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
19/342,629	09/28/2025		730	2024009-016	20	2

CONFIRMATION NO. 7873

204084
Soleado Law, PC
28 Geary Street
STE 650 #2512
San Francisco, CA 94108

FILING RECEIPT

OC00000009624862O

Date Mailed: 10/22/2025

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

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Inventor(s)

Shilei ZHANG, Suzhou, CHINA;

Applicant(s)

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Assignment For Published Patent Application

XINGMAI INNOVATION TECHNOLOGY (SUZHOU) CO., LTD., Suzhou, CHINA

Power of Attorney: The patent practitioners associated with Customer Number 204084

Domestic Applications for which benefit is claimed

This application is a CON of PCT/CN2023/116834 09/04/2024

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)
CHINA 2023107686783 06/27/2023 Access Code Provided

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The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 19/342,629**

Projected Publication Date: 01/29/2026

Non-Publication Request: No

Early Publication Request: No
**** SMALL ENTITY ****
Title

POOL ROBOT CONTROL METHOD AND APPARATUS, STORAGE MEDIUM, AND POOL ROBOT

Preliminary Class

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 19/342,629

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	70		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	308		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	352		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	20 minus 20 =	* 0	x =	0	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	*	x =	0			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0			
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	730		TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
19/342,629	09/28/2025	Shilei ZHANG	2024009-016	7873

204084 7590 10/28/2025

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EXAMINER
CENTRAL, DOCKET

ART UNIT	PAPER NUMBER
OPAP	

NOTIFICATION DATE	DELIVERY MODE
10/28/2025	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

contact@soleadolaw.com

Decision Granting Request for Prioritized Examination (Track I)	**Application No.** 19/342,629	**Applicant(s)** ZHANG, Shilei	
	Examiner FIKIRTE A GEREMEW	**Art Unit** OMBL	**AIA (FITF) Status** Yes

1. THE REQUEST FILED 28 September 2025 IS **GRANTED** .

The above-identified application has met the requirements for prioritized examination

A. ☑ for an original nonprovisional application (Track I).
B. ☐ for an application undergoing continued examination (RCE).

2. **The above-identified application will undergo prioritized examination**. The application will be accorded special status throughout its entire course of prosecution until one of the following occurs:

A. filing a **petition for extension of time** to extend the time period for filing a reply;

B. filing an **amendment to amend the application to contain more than four independent claims, more than thirty total claims** , or a multiple dependent claim;

C. filing a **request for continued examination** ;

D. filing a notice of appeal;

E. filing a request for suspension of action;

F. mailing of a notice of allowance;

G. mailing of a final Office action;

H. completion of examination as defined in 37 CFR 41.102; or

I. abandonment of the application.

Telephone inquiries with regard to this decision should be directed to FIKIRTE GEREMEW at (703) 756-193. In his/her absence, calls may be directed to Petition Help Desk at (571) 272-3282.

/FIKIRTE A GEREMEW/ PROGRAM SUPPORT SPECIALIST, OMBL	

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
19/342,629	09/28/2025	Shilei ZHANG	2024009-016	7873

204084 7590 11/28/2025

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EXAMINER	
STRYKER, NICHOLAS F	

ART UNIT	PAPER NUMBER
3665	

NOTIFICATION DATE	DELIVERY MODE
11/28/2025	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

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contact@soleadolaw.com

Office Action Summary	Application No. 19/342,629	Applicant(s) ZHANG, Shilei	
	Examiner NICHOLAS STRYKER	Art Unit 3665	AIA (First Inventor to File) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 09/28/2025.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1-20 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1-20 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on 09/28/2025 is/are: a)☑ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☑ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☑ All b)☐ Some** c)☐ None of the:

1.☑ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Application Status

2. This Office Action is in response to the application filed on **09/28/2025**. Claims **1-20** are pending and rejected as detailed below. It is noted that the Track 1 request for this application was granted on **10/28/2025.** Additionally, applicant is reminded of their duty to disclose any known prior art. No IDS was filed with this application, despite it being a continuation of a PCT application and having a ISR.

Priority

3. Receipt is acknowledged of certified copies of papers required by 37 CFR 1.55. Applicant claims priority to **PCT/CN2023/116834,** filed **09/04/2024**, and **CN2023107686783,** filed **06/27/2023.** The application has been examined with these dates in mind.

Claim Rejections - 35 USC § 102

4. In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis (i.e., changing from AIA to pre-AIA) for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

5. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (a)(1) the claimed invention was patented, described in a printed publication, or in public use, on sale, or otherwise available to the public before the effective filing date of the claimed invention.

(a)(2) the claimed invention was described in a patent issued under section 151, or in an application for patent published or deemed published under section 122(b), in which the patent or application, as the case may be, names another inventor and was effectively filed before the effective filing date of the claimed invention.

6. Claim(s) **1-5, 9, 12-17, and 19-20** is/are rejected under 35 U.S.C. 102(a)(1)(a)(2) as being anticipated by Braidic (US PG Pub 2019/0085579).

7. Regarding claim 1, Braidic teaches a pool robot control method, comprising: obtaining image information of a target water region captured by a pool robot, **([0042]-[0045] and [0048]-[0049] teach an aquatic robot that obtains images in a target region)** wherein the pool robot operates in the target water region, **([0047]-[0048] teach the robot collecting data as it moves through the aquatic environment)** wherein the image information comprises a frame of image or a plurality of frames of images; **([0048] teaches the robot collecting a series of images at it moves in the environment)**

- analyzing the image information to determine an analysis result; **([0048]-[0055] teach the system analyzing the image captured by the robot)** and
- determining a target position of a target object if the analysis result indicates that there is the target object in the target water region, **([0054]-[0055] teaches the robot system tracking the target objects, "debris" in the pool)** and controlling the pool robot to move to the target position and perform a target operation corresponding to a type of the target object. **([0056]-[0057] teaches the system determining a track to the objects and performing an operation to remove the debris based on the type of debris)**

8. Regarding claim 2, Braidic teaches the method according to claim 1, wherein the obtaining image information of a target water region captured by a pool robot comprises: obtaining the image information of the target water region captured by the pool robot when the pool robot operates in a first operation mode, **([0042]-[0045] and [0048]-[0049] teach an aquatic robot that obtains images in a target region, while operating in a specific operation mode)** wherein the first operation mode is a mode in which the pool robot operates between a plurality of preset positions along a random route

based on a preset time period. **([0081]-[0082] teach the robot system navigating by a random pathing for a time period)**

9. Regarding claim 3, Braidic teaches the method according to claim 1, wherein the determining a target position of a target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform a target operation corresponding to a type of the target object comprises: if the analysis result indicates that there is the target object in the target water region, determining the target position based on the image information; **([0054]-[0055] teaches the robot system tracking the target objects, "debris" in the pool)** and

- controlling the pool robot to move to the target position and perform the target operation corresponding to the type of the target object. **([0056]-[0057] teaches the system determining a track to the objects and performing an operation to remove the debris based on the type of debris)**

10. Regarding claim 4, Braidic teaches method according to claim 1, wherein the obtaining image information of a target water region captured by a pool robot comprises: obtaining the image information of the target water region captured by the pool robot when the pool robot operates in a second operation mode, **([0042]-[0045] and [0048]-[0049] teach the robot operating in a specific control mode and an aquatic robot that obtains images in a target region)** wherein the second operation mode is a mode in which the pool robot operates between a plurality of preset positions along a fixed route based on a preset time period. **([0047]-[0048] and [0054]-[0059] teach the robot pathing along a preset path between preset points)**

11. Regarding claim 5, Braidic teaches the method according to claim 4, wherein the determining a target position of a target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform a target

operation corresponding to a type of the target object comprises: when the pool robot operates in the second operation mode, determining the target position of the target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform the target operation corresponding to the type of the target object. **([0047]-[0048] and [0054]-[0059] teach the robot operating in the second pathing mode, and determining the location of a target object. The robot then navigates to the debris and performs an operation based on the type of debris)**

12. Regarding claim 9, Braidic teaches a pool robot control method, wherein a pool robot is configured to perform a cleaning operation in a target water region, and a camera is disposed on the pool robot, wherein the method comprises: controlling the pool robot to perform a patrolling operation in the target water region, **([0047]-[0048] and [0054]-[0059] teach the robot patrolling the pool as it moves in a preset path)** enabling the camera to capture an image of the target water region in a process of performing the patrolling operation, **([0042]-[0043] teaches a camera capturing images of the water area where the robot operates)** wherein the image is used to determine whether there is a target object in the target water region, wherein the target object needs to be cleaned; **([0048]-[0055] teach the system analyzing the image captured by the robot and determining if there is an object in the target area)** and

- controlling, if it is determined that there is the target object, the pool robot to move to a target position of the target object and perform the cleaning operation on the target object. **([0056]-[0057] teaches the system determining a track to the objects and performing an operation to remove the debris based on the type of debris)**

13. Regarding claim 12, Braidic teaches the method according to claim 9, comprising: if it is determined that there is the target object, controlling the pool robot to directly move to the target

position of the target object and perform the cleaning operation on the target object. **([0056]-[0057] teach the robot moving directly to the debris to remove it)**

14. Regarding claim 13, Braidic teaches the method according to claim 9, wherein the controlling the pool robot to perform a patrolling operation in the target water region comprises: controlling the pool robot to perform the patrolling operation in a first operation mode, wherein the first operation mode is a mode of performing the patrolling operation along a random route. **([0081]-[0082] teach the robot system navigating by a random pathing for a time period)**

15. Regarding claim 14, Braidic teaches the method according to claim 13, wherein the controlling the pool robot to perform a patrolling operation in the target water region comprises: controlling the pool robot to perform the patrolling operation in the first operation mode, wherein the first operation mode is a mode in which the pool robot operates between a plurality of preset positions along the random route based on a preset time period. **([0081]-[0082] teach the robot system navigating by a random pathing for a time period, this route would be understood to operate between preset points)**

16. Regarding claim 15, Braidic teaches the method according to claim 9, wherein the controlling the pool robot to perform a patrolling operation in the target water region comprises: controlling the pool robot to perform the patrolling operation in a second operation mode, **([0047]-[0048] and [0054]-[0059] teach the robot operating in a specific control mode)** wherein the second operation mode is a mode of performing the patrolling operation along a fixed route. **([0047]-[0048] and [0054]-[0059] teach the robot pathing along a preset path)**

17. Regarding claim 16, Braidic teaches the method according to claim 15, wherein the controlling the pool robot to perform a patrolling operation in the target water region comprises: controlling the pool robot to perform the patrolling operation in the second operation mode, **([0047]-[0048] and [0054]-[0059] teach the robot operating in a specific control mode)** wherein the second operation mode is a mode in which the pool robot operates between a plurality of preset positions along the fixed

route based on a preset time period. **([0047]-[0048] and [0054]-[0059] teach the robot pathing along a preset path between preset points)**

18. Regarding claim 17, Braidic teaches the method according to claim 15, wherein the controlling, if it is determined that there is the target object, the pool robot to move to a target position of the target object and perform the cleaning operation on the target object comprises: when the pool robot is controlled to perform the patrolling operation in the second operation mode, **([0047]-[0048] and [0054]-[0059] teach the robot operating in a specific control mode)** controlling, if it is determined that there is the target object, the pool robot to move to the target position of the target object and perform the cleaning operation on the target object. **([0047]-[0048] and [0054]-[0059] teach the robot operating in the second pathing mode, and determining the location of a target object. The robot then navigates to the debris and performs an operation based on the type of debris)**

19. Regarding claim 19, Braidic teaches the method according to claim 9, comprising: when the pool robot performs the cleaning operation at a water surface or a bottom of the target water region, controlling the pool robot to perform the patrolling operation in the target water region. **([0047] teaches the robot patrolling an aquatic environment. This environment comprises a pool, the robot cleans the entirety of the pool, surface and bottom, and patrols the rest)**

20. Regarding claim 20, Braidic teaches the method according to claim 9, comprising: if it is determined that there is the target object, determining the target position of the target object **([0054]-[0055] teaches the robot system tracking the target objects, "debris" in the pool)** and controlling the pool robot to move to the target position of the target object, wherein the image is used to determine the target position of the target object. **([0056]-[0057] teaches the system determining a track to the objects and performing an operation to remove the debris based on the type of debris)**

Claim Rejections - 35 USC § 103

21. In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis (i.e., changing from AIA to pre-AIA) for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

22. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

23. The factual inquiries for establishing a background for determining obviousness under 35 U.S.C. 103 are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.

3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

24. Claim(s) **6 and 18** is/are rejected under 35 U.S.C. 103 as being unpatentable over **Braidic in view of Regev (US PG Pub 2020/0249690).**

25. Regarding claim 6, Braidic teaches the method according to claim 4, wherein the determining a target position of a target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform a target operation corresponding to a type of the target object comprises: after the pool robot operates in the second operation mode, marking positions of a plurality of target objects on a map if the analysis result

indicates that there is the plurality of target objects in the target water region, **([0047]-[0048] teaches the system recording a series of debris objects in the pool as it navigates)** ~~wherein the map is constructed in a process in which the pool robot operates in the target water region~~;

- determining an operation route based on the positions of the plurality of target objects; **([0077]-[0078] teach the system determining a pathing for a plurality of objects)** and
- controlling the pool robot to move to the positions of the plurality of target objects along the operation route and perform a target operation corresponding to a type of each target object. **([0077]-[0079] teaches the robot moving along the selected pathing in order to perform the operation)**

26. Braidic does not teach wherein the map is constructed in a process in which the pool robot operates in the target water region.

27. However, Regev teaches "wherein the map is constructed in a process in which the pool robot operates in the target water region" **([0215] teaches the system generating a map of a pool during operation in order to better operate)**

28. It would have been prima facie obvious to one of ordinary skill in the art, before the effective filing date, to incorporate the teachings of Braidic with Regev; and have a reasonable expectation of success. Both relate to the control of pool robots. As Regev teaches in [0107] the creation of a map of the pool allows for the system to better control the cleaning trajectory. The cleaning robot is not moving in the dark and can more effectively plan a route. As seen in Braidic, the robot can determine multiple debris fields in a row and better plan how to get to all debris. The use of a map would improve this functionality by knowing the entire pool structure.

29. Regarding claim 18, Braidic teaches the method according to claim 15 comprising: in a process of controlling the pool robot to perform the patrolling operation in the second operation mode, if it is determined that there is the target object, recording the target position of the target object, or after the

pool robot is controlled to perform the patrolling operation in the second operation mode, if it is determined that there is a plurality of target objects, marking target positions of the plurality of target objects on a map, **([0047]-[0048] teaches the system recording a series of debris objects in the pool as it navigates)** ~~wherein the map is constructed in a process in which the pool robot operates in the target water region~~; and

- the controlling, if it is determined that there is the target object, the pool robot to move to a target position of the target object and perform the cleaning operation on the target object **([0077]-[0078] teach the system determining a pathing for a plurality of objects)** comprises: after the patrolling operation is completed, controlling the pool robot to move to the target positions of the plurality of target objects along an operation route and perform the cleaning operation on each target object. **([0077]-[0079] teaches the robot moving along the selected pathing in order to perform the operation)**

30. Braidic does not teach wherein the map is constructed in a process in which the pool robot operates in the target water region.

31. However, Regev teaches "wherein the map is constructed in a process in which the pool robot operates in the target water region" **([0215] teaches the system generating a map of a pool during operation in order to better operate)**

32. It would have been prima facie obvious to one of ordinary skill in the art, before the effective filing date, to incorporate the teachings of Braidic with Regev; and have a reasonable expectation of success. Both relate to the control of pool robots. As Regev teaches in [0107] the creation of a map of the pool allows for the system to better control the cleaning trajectory. The cleaning robot is not moving in the dark and can more effectively plan a route. As seen in Braidic, the robot can determine multiple debris fields in a row and better plan how to get to all debris. The use of a map would improve this functionality by knowing the entire pool structure.

33. Claim(s) **7-8 and 10-11** is/are rejected under 35 U.S.C. 103 as being unpatentable over **Braidic in view of Goldberg (US PG Pub 2018/0073266).**

34. Regarding claim 7, Braidic teaches the method according to claim 1, wherein before the obtaining image information of a target water region captured by a pool robot, the method further comprises: ~~controlling the pool robot to perform the target operation along an edge in the target water region;~~ after it is determined that the pool robot completes the target operation along the edge, controlling the pool robot to perform a patrolling operation in the target water region, **([0047]-[0048] and [0054]-[0059] teach the robot patrolling the pool as it moves in a preset path)** wherein the patrolling operation comprises controlling the pool robot to capture the image information in the target water region. **([0047]-[0048] teach the robot capturing images as it patrols in the pool)**

35. Braidic does not teach controlling the pool robot to perform the target operation along an edge in the target water region.

36. However, Goldberg teaches "controlling the pool robot to perform the target operation along an edge in the target water region;" **(Fig. 1 and [0306] teach a cleaning robot that is tasked to clean a first pool area, it follows a path that takes it along the sidewall, i.e. edge, first)**

37. It would have been prima facie obvious to one of ordinary skill in the art, before the effective filing date, to incorporate the teachings of Braidic with Goldberg; and have a reasonable expectation of success. Both relate to the control of pool cleaning robots operating in the pool. This style of edge first allows the robot to clean in a way that prevents debris from escaping the path of the robot. As Goldberg teaches in [0154]-[0156] pool regions may be varied depending of the type of pool. Going with the edge of the region first such as the sidewall allows the robot to image the future operation region and determine a path to the debris. This ensures optimal efficiency in the cleaning operation.

38. Regarding claim 8, Braidic teaches the method according to claim 1, wherein before the obtaining image information of a target water region captured by a pool robot, the method further

comprises: ~~controlling the pool robot to perform a task in the target water region, wherein the task comprises performing the target operation along an edge of the target water region, performing the target operation in the target water region along a planned route, and performing the target operation along the edge of the target water region again~~; and

- after it is determined that the pool robot completes the task, controlling the pool robot to perform a patrolling operation in the target water region, **([0047]-[0048] and [0054]-[0059] teach the robot patrolling the pool as it moves in a preset path)** wherein the patrolling operation comprises controlling the pool robot to capture the image information in the target water region. **([0047]-[0048] teach the robot capturing images as it patrols in the pool)**

39. Braidic does not teach controlling the pool robot to perform a task in the target water region, wherein the task comprises performing the target operation along an edge of the target water region, performing the target operation in the target water region along a planned route, and performing the target operation along the edge of the target water region again.

40. However, Goldberg teaches "controlling the pool robot to perform a task in the target water region, wherein the task comprises performing the target operation along an edge of the target water region," **(Fig. 1 and [0306] teach a cleaning robot that is tasked to clean a first pool area, it follows a path that takes it along the sidewall, i.e. edge, first)** "performing the target operation in the target water region along a planned route," **(Fig. 1 and [0306] show a robot completing the cleaning operation in the main region of the pool after cleaning the first edge)** and "performing the target operation along the edge of the target water region again." **(Fig. 1 and [0306] show the robot cleaning the edge a second time after cleaning the main area of operation)**

41. It would have been prima facie obvious to one of ordinary skill in the art, before the effective filing date, to incorporate the teachings of Braidic with Goldberg; and have a reasonable expectation of success. Both relate to the control of pool cleaning robots operating in the pool. This style of edge first

allows the robot to clean in a way that prevents debris from escaping the path of the robot. As Goldberg teaches in [0154]-[0156] pool regions may be varied depending of the type of pool. Going with the edge of the region first such as the sidewall allows the robot to image the future operation region and determine a path to the debris. This ensures optimal efficiency in the cleaning operation.

42. Regarding claim 10, Braidic teaches the method according to claim 9, further comprising: ~~controlling the pool robot to perform the cleaning operation in the target water region along an edge of the target water region~~; and after the pool robot completes the cleaning operation along the edge of the target water region, controlling the pool robot to perform the patrolling operation in the target water region. **([0047]-[0048] and [0054]-[0059] teach the robot patrolling the pool as it moves in a preset path)**

43. Braidic does not teach controlling the pool robot to perform the cleaning operation in the target water region along an edge of the target water region.

44. However, Goldberg teaches "controlling the pool robot to perform the cleaning operation in the target water region along an edge of the target water region" **(Fig. 1 and [0306] teach a cleaning robot that is tasked to clean a first pool area, it follows a path that takes it along the sidewall, i.e. edge, first)**

45. It would have been prima facie obvious to one of ordinary skill in the art, before the effective filing date, to incorporate the teachings of Braidic with Goldberg; and have a reasonable expectation of success. Both relate to the control of pool cleaning robots operating in the pool. This style of edge first allows the robot to clean in a way that prevents debris from escaping the path of the robot. As Goldberg teaches in [0154]-[0156] pool regions may be varied depending of the type of pool. Going with the edge of the region first such as the sidewall allows the robot to image the future operation region and determine a path to the debris. This ensures optimal efficiency in the cleaning operation.

46. Regarding claim 11, Braidic teaches the method according to claim 9, wherein the patrolling operation is performed after the pool robot completes a task, **([0047]-[0048] and [0054]-[0059] teach**

the robot patrolling the pool as it moves in a preset path) ~~wherein the task comprises performing the cleaning operation along an edge of the target water region, performing the cleaning operation in the target water region along a planned route, and performing the cleaning operation along the edge of the target water region again~~.

47. Braidic does not teach wherein the task comprises performing the cleaning operation along an edge of the target water region, performing the cleaning operation in the target water region along a planned route, and performing the cleaning operation along the edge of the target water region again.

48. However, Goldberg teaches "wherein the task comprises performing the cleaning operation along an edge of the target water region," **(Fig. 1 and [0306] teach a cleaning robot that is tasked to clean a first pool area, it follows a path that takes it along the sidewall, i.e. edge, first)** "performing the target operation in the target water region along a planned route," **(Fig. 1 and [0306] show a robot completing the cleaning operation in the main region of the pool after cleaning the first edge)** and "performing the target operation along the edge of the target water region again." **(Fig. 1 and [0306] show the robot cleaning the edge a second time after cleaning the main area of operation)**

49. It would have been prima facie obvious to one of ordinary skill in the art, before the effective filing date, to incorporate the teachings of Braidic with Goldberg; and have a reasonable expectation of success. Both relate to the control of pool cleaning robots operating in the pool. This style of edge first allows the robot to clean in a way that prevents debris from escaping the path of the robot. As Goldberg teaches in [0154]-[0156] pool regions may be varied depending of the type of pool. Going with the edge of the region first such as the sidewall allows the robot to image the future operation region and determine a path to the debris. This ensures optimal efficiency in the cleaning operation.

Conclusion

50. Any inquiry concerning this communication or earlier communications from the examiner should be directed to NICHOLAS STRYKER whose telephone number is (571)272-4659. The examiner can normally be reached Monday-Friday 7:30-5:00.

51. Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

52. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Christian Chace can be reached at (571) 272-4190. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

53. Information regarding the status of published or unpublished applications may be obtained from Patent Center. Unpublished application information in Patent Center is available to registered users. To file and manage patent submissions in Patent Center, visit: https://patentcenter.uspto.gov. Visit https://www.uspto.gov/patents/apply/patent-center for more information about Patent Center and https://www.uspto.gov/patents/docx for information about filing in DOCX format. For additional questions, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/N.S./
Examiner, Art Unit 3665
/CHRISTIAN CHACE/
Supervisory Patent Examiner, Art Unit 3665

Notice of References Cited	Application/Control No. 19/342,629	Applicant(s)/Patent Under Reexamination ZHANG, Shilei	
	Examiner NICHOLAS STRYKER	Art Unit 3665	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date YYYY-MM-DD	Name	CPC Classification	US Classification
*	A	US-20180073266-A1	2018-03-15	Goldenberg; Sharon	G05D1/10	1/1
*	B	US-20190085579-A1	2019-03-21	Braidic; Kevin	E04H4/1654	1/1
*	C	US-20200249690-A1	2020-08-06	Regev; Ofer	G05D1/0246	1/1
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date YYYY-MM-DD	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title, Date, Publisher, Edition or Volume, Pertinent Pages
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in YYYY-MM-DD format are publication dates. Classifications may be US or foreign.

Patent Owner Zodiac Pool Systems LLC
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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	19/342,629	ZHANG, Shilei
	Examiner	Art Unit
	NICHOLAS STRYKER	3665

CPC - Searched*		
Symbol	**Date**	**Examiner**
E04H4/1654	11/14/2025	NS
G05D1/648 G05D1/6484 G05D1/6486 G05D2105/10 G05D2107/29	11/14/2025	NS
G06T7/70	11/14/2025	NS
G06V20/05 G06V2201/07	11/14/2025	NS

CPC Combination Sets - Searched*		
Symbol	**Date**	**Examiner**

US Classification - Searched*			
Class	**Subclass**	**Date**	**Examiner**

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	**Date**	**Examiner**
Synonym and CPC search	11/14/2025	NS
IP.com patent and NPL search	11/14/2025	NS
AI search tools in PE2E, including similarity search - see srnt	11/14/2025	NS
Inventor and assignee search	11/14/2025	NS

/N.S./ Examiner, Art Unit 3665	

Patent Owner Zodiac Pool Systems LLC
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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	19/342,629	ZHANG, Shilei
	Examiner	Art Unit
	NICHOLAS STRYKER	3665

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

/N.S./ Examiner, Art Unit 3665	

Patent Owner Zodiac Pool Systems LLC
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Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	19/342,629	ZHANG, Shilei
	Examiner	**Art Unit**
	NICHOLAS STRYKER	3665

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS										
☐ Claims renumbered in the same order as presented by applicant					☐ CPA		☐ T.D.		☐ R.1.47	
CLAIM		DATE								
Final	Original	11/14/2025								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	✓								
	7	✓								
	8	✓								
	9	✓								
	10	✓								
	11	✓								
	12	✓								
	13	✓								
	14	✓								
	15	✓								
	16	✓								
	17	✓								
	18	✓								
	19	✓								
	20	✓								

Patent Owner Zodiac Pool Systems LLC
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Bibliographic Data

Application No: 19/342,629

Foreign Priority claimed: ◉ Yes ○ No

35 USC 119 (a-d) conditions met: ☑ Yes ☐ No ☐ Met After Allowance

Verified and Acknowledged: /NICHOLAS STRYKER/ (Examiner's Signature) | (Initials)

Title: POOL ROBOT CONTROL METHOD AND APPARATUS, STORAGE MEDIUM, AND POOL ROBOT

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
09/28/2025	701	3665	2024009-016
RULE			

APPLICANTS

XINGMAI INNOVATION TECHNOLOGY (SUZHOU) CO., LTD., Suzhou, CHINA

INVENTORS

Shilei ZHANG, Suzhou, CHINA

CONTINUING DATA

This application is a CON of PCT/CN2023/116834 09/04/2024

FOREIGN APPLICATIONS

CHINA CN2023107686783 06/27/2023

IF REQUIRED, FOREIGN LICENSE GRANTED**

10/20/2025

**** SMALL ENTITY ****

STATE OR COUNTRY

CHINA

ADDRESS

Soleado Law, PC
28 Geary Street
STE 650 #2512
San Francisco, CA 94108
UNITED STATES

FILING FEE RECEIVED

$2,596

PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L1	45	(ZHANG NEAR Shilei).in,inv.	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/10 03:51 PM
L2	28	(XINGMAI near2 INNOVATION near2 TECHNOLOGY).as,aanm.	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/10 03:51 PM
L3	21	L1 AND L2	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/10 03:52 PM
L4	50	(Artificial Intelligence) Similar to: 19/342,629 with 0 CPC Selections and 0 Text Selections Text: (CN-119516248-A OR CN-118534413-A OR US-7769203-B2 OR CN-113065392-A OR US-11907838-B2 OR CN-114078232-A OR CN-111678522-A OR CN-120515099-A OR US-20250127362-A1 OR CN-108537843-A OR AU-2021290427-A1 OR US-20220122353-A1 OR WO-2021236939-A1 OR CN-110558902-B OR US-20200012288-A1 OR CN-112766241-B OR CN-110619298-A OR CN-112766241-A OR CN-112277783-A OR CN-116977576-B OR AU-2021290427-B2 OR CN-119883070-A OR US-11488390-B2 OR CN-111246110-B OR CN-118212625-A OR US-20200074196-A1 OR CN-113627412-A OR CN-112699888-A OR CN-111325117-B OR US-10812761-B2 OR JP-2022552772-A OR CN-110558902-A OR JP-7250924-B2 OR KR-20210144887-A OR US-20090059002-A1 OR US-20200364863-	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2025/11/10 03:53 PM

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		A1 OR EP-4390599-A1 OR CN-111340030-A OR CN-110287778-B OR US-20240203107-A1 OR US-20180032833-A1 OR CN-111612812-B OR US-7953245-B2 OR CN-113514053-B OR CN-113787517-A OR CN-110491060-A OR CN-114820785-A OR US-9818038-B2 OR CN-111340030-B OR CN-108921894-B).did.					
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		OR US-20240312047-A1 OR CN-117523541-A OR JP-7660356-B2 OR US-11409303-B2 OR JP-2021516817-A OR WO-2022260755-A1 OR US-20230222838-A1 OR US-20240009851-A1 OR CN-119516248-A OR CN-118212625-A OR KR-102596388-B1 OR US-20200074196-A1 OR WO-2021236939-A1 OR CN-112560592-B OR KR-20250029083-A).did.					
L7	1	("20200311227").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/12 10:10 AM
L9	5	("20200311227"|11667 9716|114987721|11293 6313|214996404).pn.	(US-PGPUB; USPAT; FIT (CN))	OR	ON	ON	2025/11/12 10:11 AM
L11	1572	(E04H4/1654).cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/12 10:14 AM
L12	1574	(E04H4/1654 OR G05D2107/29).cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/12 10:26 AM
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L14	30246	(G06T7/70 OR G06V20/05 OR G06V2201/07).cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/12 10:27 AM
L15	44	L13 AND L12	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/12 10:27 AM
L16	2	L14 AND L12	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/12 10:27 AM
L17	56	L14 AND L13	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/12 10:28 AM
L18	20017	((obtain$3 OR captur$3 OR receiv$3 OR get$4 OR collect$4 OR procur$3 OR captur$3 OR tak$3 OR record$3) near4 (image OR video OR picture OR photograph OR photo)) SAME ((clean$3 OR cleans$3 OR scrub$4 OR wash$3 OR vacuum$4 OR brush$3 OR wip$3) near3 (robot OR roomba OR	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/12 11:30 AM

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		automaton OR dorid OR machine OR bot OR mechanism OR device))					
L19	1684	L18 AND ((target OR goal OR purpose OR objective OR intention) near3 (object OR location OR spot OR locale OR mark OR intent OR focus OR spill OR debris OR rubbish OR wast OR junk OR litter OR scrp OR residue))	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/12 11:31 AM
L20	61	L19 AND ((pool OR underwater OR spa OR pond OR swimming$1pool OR lake OR lagoon OR submersible OR submerged OR submarine OR aquatic OR marine) near4 (robot OR roomba OR automaton OR dorid OR machine OR bot OR mechanism OR device))	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/12 11:33 AM
L21	65640	(self ADJ moving OR servomechanism OR servo OR automat$2 OR robot$2) NEAR2 (cleaner OR cleaning OR vacuum OR vaccum OR home) OR roomba OR scooba OR dirt ADJ dog OR dirtdog OR verro OR looj	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/12 11:33 AM
L22	225	L21 near4 (underwater OR under$water OR marine OR undersea OR subaquatic OR subsurface OR sub$aquatic OR oceanic OR submers$3 OR nautical OR (deep ADJ ocean) OR sea$dwell$3 OR oceanographic OR hydrographic)	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/12 11:34 AM
L23	185	L22 AND @ad<"20230627"	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/12 01:19 PM
L24	13	L23 AND L18	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/12 01:25 PM

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L25	2	(20200237176|20190208979).pn.	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/12 01:27 PM
L26	308	L11 AND ((perimeter OR edge OR border OR boundary OR periphery) near4 (clean$3 OR cleans$3 OR scrub$4 OR wash$3 OR vacuum$4 OR brush$3 OR wip$3))	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/13 02:45 PM
L27	277	L26 AND @ad<"20230627"	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/13 02:45 PM
L28	28	(L11 AND ((perimeter OR edge OR border OR boundary OR periphery) near4 (map$4 OR chart$3 OR diagram$4 OR plot$4))) AND @ad<"20230627"	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/13 03:43 PM

PE2E SEARCH - Search History (Interference)

There are no Interference searches to show.

19342629 Xingmai Pool Robot

Report Run Date: 2025-11-14 UTC
Searches: 9
Markers: 0

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Search #	Timestamp	Results	Page
1	2025-11-11 12:45 UTC	~6,515,696	3
2	2025-11-11 12:46 UTC	~6,515,696	4
3	2025-11-11 12:46 UTC	1	4
4	2025-11-11 12:54 UTC	~33,628,899	4
5	2025-11-11 12:55 UTC	~28,716,212	4
6	2025-11-12 18:28 UTC	~32,583,789	4
7	2025-11-12 19:44 UTC	~30,213,570	5
8	2025-11-12 19:44 UTC	~5,826,407	5
9	2025-11-12 19:45 UTC	~409,782	5

Patent Owner Zodiac Pool Systems LLC
Exhibit 2023 - Page 104 of 377

Content: Patents + NPL (195)

US Patents | US Designs | US Applications | EPO Patents | EPO Applications | China Patents | China Applications | Japan Patents | Japan Applications | Korea Patents | Korea Applications | WIPO Applications | Argentina Patents | Argentina Applications | Brazil Patents | Brazil Applications | Canada Patents | Canada Applications | Chile Patents | Chile Applications | Colombia Applications | Costa Rica Applications | Cuba Patents | Cuba Applications | Dominican Republic Applications | Ecuador Patents | Ecuador Applications | El Salvador Applications | Guatemala Applications | Honduras Applications | Mexico Patents | Mexico Applications | Nicaragua Patents | Panama Applications | Peru Applications | Trinidad & Tobago Patents | Uruguay Applications | Austria Patents | Austria Applications | Belarus Patents | Belgium Patents | Belgium Applications | Bosnia & Herzegovina Patents | Bosnia & Herzegovina Applications | Bulgaria Patents | Bulgaria Applications | Croatia Patents | Croatia Applications | Czech Republic Patents | Czech Republic Applications | Czechoslovakia Patents | Czechoslovakia Applications | Denmark Patents | Denmark Applications | Estonia Patents | Estonia Applications | EUIPO Patents | Finland Patents | Finland Applications | France Patents | France Applications | Germany Patents | Germany Applications | Great Britain Patents | Great Britain Applications | Greece Patents | Greece Applications | Hungary Patents | Hungary Applications | Iceland Patents | Iceland Applications | Ireland Patents | Ireland Applications | Italy Patents | Italy Applications | Latvia Patents | Latvia Applications | Lithuania Patents | Lithuania Applications | Luxembourg Patents | Luxembourg Applications | Malta Patents | Monaco Patents | Montenegro Patents | Montenegro Applications | Netherlands Patents | Netherlands Applications | Norway Patents | Norway Applications | Poland Patents | Poland Applications | Portugal Patents | Portugal Applications | Republic of Moldova Patents | Republic of Moldova Applications | Romania Patents | Romania Applications | San Marino Patents | San Marino Applications | Serbia Patents | Serbia Applications | Slovakia Patents | Slovakia Applications | Slovenia Patents | Spain Patents | Spain Applications | Sweden Patents | Sweden Applications | Switzerland Patents | Switzerland Applications | Ukraine Patents | Yugoslavia/Serbia and Montenegro Patents | Yugoslavia/Serbia and Montenegro Applications | Armenia Patents | Australia Patents | Australia Applications | Cyprus Patents | Gulf Cooperation Council Patents | Hong Kong Patents | India Patents | India Applications | Indonesia Patents | Indonesia Applications | Israel Patents | Israel Applications | Jordan Patents | Jordan Applications | Kyrgyzstan Patents | Macao Applications | Malaysia Patents | Mongolia Patents | New Zealand Patents | Philippines Patents | Philippines Applications | Saudi Arabia Patents | Saudi Arabia Applications | Singapore Patents | Singapore Applications | Taiwan Patents | Taiwan Applications | Tajikistan Patents | Tajikistan Applications | Thailand Patents | Thailand Applications | Uzbekistan Patents | Vietnam Patents | Algeria Patents | ARIPO Patents | ARIPO Applications | Egypt Patents | Kenya Patents | Malawi Patents | Morocco Patents | Morocco Applications | OAPI Patents | South Africa Patents | Tunisia Applications | Zambia Patents | Zimbabwe Patents | EAPO Patents | EAPO Applications | Georgia Patents | Georgia Applications | Kazakhstan Patents | Kazakhstan Applications | Russia Patents | Russia Applications | Turkey Patents | Turkey Applications | IEEE Xplore Publications: IEEE Periodicals | IEEE Xplore Publications: IEEE Conferences | IEEE Xplore Publications: IEEE Standards | IEEE Xplore Publications: IEEE Early Access | IEEE Xplore Publications: SMPTE Periodicals | IEEE Xplore Publications: SMPTE Conferences | IEEE Xplore Publications: SMPTE Standards | IEEE Xplore Publications: MIT Press eBooks | IEEE Xplore Publications: Wiley-IEEE eBooks | IEEE Xplore Publications: IBM Periodicals | IEEE Xplore Publications: URSI Periodicals | IEEE Xplore Publications: VDE Conferences | IEEE Xplore Publications: Periodicals from China | IEEE Xplore Publications: Ericsson Technology Review | IEEE Xplore Publications: Manning Books | IEEE Xplore Publications: Packt Books | IP.com Prior Art Database: The IP.com Journal | IP.com Prior Art Database: Internet Society RFC | IP.com Prior Art Database: IBM TDB Archive | IP.com Prior Art Database: Legacy Journals | IP.com Prior Art Database: Software Patent Institute | OnePetro.org: Periodicals at OnePetro.org | OnePetro.org: Conferences at OnePetro.org | Other Literature: IBM Redbooks | Other Literature: PubMed Central | Other Literature: arXiv.org

1 2025-11-11 12:45 UTC | ~6,515,696 results from

De-Dup: Simple Family Numbers (PAT only) | **Relevance Cut-off:** None | **Sort:** Relevance

Main Concept: Text

Patent Owner Zodiac Pool Systems LLC
Exhibit 2023 - Page 105 of 377

PCT/CN2023/116834

Concept Modifiers: None

Filters: None

2 **2025-11-11 12:46 UTC | ~6,515,696 results from**

De-Dup: Simple Family Numbers (PAT only) | **Relevance Cut-off:** None | **Sort:** Relevance

Main Concept: Same as Search 1

Concept Modifiers: None

Filters: None

3 **2025-11-11 12:46 UTC | 1 results from**

De-Dup: Simple Family Numbers (PAT only) | **Relevance Cut-off:** None | **Sort:** Relevance

Main Concept: Text
CN2023107686783

Concept Modifiers: None

Filters: None

4 **2025-11-11 12:54 UTC | ~33,628,899 results from**

De-Dup: Simple Family Numbers (PAT only) | **Relevance Cut-off:** None | **Sort:** Relevance

Main Concept: Text
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Concept Modifiers: None

Filters: None

5 **2025-11-11 12:55 UTC | ~28,716,212 results from**

De-Dup: Simple Family Numbers (PAT only) | **Relevance Cut-off:** None | **Sort:** Relevance

Main Concept: Same as Search 4

Concept Modifiers: None

Filters (1):
Publication Date: To 2023-06-27

6 **2025-11-12 18:28 UTC | ~32,583,789 results from**

De-Dup: Simple Family Numbers (PAT only) | **Relevance Cut-off:** None | **Sort:** Relevance

Main Concept: Text
underwater cleaning robot routing to clean the edge of an area followed by the center

Patent Owner Zodiac Pool Systems LLC
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Concept Modifiers: None

Filters: Same as Search 5

7 2025-11-12 19:44 UTC | ~30,213,570 results from

De-Dup: Simple Family Numbers (PAT only) | **Relevance Cut-off:** None | **Sort:** Relevance

Main Concept: Text
cleaning robot routing to clean the edge of an area followed by the center

Concept Modifiers: None

Filters: Same as Search 5

8 2025-11-12 19:44 UTC | ~5,826,407 results from

De-Dup: Simple Family Numbers (PAT only) | **Relevance Cut-off:** None | **Sort:** Relevance

Main Concept: Same as Search 7

Concept Modifiers (1):
1. More Like Text: random pathing

Filters: Same as Search 5

9 2025-11-12 19:45 UTC | ~409,782 results from

De-Dup: Simple Family Numbers (PAT only) | **Relevance Cut-off:** None | **Sort:** Relevance

Main Concept: Same as Search 7

Concept Modifiers (2):
2. More Like Text: identify a target to be cleaned
1. More Like Text: random pathing

Filters: Same as Search 5

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PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 19/342,629	Filing Date 09/28/2025	☐ To be Mailed

ENTITY: ☐ LARGE ☑ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $80 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $240 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	12/22/2025	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
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	Independent (37 CFR 1.16(h))	* 2	Minus	*** 3	= 0		x $240 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

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CN116679716A Pool robot control method and device, storage medium and pool robot

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Inventors: ZHANG SHILEI

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Pool robot control method and device, storage medium and pool robot

Abstract

The embodiment of the invention provides a pool robot control method and device, a storage medium and a pool robot, and the method comprises the steps that image information, shot by the pool robot, of a target water area is acquired, and the pool robot runs in the target water area; analyzing the image information to determine an analysis result; under the condition that the analysis result is used for indicating that the target object exists in the target water area, the target position of the target object is determined, the pool robot is controlled to run to the target position, and target operation corresponding to the type of the target object is executed. Through the method and the device, the problem of low operation efficiency of a pool robot on a specific object in related technologies is solved, and the effect of improving the operation efficiency is achieved.

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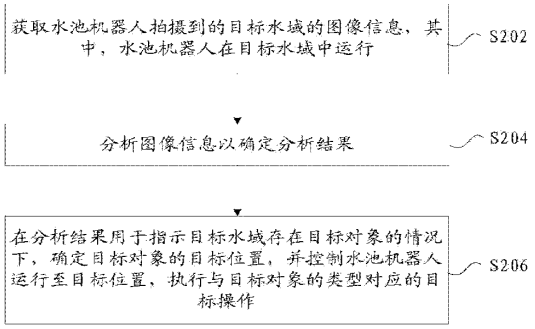
权利要求书2页 说明书8页 附图2页

(54)发明名称

水池机器人的控制方法、装置、存储介质及水池机器人

(57)摘要

本申请实施例提供了一种水池机器人的控制方法、装置、存储介质及水池机器人，其中，该方法包括：获取水池机器人拍摄到的目标水域的图像信息，其中，水池机器人在目标水域中运行；分析图像信息以确定分析结果；在分析结果用于指示目标水域存在目标对象的情况下，确定目标对象的目标位置，并控制水池机器人运行至目标位置，执行与目标对象的类型对应的目标操作。通过本申请，解决了相关技术中水池机器人对特定对象的操作效率低下的问题，达到了提高操作效率的效果。



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1.一种水池机器人的控制方法，其特征在于，包括：

获取水池机器人拍摄到的所述目标水域的图像信息，其中，所述水池机器人在所述目标水域中运行；

分析所述图像信息以确定分析结果；

在所述分析结果用于指示所述目标水域存在目标对象的情况下，确定所述目标对象的目标位置，并控制所述水池机器人运行至所述目标位置，执行与所述目标对象的类型对应的目标操作。

2.根据权利要求1所述的方法，其特征在于，获取水池机器人拍摄到的所述目标水域的图像信息，包括：

获取所述水池机器人在按照第一运行模式运行时，拍摄到的所述目标水域的图像信息，其中，第一运行模式包括所述水池机器人按照预设时间周期在多个预设位置间的随机路线中运行的模式。

3.根据权利要求2所述的方法，其特征在于，在所述分析结果用于指示所述目标水域存在目标对象的情况下，确定所述目标对象的目标位置，并控制所述水池机器人运行至所述目标位置，执行与所述目标对象的类型对应的目标操作，包括：

在所述分析结果用于指示所述目标水域中存在目标对象的情况下，根据所述图像信息确定所述目标位置；

控制所述水池机器人运行至所述目标位置，执行与所述目标对象的类型对应的目标操作。

4.根据权利要求1所述的方法，其特征在于，获取水池机器人拍摄到的所述目标水域的图像信息，包括：

获取所述水池机器人在按照第二运行模式运行时，拍摄到的所述目标水域的图像信息，其中，第二运行模式包括所述水池机器人按照预设时间周期在多个预设位置间的固定路线中运行的模式。

5.根据权利要求4所述的方法，其特征在于，在所述分析结果用于指示所述目标水域存在目标对象的情况下，确定所述目标对象的目标位置，并控制所述水池机器人运行至所述目标位置，执行与所述目标对象的类型对应的目标操作，包括：

在所述水池机器人在按照第二运行模式运行时，从所述分析结果中确定所述目标水域中包括所述目标对象的情况下，确定所述目标对象的目标位置，并控制所述水池机器人运行至所述目标位置，执行与所述目标对象的类型对应的目标操作。

6.根据权利要求3所述的方法，其特征在于，在所述分析结果用于指示所述目标水域存在目标对象的情况下，确定所述目标对象的目标位置，并控制所述水池机器人运行至所述目标位置，执行与所述目标对象的类型对应的目标操作，包括：

在所述水池机器人在按照第二运行模式运行之后，从所述分析结果中确定所述目标水域中包括多个所述目标对象的情况下，在地图中标记多个所述目标对象的位置，其中，所述地图是所述水池机器人在所述目标水域中运行的过程中构建的；

按照多个所述目标对象的位置确定运行路线；

控制所述水池机器人按照运行路线运行至多个所述目标对象的多个位置处，执行与每个所述目标对象的类型对应的目标操作。

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7.根据权利要求1-6任一项所述的方法，其特征在于，获取水池机器人拍摄到的所述目标水域的图像信息之前，所述方法还包括：

控制所述水池机器人在所述目标水域中沿边执行所述目标操作；

在确定所述水池机器人沿边执行所述目标操作之后，控制所述水池机器人在所述目标水域中执行巡视操作，其中，所述巡视操作包括控制所述水池机器人在所述目标水域中拍摄所述图像信息。

8.一种水池机器人的控制装置，其特征在于，包括：

获取模块，用于获取水池机器人拍摄到的所述目标水域的图像信息，其中，所述水池机器人在所述目标水域中运行；

分析模块，用于分析所述图像信息以确定分析结果；

确定模块，用于在所述分析结果用于指示所述目标水域存在目标对象的情况下，确定所述目标对象的目标位置，并控制所述水池机器人运行至所述目标位置，执行与所述目标对象的类型对应的目标操作。

9.一种计算机可读存储介质，其特征在于，所述计算机可读存储介质中存储有计算机程序，其中，所述计算机程序被处理器执行时实现所述权利要求1至7任一项中所述的方法的步骤。

10.一种水池机器人，包括存储器、处理器以及存储在所述存储器上并可在所述处理器上运行的计算机程序，其特征在于，所述处理器执行所述计算机程序时实现所述权利要求1至7任一项中所述的方法的步骤。

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水池机器人的控制方法、装置、存储介质及水池机器人

技术领域

[0001] 本申请实施例涉及计算机领域，具体而言，涉及一种水池机器人的控制方法、装置、存储介质及水池机器人。

背景技术

[0002] 相关技术中的水池机器人可以在水池中执行一种或多种工作任务(例如，消毒、清洁等)，但水池机器人在对特定的对象执行操作时，并不能快速的确定出对象所在的位置，从而影响执行操作的效率。

[0003] 针对上述问题，相关技术尚未提出有效的解决方案。

发明内容

[0004] 本申请实施例提供了一种水池机器人的控制方法、装置、存储介质及水池机器人，以至少解决相关技术中水池机器人对特定对象的操作效率低下的问题。

[0005] 根据本申请的一个实施例，提供了一种水池机器人的控制方法，包括：获取水池机器人拍摄到的上述目标水域的图像信息，其中，上述水池机器人在上述目标水域中运行；分析上述图像信息以确定分析结果；在上述分析结果用于指示上述目标水域存在目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作。

[0006] 在一个示例性实施例中，获取水池机器人拍摄到的上述目标水域的图像信息，包括：获取上述水池机器人在按照第一运行模式运行时，拍摄到的上述目标水域的图像信息，其中，第一运行模式包括上述水池机器人按照预设时间周期在多个预设位置间的随机路线中运行的模式。

[0007] 在一个示例性实施例中，在上述分析结果用于指示上述目标水域存在目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作，包括：在上述分析结果用于指示上述目标水域中存在目标对象的情况下，根据上述图像信息确定上述目标位置；控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作。

[0008] 在一个示例性实施例中，获取水池机器人拍摄到的上述目标水域的图像信息，包括：获取上述水池机器人在按照第二运行模式运行时，拍摄到的上述目标水域的图像信息，其中，第二运行模式包括上述水池机器人按照预设时间周期在多个预设位置间的固定路线中运行的模式。

[0009] 在一个示例性实施例中，在上述分析结果用于指示上述目标水域存在目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作，包括：在上述水池机器人在按照第二运行模式运行时，从上述分析结果中确定上述目标水域中包括上述目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类

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型对应的目标操作。

[0010] 在一个示例性实施例中，在上述分析结果用于指示上述目标水域存在目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作，包括：在上述水池机器人在按照第二运行模式运行之后，从上述分析结果中确定上述目标水域中包括多个上述目标对象的情况下，在上述地图中标记多个上述目标对象的位置，其中，上述地图是上述水池机器人在上述目标水域中运行的过程中构建的；按照多个上述目标对象的位置确定运行路线；控制上述水池机器人按照运行路线运行至多个上述目标对象的多个位置处，执行与每个上述目标对象的类型对应的目标操作。

[0011] 在一个示例性实施例中，获取水池机器人拍摄到的上述目标水域的图像信息之前，上述方法还包括：控制上述水池机器人在上述目标水域中沿边执行上述目标操作；在确定上述水池机器人沿边执行上述目标操作之后，控制上述水池机器人在上述目标水域中执行巡视操作，其中，上述巡视操作包括控制上述水池机器人在上述目标水域中拍摄上述图像信息。

[0012] 根据本申请的另一个实施例，提供了一种水池机器人的控制装置，包括：获取模块，用于获取水池机器人拍摄到的上述目标水域的图像信息，其中，上述水池机器人在上述目标水域中运行；分析模块，用于分析上述图像信息以确定分析结果；确定模块，用于在上述分析结果用于指示上述目标水域存在目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作。

[0013] 在一个示例性实施例中，上述获取模块包括：第一获取子模块，用于获取上述水池机器人在按照第一运行模式运行时，拍摄到的上述目标水域的图像信息，其中，第一运行模式包括上述水池机器人按照预设时间周期在多个预设位置间的随机路线中运行的模式。

[0014] 在一个示例性实施例中，上述确定模块包括：第一确定子模块，用于在上述分析结果用于指示上述目标水域中存在目标对象的情况下，根据上述图像信息确定上述目标位置；控制子模块，用于控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作。

[0015] 在一个示例性实施例中，上述获取模块包括：第二获取子模块，用于获取上述水池机器人在按照第二运行模式运行时，拍摄到的上述目标水域的图像信息，其中，第二运行模式包括上述水池机器人按照预设时间周期在多个预设位置间的固定路线中运行的模式。

[0016] 在一个示例性实施例中，上述确定模块包括：第二确定子模块，用于在上述水池机器人在按照第二运行模式运行时，从上述分析结果中确定上述目标水域中包括上述目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作。

[0017] 在一个示例性实施例中，上述确定模块还包括：第三确定子模块，用于在上述水池机器人在按照第二运行模式运行之后，从上述分析结果中确定上述目标水域中包括多个上述目标对象的情况下，在上述地图中标记多个上述目标对象的位置，其中，上述地图是上述水池机器人在上述目标水域中运行的过程中构建的；第四确定子模块，用于按照多个上述目标对象的位置确定运行路线；控制子模块，用于控制上述水池机器人按照运行路线运行

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至多个上述目标对象的多个位置处，执行与每个上述目标对象的类型对应的目标操作。

[0018] 在一个示例性实施例中，上述装置还包括：第一控制模块，用于获取水池机器人拍摄到的上述目标水域的图像信息之前，控制上述水池机器人在上述目标水域中沿边执行上述目标操作；第二控制模块，用于在确定上述水池机器人沿边执行上述目标操作之后，控制上述水池机器人在上述目标水域中执行巡视操作，其中，上述巡视操作包括控制上述水池机器人在上述目标水域中拍摄上述图像信息。根据本申请的又一个实施例，还提供了一种计算机可读存储介质，上述计算机可读存储介质中存储有计算机程序，其中，上述计算机程序被设置为运行时执行上述任一项方法实施例中的步骤。

[0019] 根据本申请的又一个实施例，还提供了一种水池机器人，包括存储器和处理器，上述存储器中存储有计算机程序，上述处理器被设置为运行上述计算机程序以执行上述任一项方法实施例中的步骤。

[0020] 通过本申请，通过分析水池机器人拍摄的目标水域图像信息，可以识别出目标对象并且确认目标对象的位置，进而可以控制机器人直接前往目标对象的位置并对目标对象执行目标操作，避免出现水池机器人无法定位目标对象，只能按照预设路线重新清理整个目标水域的情况，有效解决了相关技术中水池机器人对特定对象的操作效率低下的问题，达到了提高操作效率的效果。

附图说明

[0021] 图1是根据本申请实施例的水池机器人的控制方法的移动终端的硬件结构框图；

[0022] 图2是根据本申请实施例的水池机器人的控制方法的流程图；

[0023] 图3是根据本申请实施例的水池机器人的控制装置的结构框图。

具体实施方式

[0024] 下文中将参考附图并结合实施例来详细说明本申请的实施例。

[0025] 需要说明的是，本申请的说明书和权利要求书及上述附图中的术语“第一”、“第二”等是用于区别类似的对象，而不必用于描述特定的顺序或先后次序。

[0026] 本申请实施例中所提供的方法实施例可以在移动终端、计算机终端或者类似的运算装置中执行。以运行在移动终端上为例，图1是本申请实施例的一种水池机器人控制方法的移动终端的硬件结构框图。如图1所示，移动终端可以包括一个或多个(图1中仅示出一个)处理器102(处理器102可以包括但不限于微处理器MCU或可编程逻辑器件FPGA等的处理装置)和用于存储数据的存储器104，其中，上述移动终端还可以包括用于通信功能的传输设备106以及输入输出设备108。本领域普通技术人员可以理解，图1所示的结构仅为示意，其并不对上述移动终端的结构造成限定。例如，移动终端还可包括比图1中所示更多或者更少的组件，或者具有与图1所示不同的配置。

[0027] 存储器104可用于存储计算机程序，例如，应用软件的软件程序以及模块，如本申请实施例中的水池机器人控制方法对应的计算机程序，处理器102通过运行存储在存储器104内的计算机程序，从而执行各种功能应用以及数据处理，即实现上述的方法。存储器104可包括高速随机存储器，还可包括非易失性存储器，如一个或者多个磁性存储装置、闪存、或者其他非易失性固态存储器。在一些实例中，存储器104可进一步包括相对于处理器102

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远程设置的存储器，这些远程存储器可以通过网络连接至移动终端。上述网络的实例包括但不限于互联网、企业内部网、局域网、移动通信网及其组合。

[0028] 传输设备106用于经由一个网络接收或者发送数据。上述的网络具体实例可包括移动终端的通信供应商提供的无线网络。在一个实例中，传输设备106包括一个网络适配器(NetworkInterfaceController，简称为NIC)，其可通过基站与其他网络设备相连从而可与互联网进行通讯。在一个实例中，传输设备106可以为射频(RadioFrequency，简称为RF)模块，其用于通过无线方式与互联网进行通讯。

[0029] 在本实施例中提供了一种水池机器人控制方法，图2是根据本申请实施例的流程图，如图2所示，该流程包括如下步骤：

[0030] 步骤S202，获取水池机器人拍摄到的上述目标水域的图像信息，其中，上述水池机器人在上述目标水域中运行；

[0031] 步骤S204，分析上述图像信息以确定分析结果；

[0032] 步骤S206，在上述分析结果用于指示上述目标水域存在目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作。

[0033] 其中，上述步骤的执行主体可以为水池机器人的控制器，或者是具备数据处理、信号交互能力的处理器，或者还可以是其他的具备类似处理能力的处理设备或处理单元等但不限于此。

[0034] 在上述实施例中，上述水池机器人用于拍摄的设备是防水等级较高的摄像头，该摄像头可以置于水池机器人的前端，侧面，顶端等位置，具体设置位置不限。上述目标水域包括但不限于泳池、观赏型水库、野外水池等。上述水池机器人可以位于目标水域水面，也可以位于目标水域水底，或者悬浮与目标水域内，在上述目标水域是泳池的情况下还可以位于泳池池壁。对上述图像信息进行分析可以采用通过预先训练的网络模型对图像信息进行识别，或者是利用其他的图像分析设备对图像信息进行识别的方式。上述目标对象包括但不限于各类水域垃圾，例如塑料瓶盖、树叶等。上述图像信息可以是图片，可以是包括多帧图像的视频，上述图像信息是机器人在目标水域中进行巡视的过程中实时获取的。上述目标操作包括但不限于清洁操作、消毒操作、报警操作等，例如，水池机器人可以对各类水域垃圾(如塑料瓶盖、树叶等)进行清洁，水池机器人还可以对需要消毒的目标对象所在区域进行消毒，水池机器人还可以在检测到目标对象为意外落水的人或动物时发出报警信号。

[0035] 可选的，分析上述图像信息以确定分析结果包括：将上述图像信息输入至目标网络模型，得到上述目标网络模型输出的上述图像信息中包括的对象的特征信息，其中，上述特征信息包括每帧上述图像中包括的对象的空间特征和语义特征；从每帧上述图像中包括的对象的特征信息中确定上述目标对象。在本实施例中，上述空间特征也即浅层视觉特征，包括纹理、颜色、形状、空间关系等，上述语义特征包括深层的对象与对象间的关系。

[0036] 可选的，上述目标网络模型的一种训练方法包括：获取M帧样本图像，其中，每帧上述样本图像中均包括预设对象，其中，上述M是大于或等于1的自然数；在每帧上述样本图像中对上述预设对象进行标记，得到M帧标记后的样本图像；利用M帧上述标记后的样本图像训练原始网络模型，得到上述目标网络模型。在本实施例中，上述原始网络模型可以是

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yolov3(YOLO算法的第三个版本)，还可以是FasterRcnn(FastRcnn算法的优化版本，感兴趣区域的生成方法采用RegionProposal网络)。当然，上述算法仅仅是一种说明性的示例，原始网络模型可以是任一能够满足识别需求的模型。上述样本图像可以是网络资源，也可以是人工拍摄的数据，还可以是AI生成的训练素材，对样本图像中的目标对象进行标记可以采取人工标记的方式，每个样本图像可以包括多个目标对象。

[0037] 通过本申请实施例，通过分析水池机器人拍摄的目标水域图像信息，可以识别出目标对象并且确认目标对象的位置，进而可以控制机器人直接前往目标对象的位置，并对目标对象执行目标操作，避免出现水池机器人无法定位目标对象只能按照预设路线重新清理整个目标水域的情况。

[0038] 在一个示例性实施例中，获取水池机器人拍摄到的上述目标水域的图像信息，包括：获取上述水池机器人在按照第一运行模式运行时，拍摄到的上述目标水域的图像信息，其中，第一运行模式包括上述水池机器人按照预设时间周期在多个预设位置间的随机路线中运行的模式。在上述实施例中，上述第一运行模式包括沿随机路径巡视的模式，上述预设时间周期可以是5分钟，可以是6分钟，还可以是10分钟，当然，上述时间仅仅是一种说明性的示例，预设时间周期可以是能够满足水池机器人巡视需求的任一时长。示例性地，在目标水域包括A、B、C三个预设位置的情况下，第一运行模式可以是上述水池机器人在A、B、C三个预设位置间随机迅游5分钟。通过上述实施例，通过随机路径巡视的方式，确定目标水域中存在的个别目标对象，能够有效提高水池机器人对特定对象的处理效率。

[0039] 在一个示例性实施例中，在上述分析结果用于指示上述目标水域存在目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作，包括：在上述分析结果用于指示上述目标水域中存在目标对象的情况下，根据上述图像信息确定上述目标位置；控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作。

[0040] 可选的，上述根据图像信息确定目标位置的方法包括：确定上述目标对象在每帧图像中的像素坐标，得到N个像素坐标，其中，上述图像信息包括上述图像；利用水池机器人摄像设备的第一配置参数将N个上述像素坐标转化映射至摄像设备坐标系中，得到N个映射坐标，其中，上述第一配置参数包括拍摄上述图像信息时的参数；利用N个上述映射坐标和上述摄像设备的第二配置参数确定上述目标位置，其中，上述第二配置参数包括上述摄像设备拍摄上述图像信息时的位姿信息，上述位姿信息包括旋转矩阵和平移向量。在本实施例中，在上述实施例中，上述将像素坐标转化映射到摄像设备坐标系中可以是将上述像素坐标转化为摄像设备坐标系下的归一化坐标(转化为归一化坐标的形式能够简化后续对目标位置的计算)，也可以是将上述像素坐标转化为摄像设备坐标系下的成像面坐标(也即归焦距化坐标，这种情况下成像面坐标间的距离就是对应的像素坐标间的距离)。通过上述实施例，通过图像信息确定目标对象位置信息，快速定位目标水域中存在的个别目标对象，能够有效提高水池机器人对特定对象的处理效率。

[0041] 在一个示例性实施例中，获取水池机器人拍摄到的上述目标水域的图像信息，包括：获取上述水池机器人在按照第二运行模式运行时，拍摄到的上述目标水域的图像信息，其中，第二运行模式包括上述水池机器人按照预设时间周期在多个预设位置间的固定路线中运行的模式。在上述实施例中，上述第二运行模式包括沿固定路径巡视的模式，上述预设

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时间周期可以是5分钟，可以是6分钟，还可以是10分钟，当然，上述时间仅仅是一种说明性的示例，预设时间周期可以是能够满足水池机器人巡视需求的任一时长。示例性地，在目标水域包括A、B、C三个预设位置的情况下，第二运行模式可以是上述水池机器人沿A→B→C的预设固定路径迅游10分钟。通过上述实施例，通过固定路径巡视的方式，确定目标水域中存在的个别目标对象，能够有效提高水池机器人对特定对象的处理效率。

[0042] 在一个示例性实施例中，在上述分析结果用于指示上述目标水域存在目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作，包括：在上述水池机器人在按照第二运行模式运行时，从上述分析结果中确定上述目标水域中包括上述目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作。通过上述实施例，通过图像信息确定目标对象位置信息，快速定位目标水域中存在的个别目标对象，能够有效提高水池机器人对特定对象的处理效率。

[0043] 在一个示例性实施例中，在上述分析结果用于指示上述目标水域存在目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作，包括：在上述水池机器人在按照第二运行模式运行之后，从上述分析结果中确定上述目标水域中包括多个上述目标对象的情况下，在上述地图中标记多个上述目标对象的位置，其中，上述地图是上述水池机器人在上述目标水域中运行的过程中构建的；按照多个上述目标对象的位置确定运行路线；控制上述水池机器人按照运行路线运行至多个上述目标对象的多个位置处，执行与每个上述目标对象的类型对应的目标操作。在上述实施例中，可选的，按照多个上述目标对象的位置确定运行路线包括：将多个上述目标对象的位置输入目标最短路模型以得到上述运行路线。上述目标最短路模型可以通过启发式算法(例如遗传算法、蚁群算法等)计算遍历上述多个位置的最短运行路线。示例性地，一种通过遗传算法确定最短路的方法包括：定义目标函数为运行路线长度，将随机组合的多个运行路线作为父代，再次随机组合的多个运行路线作为子代，选择目标函数值较优秀的子代作为新的父代，持续迭代，在子代目标函数值不能明显超过父代的情况下，确定子代为上述运行路线。通过在固定路径巡视过程过程中记录目标对象位置，并在巡视完成后规划路线处理，能够节省处理距离，有效提高水池机器人清洁效率。

[0044] 在一个示例性实施例中，获取水池机器人拍摄到的上述目标水域的图像信息之前，上述方法还包括：控制上述水池机器人在上述目标水域中沿边执行上述目标操作；在确定上述水池机器人沿边执行上述目标操作之后，控制上述水池机器人在上述目标水域中执行巡视操作，其中，上述巡视操作包括控制上述水池机器人在上述目标水域中拍摄上述图像信息。在上述实施例中，水池机器人工作任务包括沿目标水域边界执行目标操作、按照规划路线在目标水域中执行目标操作、再次沿目标水域边界执行目标操作，上述沿边执行目标操作对应于工作任务中再次沿目标水域边界执行目标操作，也即，巡视操作可以在水池机器人完成工作任务后执行。通过上述实施例，在水池机器人执行工作任务后进行巡视，能够对目标水域进行补充清洁，有效改善了水池机器人工作效果。

[0045] 通过以上的实施方式的描述，本领域的技术人员可以清楚地了解到根据上述实施例的方法可借助软件加必需的通用硬件平台的方式来实现，当然也可以通过硬件，但很多情况下前者是更佳的实施方式。基于这样的理解，本申请的技术方案本质上或者说对现有

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技术做出贡献的部分可以以软件产品的形式体现出来，该计算机软件产品存储在一个存储介质(如ROM/RAM、磁碟、光盘)中，包括若干指令用以使得一台终端设备(可以是手机，计算机，服务器，或者网络设备等)执行本申请各个实施例上述的方法。

[0046] 在本实施例中还提供了一种水池机器人的控制装置，该装置用于实现上述实施例及优选实施方式，已经进行过说明的不再赘述。如以下所使用的，术语“模块”可以实现预定功能的软件和/或硬件的组合。尽管以下实施例所描述的装置较佳地以软件来实现，但是硬件，或者软件和硬件的组合的实现也是可能并被构想的。

[0047] 图3是根据本申请实施例的水池机器人的控制装置的结构框图，如图3所示，该装置包括：获取模块32，用于获取水池机器人拍摄到的上述目标水域的图像信息，其中，上述水池机器人在上述目标水域中运行；分析模块34，用于分析上述图像信息以确定分析结果；确定模块36，用于在上述分析结果用于指示上述目标水域存在目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作。

[0048] 在一个示例性实施例中，上述获取模块32包括：第一获取子模块，用于获取上述水池机器人在按照第一运行模式运行时，拍摄到的上述目标水域的图像信息，其中，第一运行模式包括上述水池机器人按照预设时间周期在多个预设位置间的随机路线中运行的模式。

[0049] 在一个示例性实施例中，上述确定模块36包括：第一确定子模块，用于在上述分析结果用于指示上述目标水域中存在目标对象的情况下，根据上述图像信息确定上述目标位置；控制子模块，用于控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作。

[0050] 在一个示例性实施例中，上述获取模块32包括：第二获取子模块，用于获取上述水池机器人在按照第二运行模式运行时，拍摄到的上述目标水域的图像信息，其中，第二运行模式包括上述水池机器人按照预设时间周期在多个预设位置间的固定路线中运行的模式。

[0051] 在一个示例性实施例中，上述确定模块36包括：第二确定子模块，用于在上述水池机器人在按照第二运行模式运行时，从上述分析结果中确定上述目标水域中包括上述目标对象的情况下，确定上述目标对象的目标位置，并控制上述水池机器人运行至上述目标位置，执行与上述目标对象的类型对应的目标操作。

[0052] 在一个示例性实施例中，上述确定模块36还包括：第三确定子模块，用于在上述水池机器人在按照第二运行模式运行之后，从上述分析结果中确定上述目标水域中包括多个上述目标对象的情况下，在上述地图中标记多个上述目标对象的位置，其中，上述地图是上述水池机器人在上述目标水域中运行的过程中构建的；第四确定子模块，用于按照多个上述目标对象的位置确定运行路线；控制子模块，用于控制上述水池机器人按照运行路线运行至多个上述目标对象的多个位置处，执行与每个上述目标对象的类型对应的目标操作。

[0053] 在一个示例性实施例中，上述装置还包括：第一控制模块，用于获取水池机器人拍摄到的上述目标水域的图像信息之前，控制上述水池机器人在上述目标水域中沿边执行上述目标操作；第二控制模块，用于在确定上述水池机器人沿边执行上述目标操作之后，控制上述水池机器人在上述目标水域中执行巡视操作，其中，上述巡视操作包括控制上述水池机器人在上述目标水域中拍摄上述图像信息。

[0054] 需要说明的是，上述各个模块是可以通过软件或硬件来实现的，对于后者，可以通

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过以下方式实现，但不限于此：上述模块均位于同一处理器中；或者，上述各个模块以任意组合的形式分别位于不同的处理器中。

[0055] 本申请的实施例还提供了一种计算机可读存储介质，该计算机可读存储介质中存储有计算机程序，其中，该计算机程序被设置为运行时执行上述任一项方法实施例中的步骤。

[0056] 在一个示例性实施例中，上述计算机可读存储介质可以包括但不限于：U盘、只读存储器(Read-OnlyMemory，简称为ROM)、随机存取存储器(RandomAccessMemory，简称为RAM)、移动硬盘、磁碟或者光盘等各种可以存储计算机程序的介质。

[0057] 本申请的实施例还提供了一种水池机器人，包括存储器和处理器，该存储器中存储有计算机程序，该处理器被设置为运行计算机程序以执行上述任一项方法实施例中的步骤。

[0058] 在一个示例性实施例中，上述水池机器人还可以包括传输设备以及输入输出设备，其中，该传输设备和上述处理器连接，该输入输出设备和上述处理器连接。

[0059] 本实施例中的具体示例可以参考上述实施例及示例性实施方式中所描述的示例，本实施例在此不再赘述。

[0060] 显然，本领域的技术人员应该明白，上述的本申请的各模块或各步骤可以用通用的计算装置来实现，它们可以集中在单个的计算装置上，或者分布在多个计算装置所组成的网络上，它们可以用计算装置可执行的程序代码来实现，从而，可以将它们存储在存储装置中由计算装置来执行，并且在某些情况下，可以以不同于此处的顺序执行所示出或描述的步骤，或者将它们分别制作成各个集成电路模块，或者将它们中的多个模块或步骤制作成单个集成电路模块来实现。这样，本申请不限制于任何特定的硬件和软件结合。

[0061] 以上上述仅为本申请的优选实施例而已，并不用于限制本申请，对于本领域的技术人员来说，本申请可以有各种更改和变化。凡在本申请的原则之内，所作的任何修改、等同替换、改进等，均应包含在本申请的保护范围之内。

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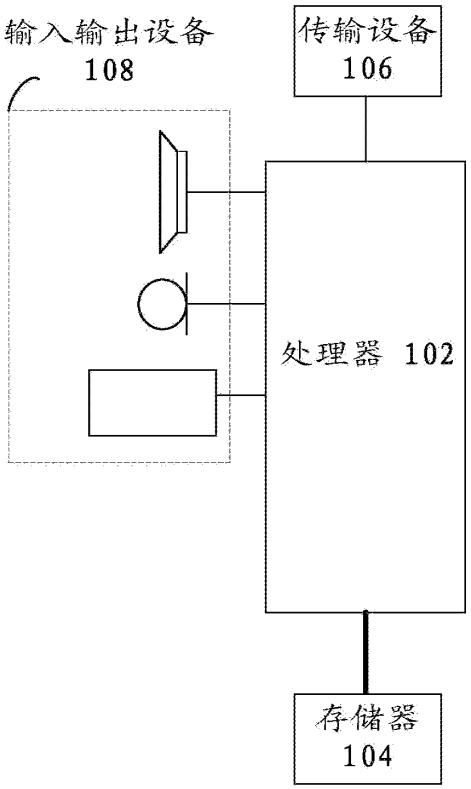


图1

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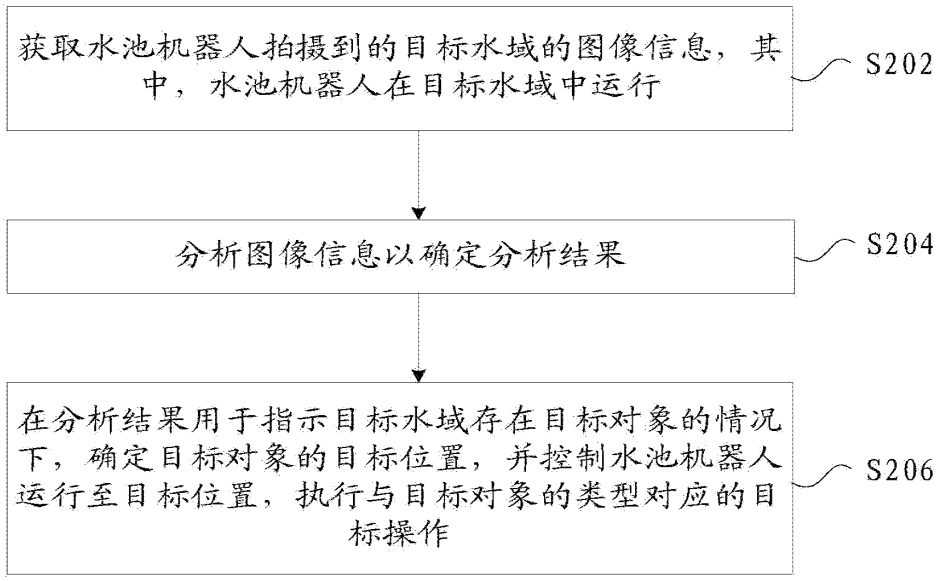


图2

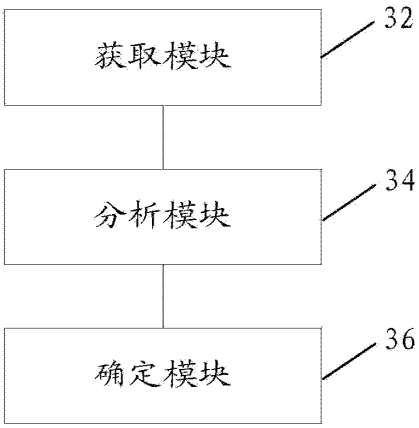


图3

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Espacenet

CN114987721A Underwater cleaning method and device, electronic equipment and storage medium

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CPC **B63C11/34 (CN); B63G8/001 (CN); B63G8/38 (CN); G06N3/08 (CN); G06V10/764 (CN); G06V10/774 (CN); G06V10/82 (CN); G06V20/05 (CN);** B63G2008/007 (CN); Y02A20/204 (EP);

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Underwater cleaning method and device, electronic equipment and storage medium

Abstract

The invention relates to the technical field of garbage cleaning, in particular to an underwater cleaning method and device, electronic equipment and a storage medium. According to the underwater cleaning method in the first aspect of the embodiment of the invention, the operation starting instruction from the control center is firstly obtained, then the camera shooting assembly is controlled to collect the underwater image information according to the operation starting instruction, and then the underwater image information is processed through the target recognition model; the garbage type of the underwater garbage and the to-be-cleaned position of the underwater garbage in the underwater environment are recognized, and finally the underwater garbage is collected according to the to-be-cleaned position of the underwater garbage in the underwater environment. According to the underwater cleaning method, garbage type confirmation and to-be-cleaned position confirmation of the underwater garbage in the target water area can be automatically completed on the target water area based on the target recognition model, then cleaning work is completed, the labor cost is liberated, and the underwater cleaning treatment efficiency is further improved.

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G06V 10/82 (2022.01)
G06N 3/04 (2006.01)
G06N 3/08 (2006.01)

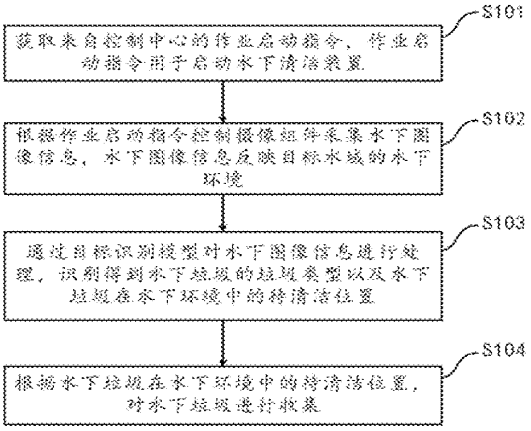
权利要求书2页 说明书12页 附图6页

(54) 发明名称

一种水下清洁方法及其装置、电子设备、存储介质

(57) 摘要

本发明涉及垃圾清洁技术领域，尤其是涉及一种水下清洁方法及其装置、电子设备、存储介质。根据本发明的第一方面实施例的水下清洁方法，本发明通过先获取来自控制中心的作业启动指令，然后根据作业启动指令控制摄像组件采集水下图像信息，进而通过目标识别模型对水下图像信息进行处理，识别得到水下垃圾的垃圾类型以及水下垃圾在水下环境中的待清洁位置，最终根据水下垃圾在水下环境中的待清洁位置，对水下垃圾进行收集。本发明中的水下清洁方法能够基于目标识别模型对目标水域自动完成对目标水域的水下垃圾进行垃圾类型的确认以及待清洁位置的确认，进而完成清洁工作，解放人力成本，进一步提高水下清洁的处理效率。



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1.一种水下清洁方法，应用于水下清洁装置，其特征在于，所述方法包括：

获取来自控制中心的作业启动指令，所述作业启动指令用于启动水下清洁装置；

根据所述作业启动指令控制摄像组件采集水下图像信息，所述水下图像信息反映目标水域的水下环境；

通过目标识别模型对所述水下图像信息进行处理，识别得到水下垃圾的垃圾类型以及所述水下垃圾在所述水下环境中的待清洁位置；

根据所述水下垃圾在所述水下环境中的所述待清洁位置，对所述水下垃圾进行收集。

2.根据权利要求1所述的方法，其特征在于，所述水下清洁装置通过线缆与母船连接，所述获取来自控制中心的作业启动指令包括：

通过线缆获取来自所述控制中心的所述作业启动指令，所述作业启动指令经由所述母船进行中继通信。

3.根据权利要求1所述的方法，其特征在于，所述通过目标识别模型对所述水下图像信息进行处理，识别得到水下垃圾的垃圾类型以及所述水下垃圾在所述水下环境中的待清洁位置之前，还包括：

将带有垃圾分类标签的训练数据集输入基础识别模型进行迭代训练；

每一轮所述迭代训练后，计算所述基础识别模型的垃圾识别准确率并对所述基础识别模型进行更新；

统计所述垃圾识别准确率在每一轮所述迭代训练中的变化情况，当所述垃圾识别准确率收敛于定值，停止所述迭代训练并得到训练好的所述目标识别模型。

4.根据权利要求3所述的方法，其特征在于，所述通过目标识别模型对所述水下图像信息进行处理，识别得到水下垃圾的垃圾类型以及所述水下垃圾在所述水下环境中的待清洁位置，包括：

通过所述目标识别模型将所述水下图像信息网格化，并根据所述网格化后的所述水下图像信息得到多个目标边界框；

将多个所述目标边界框与所述训练数据集中的分类标准框进行重叠度比对；

以重叠度最高的所述目标边界框对待检测目标进行识别分类，并保留置信度高于预设阈值的识别结果，得到所述水下垃圾的所述垃圾类型。

5.根据权利要求1至4任一项所述的方法，其特征在于，所述水下清洁装置包括机械臂，所述根据所述水下垃圾在所述水下环境中的所述待清洁位置，对所述水下垃圾进行收集，包括：

对所述水下清洁装置的推进器进行驱动，以控制所述水下清洁装置移动至所述待清洁位置；

当到达所述待清洁位置，控制所述机械臂对所述水下垃圾进行抓取；

将所述机械臂抓取到的所述水下垃圾置于垃圾存放装置，并基于所述垃圾存放装置完成对所述水下垃圾的收集。

6.根据权利要求5所述的方法，其特征在于，所述将所述机械臂抓取到的所述水下垃圾置于垃圾存放装置，并基于所述垃圾存放装置完成对所述水下垃圾的收集，包括：

当所述机械臂将抓取到的所述水下垃圾置于所述垃圾存放装置的收集口，启动所述收集口与垃圾收集仓之间的传送带，所述垃圾收集仓设置于所述垃圾存放装置内部；

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当所述传送带将所述水下垃圾运送至所述垃圾收集仓中，关闭所述传送带。

7.一种水下清洁装置，其特征在于，包括：指令接收模块、图像采集模块、识别处理模块、垃圾收集模块；

所述指令接收模块用于获取来自控制中心的作业启动指令，所述作业启动指令用于启动水下清洁作业；

所述图像采集模块用于根据所述作业启动指令控制摄像组件采集水下图像信息，所述水下图像信息反映目标水域的所述水下环境；

所述识别处理模块用于通过目标识别模型对所述水下图像信息进行处理，识别得到水下垃圾以及所述水下垃圾在所述水下环境中的待清洁位置；

所述垃圾收集模块用于根据所述水下垃圾在所述水下环境中的所述待清洁位置，对所述水下垃圾进行收集。

8.根据权利要求7所述的水下清洁装置，其特征在于，所述水下清洁装置还包括推进器，所述推进器由多个不同方向的水下外转子直流电机组成，用于实现水下多自由度控制。

9.一种电子设备，其特征在于，包括：存储器、处理器，所述存储器存储有计算机程序，所述处理器执行所述计算机程序时实现如权利要求1至6中任意一项所述的水下清洁方法。

10.一种计算机可读存储介质，其特征在于，所述存储介质存储有程序，所述程序被处理器执行实现如权利要求1至6中任意一项所述的水下清洁方法。

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一种水下清洁方法及其装置、电子设备、存储介质

技术领域

[0001] 本发明涉及垃圾清洁技术领域，尤其是涉及一种水下清洁方法及其装置、电子设备、存储介质。

背景技术

[0002] 随着人们生活水平的提高，人们对环境卫生越来越重视，而由于水下工作环境较为恶劣、水底地形复杂多变，因此对水域污染的整治成为了一大难题。尤其是在狭小河道、湖泊的垃圾清洁和环境监测任务，基于水底地形的复杂多变，相关技术中大多还是只能采用网兜将水面垃圾捞出水面，这种作业方式劳动强度较大，工作效率非常低，清除效果并不理想，因此其应用范围十分受限，故而，如何令水下清洁装置在作业进程中解放人力，提升水下清洁效率，成为业内人员亟待解决的问题。

发明内容

[0003] 本发明旨在至少解决现有技术中存在的技术问题之一。为此，本发明提出一种水下清洁方法及其装置、电子设备、存储介质，能够在水下作业进程中具备更高的工作效率。

[0004] 根据本发明的第一方面实施例的水下清洁方法，应用于水下清洁装置，所述方法包括：

[0005] 获取来自控制中心的作业启动指令，所述作业启动指令用于启动水下清洁装置；

[0006] 根据所述作业启动指令控制摄像组件采集水下图像信息，所述水下图像信息反映目标水域的所述水下环境。

[0007] 通过目标识别模型对所述水下图像信息进行处理，识别得到水下垃圾的垃圾类型以及所述水下垃圾在所述水下环境中的待清洁位置；

[0008] 根据所述水下垃圾在所述水下环境中的所述待清洁位置，对所述水下垃圾进行收集；

[0009] 可选的，根据本发明的一些实施例，所述水下清洁装置通过线缆与母船连接，所述获取来自控制中心的作业启动指令包括：

[0010] 通过线缆获取来自所述控制中心的所述作业启动指令，所述作业启动指令经由所述母船进行中继通信。

[0011] 可选的，根据本发明的一些实施例，所述通过目标识别模型对所述水下图像信息进行处理，识别得到水下垃圾的垃圾类型以及所述水下垃圾在所述水下环境中的待清洁位置之前，还包括：

[0012] 将带有垃圾分类标签的训练数据集输入基础识别模型进行迭代训练；

[0013] 每一轮所述迭代训练后，计算所述基础识别模型的垃圾识别准确率并对所述基础识别模型进行更新；

[0014] 统计所述垃圾识别准确率在每一轮所述迭代训练中的变化情况，当所述垃圾识别准确率收敛于定值，停止所述迭代训练并得到训练好的所述目标识别模型。

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[0015] 可选的，根据本发明的一些实施例，所述通过目标识别模型对所述水下图像信息进行处理，识别得到水下垃圾的垃圾类型以及所述水下垃圾在所述水下环境中的待清洁位置，包括：

[0016] 通过所述目标识别模型将所述水下图像信息网格化，并根据所述网格化后的所述水下图像信息得到多个目标边界框；

[0017] 将多个所述目标边界框与所述训练数据集中的分类标准框进行重叠度比对；

[0018] 以重叠度最高的所述目标边界框对待检测目标进行识别分类，并保留置信度高于预设阈值的识别结果，得到所述水下垃圾的所述垃圾类型。

[0019] 可选的，根据本发明的一些实施例，所述水下清洁装置包括机械臂，所述根据所述水下垃圾在所述水下环境中的所述待清洁位置，对所述水下垃圾进行收集，包括：

[0020] 对所述水下清洁装置的推进器进行驱动，以控制所述水下清洁装置移动至所述待清洁位置；

[0021] 当到达所述待清洁位置，控制所述机械臂对所述水下垃圾进行抓取；

[0022] 将所述机械臂抓取到的所述水下垃圾置于垃圾存放装置，并基于所述垃圾存放装置完成对所述水下垃圾的收集。

[0023] 可选的，根据本发明的一些实施例，所述将所述机械臂抓取到的所述水下垃圾置于垃圾存放装置，并基于所述垃圾存放装置完成对所述水下垃圾的收集，包括：

[0024] 当所述机械臂将抓取到的所述水下垃圾置于所述垃圾存放装置的收集口，启动所述收集口与垃圾收集仓之间的传送带，所述垃圾收集仓设置于所述垃圾存放装置内部；

[0025] 当所述传送带将所述水下垃圾运送至所述垃圾收集仓中，关闭所述传送带。

[0026] 根据本发明的第二方面实施例的水下清洁装置，包括：指令接收模块、图像采集模块、识别处理模块、垃圾收集模块；

[0027] 所述指令接收模块用于获取来自控制中心的作业启动指令，所述作业启动指令用于启动水下清洁作业；

[0028] 所述图像采集模块用于根据所述作业启动指令控制摄像组件采集水下图像信息，所述水下图像信息反映目标水域的所述水下环境；

[0029] 所述识别处理模块用于通过目标识别模型对所述水下图像信息进行处理，识别得到水下垃圾以及所述水下垃圾在所述水下环境中的待清洁位置；

[0030] 所述垃圾收集模块用于根据所述水下垃圾在所述水下环境中的所述待清洁位置，对所述水下垃圾进行收集。

[0031] 可选的，根据本发明的一些实施例，所述水下清洁装置还包括推进器，所述推进器由多个不同方向的水下外转子直流电机组成，用于实现水下多自由度控制。

[0032] 第三方面，本发明实施例提供了一种电子设备，包括：存储器、处理器，所述存储器存储有计算机程序，所述处理器执行所述计算机程序时实现如本发明第一方面实施例中任意一项所述的水下清洁方法。

[0033] 第四方面，本发明实施例提供了一种计算机可读存储介质，所述存储介质存储有程序，所述程序被处理器执行实现如本发明第一方面实施例中任意一项所述的水下清洁方法。

[0034] 根据本发明实施例的水下清洁方法及其装置、电子设备、存储介质，至少具有如下

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有益效果：

[0035] 本发明通过先获取来自控制中心的作业启动指令，然后根据所述作业启动指令控制摄像组件采集水下图像信息，进而通过目标识别模型对所述水下图像信息进行处理，识别得到水下垃圾的垃圾类型以及所述水下垃圾在所述水下环境中的待清洁位置，最终根据所述水下垃圾在所述水下环境中的所述待清洁位置，对所述水下垃圾进行收集。本发明中的水下清洁方法能够基于目标识别模型对目标水域自动完成对目标水域的水下垃圾进行垃圾类型的确认以及待清洁位置的确认，进而完成清洁工作，解放人力成本，进一步提高水下清洁的处理效率。

[0036] 本发明的附加方面和优点将在下面的描述中部分给出，部分将从下面的描述中变得明显，或通过本发明的实践了解到。

附图说明

[0037] 本发明的上述和/或附加的方面和优点从结合下面附图对实施例的描述中将变得明显和容易理解，其中：

[0038] 图1为本发明实施例提供的水下清洁方法流程示意图；

[0039] 图2为本发明实施例提供的另一水下清洁方法流程示意图；

[0040] 图3为本发明实施例提供的另一水下清洁方法流程示意图；

[0041] 图4为本发明实施例提供的另一水下清洁方法流程示意图；

[0042] 图5为本发明实施例提供的另一水下清洁方法流程示意图；

[0043] 图6为本发明实施例提供的水下清洁装置模块示意图；

[0044] 图7为本发明实施例提供的水下清洁装置工作示意图；

[0045] 图8为本发明实施例提供的水下清洁装置、母船系统模块示意图；

[0046] 图9为本发明实施例提供的水下清洁装置、母船、控制中心通讯关系示意图；

[0047] 图10为本发明实施例提供的实施水下清洁方法的电子设备示意图。

具体实施方式

[0048] 下面详细描述本发明的实施例，所述实施例的示例在附图中示出，其中自始至终相同或类似的标号表示相同或类似的元件或具有相同或类似功能的元件。下面通过参考附图描述的实施例是示例性的，仅用于解释本发明，而不能理解为对本发明的限制。

[0049] 在本发明的描述中，若干的含义是一个或者多个，多个的含义是两个以上，大于、小于、超过等理解为不包括本数，以上、以下、以内等理解为包括本数。如果有描述到第一、第二只是用于区分技术特征为目的，而不能理解为指示或暗示相对重要性或者隐含指明所指示的技术特征的数量或者隐含指明所指示的技术特征的先后关系。

[0050] 在本发明的描述中，需要理解的是，涉及到方位描述，例如上、下、左、右、前、后等指示的方位或位置关系为基于附图所示的方位或位置关系，仅是为了便于描述本发明和简化描述，而不是指示或暗示所指的装置或元件必须具有特定的方位、以特定的方位构造和操作，因此不能理解为对本发明的限制。

[0051] 在本说明书的描述中，参考术语“一个实施例”、“一些实施例”、“示意性实施例”、“示例”、“具体示例”、或“一些示例”等的描述意指结合该实施例或示例描述的具体特征、结

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构、材料或者特点包含于本发明的至少一个实施例或示例中。在本说明书中，对上述术语的示意性表述不一定指的是相同的实施例或示例。而且，描述的具体特征、结构、材料或者特点可以在任何的一个或多个实施例或示例中以合适的方式结合。

[0052] 本发明的描述中，需要说明的是，除非另有明确的限定，设置、安装、连接等词语应做广义理解，所属技术领域技术人员可以结合技术方案的具体内容合理确定上述词语在本发明中的具体含义。另外，下文中对于具体步骤的标识并不代表对于步骤顺序与执行逻辑的限定，步骤之间的执行顺序与执行逻辑应参照对应的说明性表述进行理解与推定。

[0053] 随着人们生活水平的提高，人们对环境卫生越来越重视，而由于水下工作环境较为恶劣、水底地形复杂多变，因此对水域污染的整治成为了一大难题。尤其是在狭小河道、湖泊的垃圾清洁和环境监测任务，基于水底地形的复杂多变，相关技术中大多还是只能采用网兜将水面垃圾捞出水面，这种作业方式劳动强度较大，工作效率非常低，清除效果并不理想，因此其应用范围十分受限，故而，如何令水下清洁装置在作业进程中解放人力，提升水下清洁效率，成为业内人员亟待解决的问题。

[0054] 需要说明的是，一些相关技术还存在如下不足：

[0055] 其一，在狭小的河道、湖泊中，垃圾清洁和环境监测任务大多依赖于人力用网兜将水域中存在的各类垃圾捞出，这种作业方式劳动强度较大，工作效率非常低，清除效果并不理想，因此其应用范围受限；

[0056] 其二，燃油驱动垃圾清理船基于燃油驱动，在执行垃圾清洁的同时会对清理水域会造成二次污染，在环境监测任务的过程中也会引入测量误差；

[0057] 其三，水域中悬浮的水下垃圾，通常都是由潜水员进行收集，该清洁方式不仅原始古老、成本高昂、效率低下、而且对于潜水员的安全很难保证。

[0058] 本发明旨在至少解决现有技术中存在的技术问题之一。为此，本发明提出一种水下清洁方法及其装置、电子设备、存储介质，能够在水下作业进程中具备更高的工作效率。

[0059] 下面参照附图作进一步说明。

[0060] 参照图1，根据本发明的第一方面实施例的水下清洁方法，应用于水下清洁装置，水下清洁方法包括：

[0061] 步骤S101，获取来自控制中心的作业启动指令，作业启动指令用于启动水下清洁装置；

[0062] 根据本发明提供的一些实施例，控制中心，指的是远程向水下清洁装置发送控制信号以及接收水下清洁装置反馈信号的通讯中心，其中控制信号包括但不限于作业启动指令、图像处理指令等，反馈信号包括但不限于作业准备信号、作业完毕信号等。

[0063] 步骤S102，根据作业启动指令控制摄像组件采集水下图像信息，水下图像信息反映目标水域的水下环境；

[0064] 需要说明的是，摄像组件设置于水下清洁装置，本发明一些实施例中，摄像组件由若干前置探照灯和集成在主控仓内部的云台摄像机组成，应理解，当水下清洁装置处于自动模式时，摄像组件可帮助实现水下垃圾自主识别，当水下清洁装置处于手动模式时，摄像组件可以辅助操作员进行垃圾抓取。应理解，目标水域指的是作为清洁目标的水域，目标水域可以预先设置也可以由控制中心规划确定。

[0065] 步骤S103，通过目标识别模型对水下图像信息进行处理，识别得到水下垃圾的垃

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圾类型以及水下垃圾在水下环境中的待清洁位置；

[0066] 本发明一些实施例中，在获取水下图像信息之后，通过目标识别模型对水下图像信息进行识别处理。需要说明的是，目标识别模型指的是用于对水下图像信息中的各个目标物进行分类识别的人工智能模型，目标识别模型能够对图像中的物体进行识别分类以及帮助确定水下垃圾在水下环境中的待清洁位置。

[0067] 根据本发明提供的一些实施例，目标识别模型可以有多种选用方案，包括但不限于基于卷积神经网络(Convolutional Neural Networks,CNN)的目标识别模型、基于YOLO(You only look once)算法的目标识别模型与基于SSD(Single Shot MultiBox Detector)算法的目标识别模型。其中，基于卷积神经网络的目标识别模型是一类包含卷积计算且具有深度结构的前馈神经网络，它是仿造生物的视知觉机制构建，可以进行监督学习和非监督学习，具有表征学习的能力。其在工作时会运行一种分割算法将一幅图像分割为一个个小块，然后在这些小块上运行分类器，从而实现对图片中物体的识别，Fast R-CNN目标识别模型是典型的基于卷积神经网络的目标识别模型；其中，基于YOLO算法的目标识别模型是一种基于深度神经网络的对象识别和定位Python算法，它将单个卷积神经网络应用于整个图像，将图像分成网格，并预测每个网格的类概率和边界框。每个边界框可以用四个描述符进行描述：边界框的中心点、高度、宽度以及值映射到对象所属的类。如果一个对象的中心落在一个网格单元中，则该网格单元负责检测该对象。每个网格中将有多个边界框。在训练时，为了使得每个对象只有一个边界框，因此，需要根据各个边界框与分类标准框(Ground Truth Box,GT框)的重叠度，从而分配一个重叠度最高的边界框来负责预测对象，最后过滤掉置信度小于预设阈值的边界框，即可得出置信度最高的完成预测。基于SSD算法的目标识别模型是在Fast R-CNN算法与YOLO算法的基础上略作修改，使其精度超过YOLO，识别速度超过Fast R-CNN。但是基于SSD算法的目标识别模型对于小尺寸的目标识别效果较差，达不到Fast R-CNN目标识别模型与基于YOLO算法的目标识别模型的高度，且SSD网络中预置框(Default Boxes)的基础大小和形状无法在学习中自动获取，必须要手动设置。因此，相比于Fast R-CNN目标识别模型和基于SSD算法的目标识别模型，基于YOLO算法的目标识别模型具备较高的识别精度，同时运行速度最快，并且能够处理实时视频流。因此，本发明一些较为优选的实施例中，选用基于YOLO算法的目标识别模型作为本发明的目标识别模型。

[0068] 步骤S104，根据水下垃圾在水下环境中的待清洁位置，对水下垃圾进行收集。

[0069] 根据本发明提供的一些实施例，根据水下图像信息，明确目标水域的水下环境中水下垃圾所处方位之后，通过水下清洁装置的推进器，将水下清洁装置移动至水下垃圾所处方位的附近，以便于对水下垃圾进行收集。需要说明的是，推进器可以由多个不同方向的水下外转子直流电机组成，如此设计的推进器能够使得水下清洁装置在目标水域的水下环境中实现稳定、灵活、精准高效的多自由度移动。关于收集目标水域的水下垃圾，本发明一些实施例中采用机械臂抓取的方式将水下垃圾(例如水底部塑料、布料垃圾等)，放入大口径垃圾传送仓并将其传送至垃圾收集仓，其中垃圾传送仓与垃圾收集仓之间可以通过传送带连通，传送带用以传输水下垃圾。应理解，根据水下垃圾在水下环境中的待清洁位置，对水下垃圾进行收集包括但不限于上述举出的具体实施例。

[0070] 根据本发明提供的一些实施例，控制中心用于对水下清洁装置的主控和运动控制

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系统进行配置，可观看水下清洁装置的云台摄像机视频流，能够控制水下清洁装置的功能。需要说明的是，水下清洁装置可根据不同检测需求，集成不同的传感器，从而通过无线传输系统将各类传感器采集到的传感器数据发送至控制中心，控制中心进而对得到的各类传感器数据进行分析处理，得到各种监控指标，其中监控指标包括但不限于各类参数的数值、系统和设备运行状态的日报、月报、季报和年报、报警信息以及设备运行状态报表等。基于不同的检测需求，控制中心能够具备的功能包括但不限于：数据整合、数据存储、监测及预警、统计查询、事件处理、统计和趋势分析等。

[0071] 本发明通过先获取来自控制中心的作业启动指令，然后根据所述作业启动指令控制摄像组件采集水下图像信息，进而通过目标识别模型对所述水下图像信息进行处理，识别得到水下垃圾的垃圾类型以及所述水下垃圾在所述水下环境中的待清洁位置，最终根据所述水下垃圾在所述水下环境中的所述待清洁位置，对所述水下垃圾进行收集。本发明中的水下清洁方法能够基于目标识别模型对目标水域自动完成对目标水域的水下垃圾进行垃圾类型的确认以及待清洁位置的确认，进而完成清洁工作，解放人力成本，进一步提高水下清洁的处理效率。

[0072] 根据本发明的一些实施例，水下清洁装置通过线缆与母船连接，获取来自控制中心的作业启动指令包括：

[0073] 通过线缆获取来自控制中心的作业启动指令，作业启动指令经由母船进行中继通信。

[0074] 根据本发明提供的一些实施例，水下清洁装置通过线缆与母船连接，其中母船航行于水面并用于水下清洁装置与控制中心的中继通信。应理解，由于在水下清洁方法的各个步骤中，母船均航行于水面之上，因此经由母船进行中继通信，能够保证水下清洁装置与控制中心之间较好的数据通信质量，以至于令水下清洁装置实施水下清洁方法的过程顺利进行。需要说明的是，本发明一些实施例中，水下清洁装置与母船共用一套通讯系统，水下清洁装置与母船分别将需要回传的数据发送到置于母船上的小型单板计算机，由小型单板计算机对数据进行打包，再由母船的无线通讯系统通过无线电波将其发送到控制中心，控制中心再对IP地址信息进行识别和处理，基于IP地址信息明确信息的来源是母船还是水下清洁装置。同样的，当控制中心向系统发送控制指令时，利用IP地址的不同，分别向水下清洁装置或者母船发送控制信号，先由置于母船上的数据接收器和数据处理器对收到的控制信号进行处理，再分别将指令发送到水下清洁装置主控与母船主控，进而将数据包进行解压处理，读取命令，执行操作。

[0075] 本发明一些实施例中，根据投放指令将水下清洁装置从母船投入目标水域，可以通过控制电动揽盘来执行。其中，投放指令可以是控制中心发送而来的控制信号的其中一种。需要说明的是，电动缆盘的是水下清洁装置从母船稳定下放和回收的关键，控制电动揽盘来执行投放指令，主要包括机械结构和软件控制两方面：机械结构上，电动揽盘由绞盘、直流电机、电子滑环、安装结构等部分组成，一些较为优选的情况下，电动揽盘可以安装于母船的内部甲板上，当需要投放水下清洁装置至水中时，利用绞盘收缆组件将电缆释放，电缆另一头的水下清洁装置即被投放置入水中，实现了电缆线的有序缠绕，排线整齐；软件控制上，则通过主控模块编写固件程序，通过控制中心发送控制信号，对电缆线缆盘电机进行正反转控制，以使得电动缆盘的电缆线一直处于恒张力状态，实现水下清洁装置在水下自

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由稳定活动。

[0076] 参照图2，根据本发明的一些实施例，通过目标识别模型对水下图像信息进行处理，识别得到水下垃圾的垃圾类型以及水下垃圾在水下环境中的待清洁位置之前，还包括：

[0077] 步骤S201，将带有垃圾分类标签的训练数据集输入基础识别模型进行迭代训练；

[0078] 步骤S202，每一轮迭代训练后，计算基础识别模型的垃圾识别准确率并对基础识别模型进行更新；

[0079] 步骤S203，统计垃圾识别准确率在每一轮迭代训练中的变化情况，当垃圾识别准确率收敛于定值，停止迭代训练并得到训练好的目标识别模型。

[0080] 需要说明的是，迭代训练的目的，是为了经过的数轮分类预测训练，逐渐提升垃圾类型识别准确率。根据本发明提供的一些实施例，目标识别模型的训练过程包括：将带有垃圾分类标签的训练数据集输入基础识别模型进行迭代训练，每一轮迭代训练后，计算基础识别模型的垃圾类型识别准确率并对基础识别模型进行更新。其中，基础识别模型由原始预设模型经过预训练得到，其中，原始识别模型指的是尚未经过预训练的图像识别模型，而预训练则指的是基于带有预设标签的标准数据集对图像识别模型进行初步训练，从而令图像识别模型具备基本的物体类型识别水平。需要说明的是，迭代训练的目的是为了不断优化基础识别模型的垃圾类型识别能力。每一轮迭代训练后，都需要计算基础识别模型的垃圾类型识别准确率，以明确优化训练过程中基础识别模型的识别准确率在逐渐提升。需要说明的是，在优化训练的过程中，每经过一轮迭代训练，都需要对基础识别模型进行一次更新，以使得基础识别模型能在下一轮迭代训练中对垃圾类型的识别处理有更好的表现。迭代训练中，对基础识别模型进行更新主要通过调整基础识别模型的参数来完成，基础识别模型的参数即基础识别模型内部与垃圾类型识别准确率相关的内部参数。

[0081] 需要说明的是，当垃圾识别准确率收敛于定值，停止迭代训练并得到训练好的目标识别模型，其中定值指的是：在对基础识别模型的内部参数进行数轮调整后，基础识别模型的垃圾类型识别准确率收敛值。本发明提供的一些实施例中，基础识别模型的垃圾类型识别准确率将会稳定在某一误差区间内，例如垃圾类型识别准确率在84％到86％区间内波动，则可以认为定值为85％。应理解，定值不是一个确切不变的值，而是一个会随训练条件发生变化的值。当垃圾类型识别准确率收敛于定值，判定优化训练已达较佳效果，即可停止迭代训练，其中，停止迭代训练后得到的垃圾类型识别模型即目标识别模型，通过优化训练得到的目标识别模型将具备更加精确的垃圾类型识别准确率。

[0082] 参照图3，根据本发明的一些实施例，通过目标识别模型对水下图像信息进行处理，识别得到水下垃圾的垃圾类型以及水下垃圾在水下环境中的待清洁位置，包括：

[0083] 步骤S301，通过目标识别模型将水下图像信息网格化，并根据网格化后的水下图像信息得到多个目标边界框；

[0084] 步骤S302，将多个目标边界框与训练数据集中的分类标准框进行重叠度比对；

[0085] 步骤S303，以重叠度最高的目标边界框对待检测目标进行识别分类，并保留置信度高于预设阈值的识别结果，得到水下垃圾的垃圾类型。

[0086] 本发明一些实施例中，选用YOLO算法作为目标识别模型的核心算法。基于YOLO算法的目标识别模型是一种基于深度神经网络的对象识别和定位Python算法。具体而言，它将单个卷积神经网络应用于整个水下图像信息，将水下图像信息网格化，并基于网格化后

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的水下图像信息预测每个网格的类概率和目标边界框。每个目标边界框可以用四个描述符进行描述：目标边界框的中心点、高度、宽度以及值映射到对象所属的类。如果一个对象的中心落在一个网格单元中，则该网格单元负责检测该对象。每个网格中将有多个目标边界框。在训练时，为了使得每个对象只有一个目标边界框，因此，需要将多个目标边界框与训练数据集中的分类标准框(Ground Truth Box)进行重叠度比对，从而分配一个重叠度最高的目标边界框来负责预测对象，最后以重叠度最高的目标边界框对待检测目标进行识别分类，过滤掉置信度小于预设阈值的目标边界框并保留置信度高于预设阈值的识别结果，最终得到水下垃圾的垃圾类型，应理解，识别得到的垃圾类型可以是置信度最高识别结果。需要说明的是，基于YOLO算法的目标识别模型具备较高的识别精度，同时运行速度最快，并且能够处理实时视频流。因此，本发明一些较为优选的实施例中，选用基于YOLO算法的目标识别模型作为本发明的目标识别模型。根据本发明一些实施例，目标识别模型在对待检测目标进行识别分类的同时，可以明确待检测目标在水下图像信息中的位置，进而得到水下垃圾在水下环境中的水下待清洁位置。

[0087] 参照图4，根据本发明的一些实施例，水下清洁装置包括机械臂，根据水下垃圾在水下环境中的待清洁位置，对水下垃圾进行收集，包括：

[0088] 步骤S401，对水下清洁装置的推进器进行驱动，以控制水下清洁装置移动至待清洁位置；

[0089] 步骤S402，当到达待清洁位置，控制机械臂对水下垃圾进行抓取；

[0090] 步骤S403，将机械臂抓取到的水下垃圾置于垃圾存放装置，并基于垃圾存放装置完成对水下垃圾的收集。

[0091] 根据本发明提供的一些实施例，在通过目标识别模型对水下图像信息进行处理，识别得到水下垃圾在水下环境中的水下待清洁位置之后，即可控制水下清洁装置对水下垃圾进行收集。根据本发明提供的一些实施例，根据水下图像信息，明确目标水域的水下环境中水下垃圾所处方位之后，通过水下清洁装置的推进器系统，将水下清洁装置移动至水下垃圾所处方位的附近，以便于对水下垃圾进行收集。需要说明的是，推进器系统可以由多个不同方向的水下外转子直流电机组成，如此设计的推进器系统能够使得水下清洁装置在目标水域的水下环境中实现稳定、灵活、精准高效的多自由度移动。

[0092] 水下清洁装置对垃圾的收集分为两个过程，分别是垃圾的抓取和垃圾的传送。由于水下垃圾不会简单地摆放在水底，可能存在缠绕、半掩埋等多种存在形式，因此关于收集目标水域的水下垃圾，本发明一些实施例中采用机械臂抓取的方式将水下垃圾(例如水底部塑料、布料垃圾等)，放入大口径垃圾传送仓并将其传送至垃圾收集仓，其中垃圾传送仓与垃圾收集仓之间可以通过传送带连通，传送带用以传输水下垃圾。在一些较为具体的实施例中，推进器系统由六个不同方向的水下外转子直流电机组成，可在水下实现稳定、灵活、精准高效的六自由度控制，应理解，六自由度控制指的是沿x、y、z三个直角坐标轴(参照系根据实际情况建立)方向的移动自由度和绕这三个坐标轴的转动自由度。

[0093] 根据本发明一些实施例，水下沉积着各种杂物，泥沙、石块、贝类、珊瑚等等，不可能将所有的东西都算作水下垃圾来进行清理收集，所以对于垃圾的识别技术就显得尤为重要。需要说明的是，水下清洁装置对垃圾的清理方式大致有两种：其一，是在水下情况比较简单时可以使用自动识别模式，采用摄像机视频智能识别技术，自动识别水中垃圾污染物，

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协同母船运动控制及水下清洁装置运动控制，自主航行收集垃圾；其二，是当工作水域中水下环境比较复杂时，可以切换为手动操作模式，通过水下清洁装置携带的摄像头传回的视频数据，手动对水下清洁装置的水下行进以及垃圾抓取过程进行操控，从而实现对水下垃圾的甄别和清理。应理解，根据水下待清洁位置，控制水下清洁装置对水下垃圾进行收集包括但不限于上述举出的具体实施例。

[0094] 参照图5，根据本发明的一些实施例，将机械臂抓取到的水下垃圾置于垃圾存放装置，并基于垃圾存放装置完成对水下垃圾的收集，包括：

[0095] 步骤S501，当机械臂将抓取到的水下垃圾置于垃圾存放装置的收集口，启动收集口与垃圾收集仓之间的传送带，垃圾收集仓设置于垃圾存放装置内部；

[0096] 步骤S502，当传送带将水下垃圾运送至垃圾收集仓中，关闭传送带。

[0097] 根据本发明提供的一些实施例，垃圾存放装置包括垃圾传送仓、垃圾收集仓，其中垃圾传送仓设有收集口。需要说明的是，水下清洁装置对垃圾的收集分为两个过程，分别是垃圾的抓取和垃圾的传送。由于水下垃圾不会简单地摆放在水底，可能存在缠绕、半掩埋等多种存在形式，因此关于收集目标水域的水下垃圾，本发明一些实施例中采用机械臂抓取的方式将水下垃圾(例如水底部塑料、布料垃圾等)经由垃圾存放装置的收集口放入垃圾传送仓，并从垃圾传送仓将垃圾传送至垃圾收集仓，其中垃圾传送仓与垃圾收集仓之间可以通过传送带连通，传送带用以传输水下垃圾。

[0098] 参照图6，根据本发明的第二方面实施例的水下清洁装置，包括：指令接收模块、图像采集模块、识别处理模块、垃圾收集模块；

[0099] 指令接收模块用于获取来自控制中心的作业启动指令，作业启动指令用于启动水下清洁作业；

[0100] 图像采集模块用于根据作业启动指令控制摄像组件采集水下图像信息，水下图像信息反映目标水域的水下环境；

[0101] 识别处理模块用于通过目标识别模型对水下图像信息进行处理，识别得到水下垃圾以及水下垃圾在水下环境中的待清洁位置，目标识别模型用于对图像中的物体进行识别分类；

[0102] 垃圾收集模块用于根据水下垃圾在水下环境中的待清洁位置，对水下垃圾进行收集。

[0103] 根据本发明的一些实施例，水下清洁装置还包括推进器，推进器由多个不同方向的水下外转子直流电机组成，用于实现水下多自由度控制。

[0104] 参照图7，本发明一些实施例中，水下清洁装置740是水域清洁设备700的一部分。水域清洁设备700，包括：控制模块710、数据收发模块720、母船730、水下清洁装置740。其中，数据收发模块720用于获取控制中心800发送的投放指令，以及当水下清洁装置潜入目标水域的水面之下，向控制中心800发送作业准备信号，以获取作业启动指令。而控制模块710，则用于根据投放指令将水下清洁装置740从母船730投入目标水域，以及根据作业启动指令，控制水下清洁装置740对目标水域的水下环境进行检测，并基于水下环境识别目标水域的水下垃圾900，控制水下清洁装置740收集水下垃圾，当水下垃圾收集完毕，将水下清洁装置回收至母船730。

[0105] 参照图7、图8，根据本发明一些实施例中的水域清洁设备700，控制模块710还可以

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分为母船主控与水下清洁装置主控。需要说明的是，控制模块710中的母船主控用于控制母船上配备的各类模块，母船上配备的各类模块涉及的类型包括：电缆供电、电动绞盘链接、有线通讯、电动推杆、电动履带、云台相机、电动绞盘、GPS模块、柔性太阳能电池板、太阳能板控制器、电池、电源控制、推进器、避障雷达、4G/无线电模块、压力传感器以及其他类型的母船扩展模块。应理解，母船拓展模块可以包括的类型有生物光谱仪、自动流式细胞仪、气象仪、波浪仪、多普勒流苏剖面仪等。应理解，母船上配备的各类模块的类型不限于上述举出的具体实施例。另外，控制模块710中的水下清洁装置主控用于控制水下清洁装置上配备的各类模块，水下清洁装置上配备的各类模块涉及的类型包括：电缆供电、电动绞盘链接、有线通讯、水下云台相机、水下探照灯、推进器、压力传感器、机械臂、电动履带以及其他类型的水下清洁装置扩展模块。应理解，水下清洁装置拓展模块可以包括的类型有水质分析仪、自动流式细胞仪、生物光谱仪、沉积物补集器等。应理解，水下清洁装置上配备的各类模块的类型不限于上述举出的具体实施例。

[0106] 根据本发明一些实施例，水下清洁装置还包括有驱动模块(或称自动驾驶模块)，可将运动控制固件加载到模块上。自动驾驶模块主要处理运动执行输入和传感器数据，并控制水下清洁装置的推进器、照明灯、伺服系统、机械臂和继电器(控制垃圾收集传送带)，以及可根据不同的科学需求集成相关的传感器。本发明一个较为优选的实施例，采用Pixhawk作为本发明自动驾驶模块的核心组件，Pixhawk是一种基于流行的通用飞行控制器Pixhawk项目FMUv2开放硬件设计，结合了PX4FMU、PX4IO的功能，可在NuttXOS上运行PX4。Pixhawk模块采用STM32F427作为主芯片，包括180MHz的CPU、256KB的SRAM。另外，故障安全片上系统采用STM32F100芯片(CPU:24MHz ARM Cortex M3,RAM:5KB SRAM)，Pixhawk还包阔Wifi模块、GPS模块、4个串口接口、14路PWM、I2C、SPI等资源。此外，Pixhawk还可以搭载SPI转UART模块，可扩展多路串口接口，能够用于集成多个外围传感器，在硬件电路上实现多传感器集成的功能。

[0107] 参照图7、图9，根据本发明一些实施例中的水域清洁设备700，控制中心800、母船730与水下清洁装置740三者之间的通讯关系如图9所示。本发明一些实施例中，水下清洁装置740与母船730共用一套通讯系统，水下清洁装置740与母船730分别将需要回传的数据发送到水域清洁设备的小型单板计算机，由小型单板计算机对数据进行打包，再由水域清洁设备的无线通讯系统通过无线电波将其发送到控制中心800，控制中心800再对IP地址信息进行识别和处理，基于IP地址信息明确信息的来源是母船730还是水下清洁设备。同样的，当控制中心800向系统发送控制指令时，利用IP地址的不同，分别向水下清洁装置740与母船730发送控制信号，母船730上的数据接收器和数据处理器对收到的数据包进行处理，分别将指令发送到水下清洁装置740与母船730，进而将数据包进行解压处理，读取命令，执行操作。一些更为具体的实施例中，水下清洁装置740的自动驾驶仪板与母船730的自动驾驶仪板分别将需要回传的数据发送到小型单板计算机，由小型单板计算机对数据进行打包，再由母船730上的无线通讯系统通过无线电波将其发送到控制中心800的PC端，控制中心800的PC端再对地址信息进行识别和处理，明确信息的来源是母船730还是水下清洁设备。同样的，当PC端向系统发送控制指令时，利用IP地址的不同，分别向水下清洁装置740与母船730发送控制信号，母船730上的数据接收器和数据处理器对收到的数据包进行处理，分别将指令发送到水下清洁装置740与母船730，进而将数据包进行解压处理，读取命令，执行

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操作。

[0108] 图10示出了本发明实施例提供的电子设备1000。电子设备1000包括：处理器1001、存储器1002及存储在存储器1002上并可在处理器1001上运行的计算机程序，计算机程序运行时用于执行上述的水下清洁方法。

[0109] 处理器1001和存储器1002可以通过总线或者其他方式连接。

[0110] 存储器1002作为一种非暂态计算机可读存储介质，可用于存储非暂态软件程序以及非暂态性计算机可执行程序，如本发明实施例描述的水下清洁方法。处理器1001通过运行存储在存储器1002中的非暂态软件程序以及指令，从而实现上述的水下清洁方法。

[0111] 存储器1002可以包括存储程序区和存储数据区，其中，存储程序区可存储操作系统、至少一个功能所需要的应用程序。存储数据区可存储执行上述的水下清洁方法。此外，存储器1002可以包括高速随机存取存储器1002，还可以包括非暂态存储器1002，例如至少一个储存设备存储器件、闪存器件或其他非暂态固态存储器件。在一些实施方式中，存储器1002可选包括相对于处理器1001远程设置的存储器1002，这些远程存储器1002可以通过网络连接至该电子设备1000。上述网络的实例包括但不限于互联网、企业内部网、局域网、移动通信网及其组合。

[0112] 实现上述的水下清洁方法所需的非暂态软件程序以及指令存储在存储器1002中，当被一个或者多个处理器1001执行时，执行上述的水下清洁方法，例如，执行图1中的方法步骤S101至步骤S104、图2中的方法步骤S201至步骤S203、图3中的方法步骤S301至步骤S303、图4中的方法步骤S401至步骤S403、图5中的方法步骤S501至步骤S502。

[0113] 本发明实施例还提供了计算机可读存储介质，存储有计算机可执行指令，计算机可执行指令用于执行上述的水下清洁方法。

[0114] 在一实施例中，该计算机可读存储介质存储有计算机可执行指令，该计算机可执行指令被一个或多个控制处理器执行，例如，执行图1中的方法步骤S101至步骤S104、图2中的方法步骤S201至步骤S203、图3中的方法步骤S301至步骤S303、图4中的方法步骤S401至步骤S403、图5中的方法步骤S501至步骤S502。

[0115] 以上所描述的装置实施例仅仅是示意性的，其中作为分离部件说明的单元可以是或者也可以不是物理上分开的，即可以位于一个地方，或者也可以分布到多个网络单元上。可以根据实际的需要选择其中的部分或者全部模块来实现本实施例方案的目的。

[0116] 本领域普通技术人员可以理解，上文中所公开方法中的全部或某些步骤、系统可以被实施为软件、固件、硬件及其适当的组合。某些物理组件或所有物理组件可以被实施为由处理器，如中央处理器、数字信号处理器或微处理器执行的软件，或者被实施为硬件，或者被实施为集成电路，如专用集成电路。这样的软件可以分布在计算机可读介质上，计算机可读介质可以包括计算机存储介质(或非暂时性介质)和通信介质(或暂时性介质)。如本领域普通技术人员公知的，术语计算机存储介质包括在用于存储信息(诸如计算机可读指令、数据结构、程序模块或其他数据)的任何方法或技术中实施的易失性和非易失性、可移除和不可移除介质。计算机存储介质包括但不限于RAM、ROM、EEPROM、闪存或其他存储器技术、CD-ROM、数字多功能盘(DVD)或其他光盘存储、磁盒、磁带、储存设备存储或其他磁存储装置、或者可以用于存储期望的信息并且可以被计算机访问的任何其他的介质。此外，本领域普通技术人员公知的是，通信介质通常包括计算机可读指令、数据结构、程序模块或者诸如

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载波或其他传输机制之类的调制数据信号中的其他数据，并且可包括任何信息递送介质。还应了解，本发明实施例提供的各种实施方式可以任意进行组合，以实现不同的技术效果。

[0117] 以上是对本发明的较佳实施进行了具体说明，但本发明并不局限于上述实施方式，熟悉本领域的技术人员在不违背本发明精神的共享条件下还可作出种种等同的变形或替换，这些等同的变形或替换均包括在本发明权利要求所限定的范围内。

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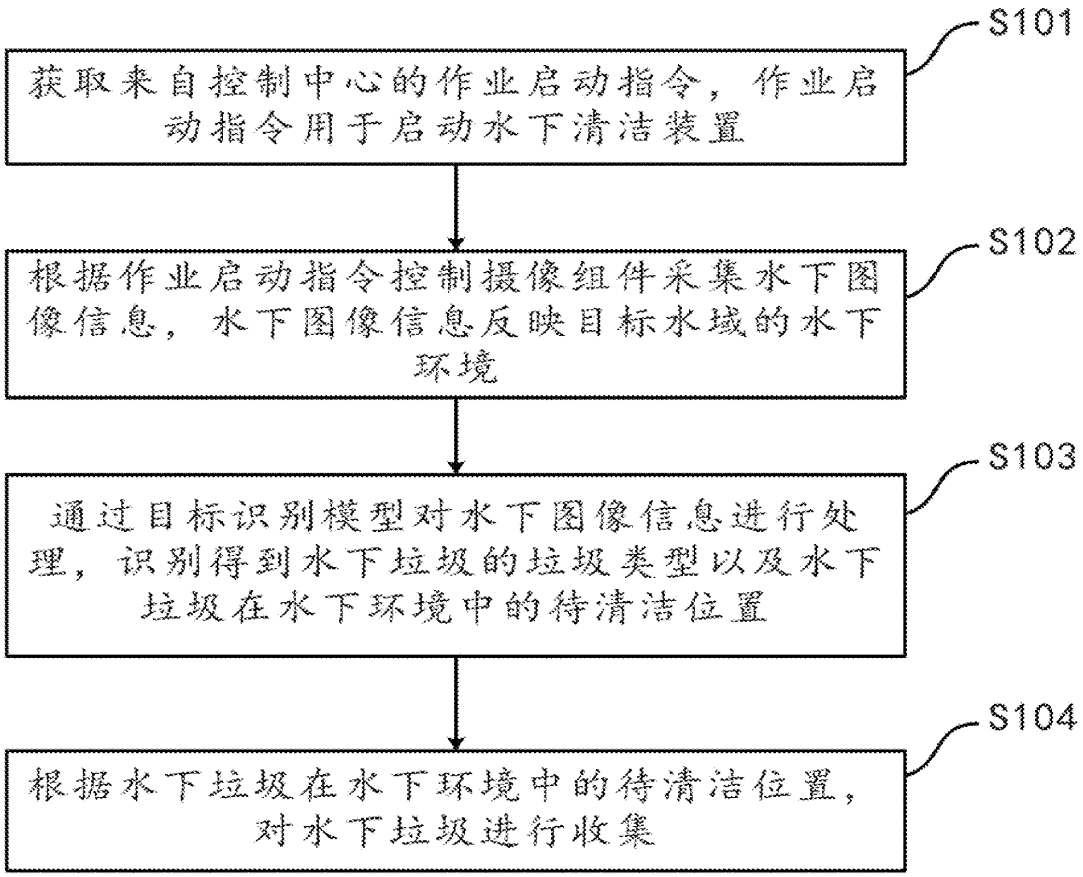


图1

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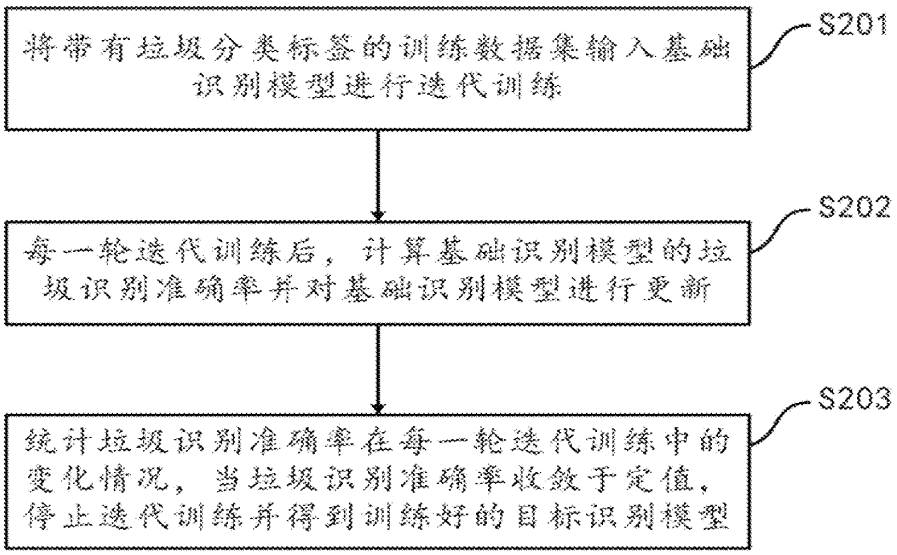


图2

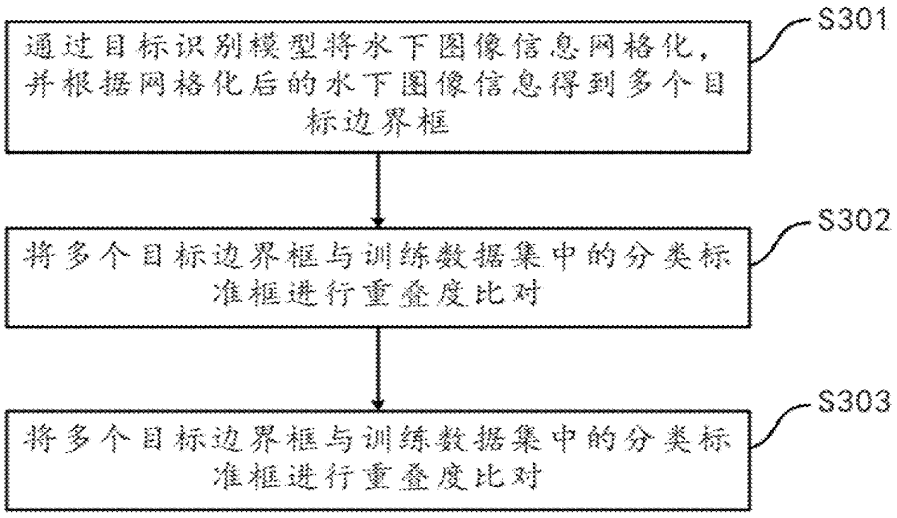


图3

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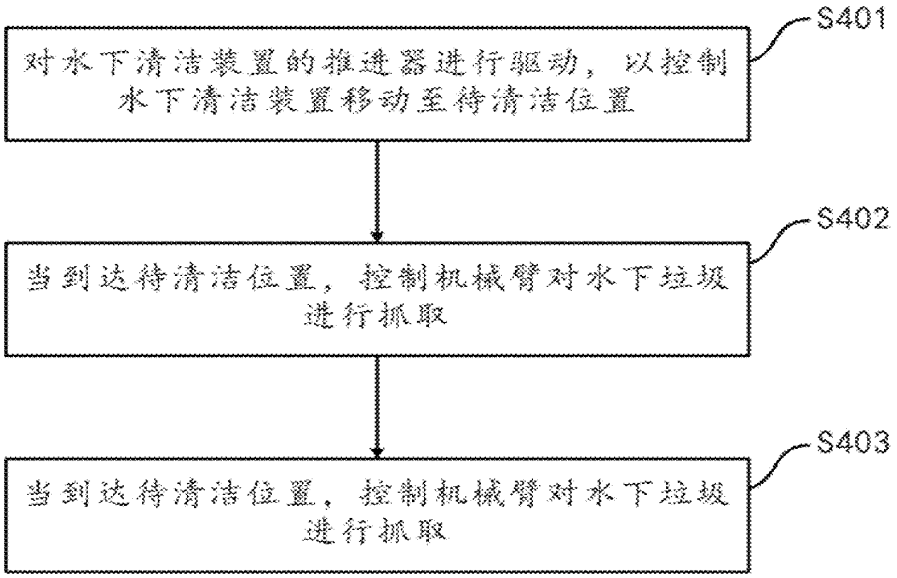


图4

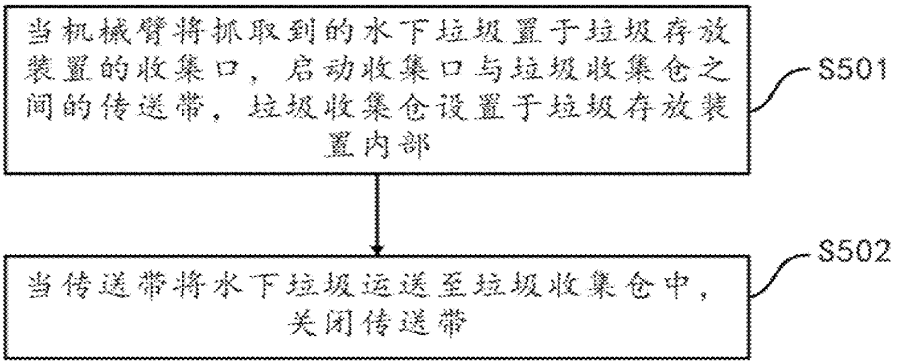


图5

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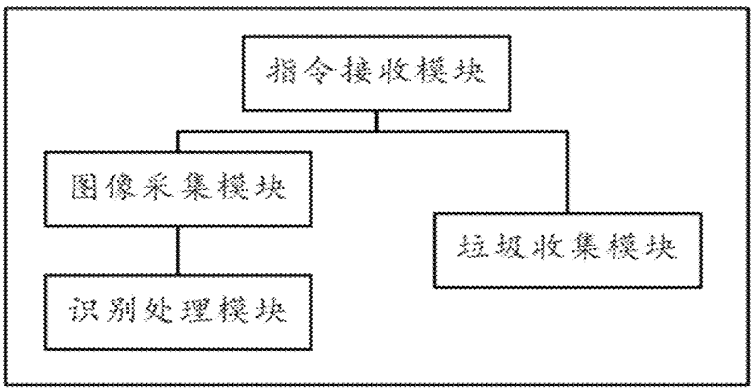


图6

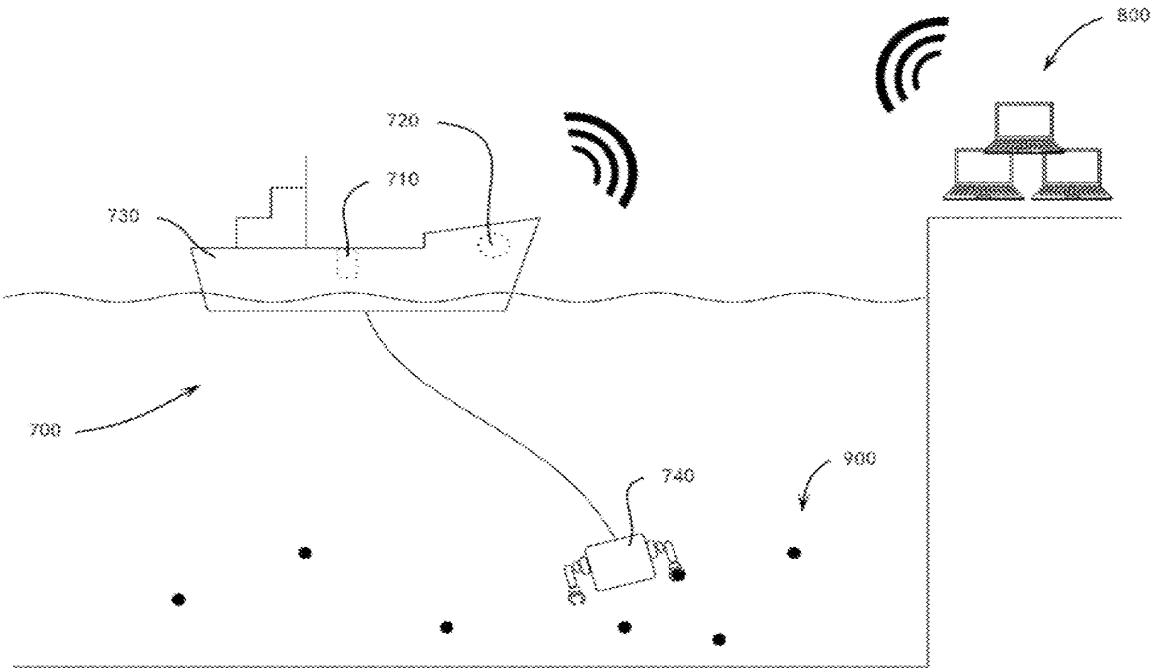


图7

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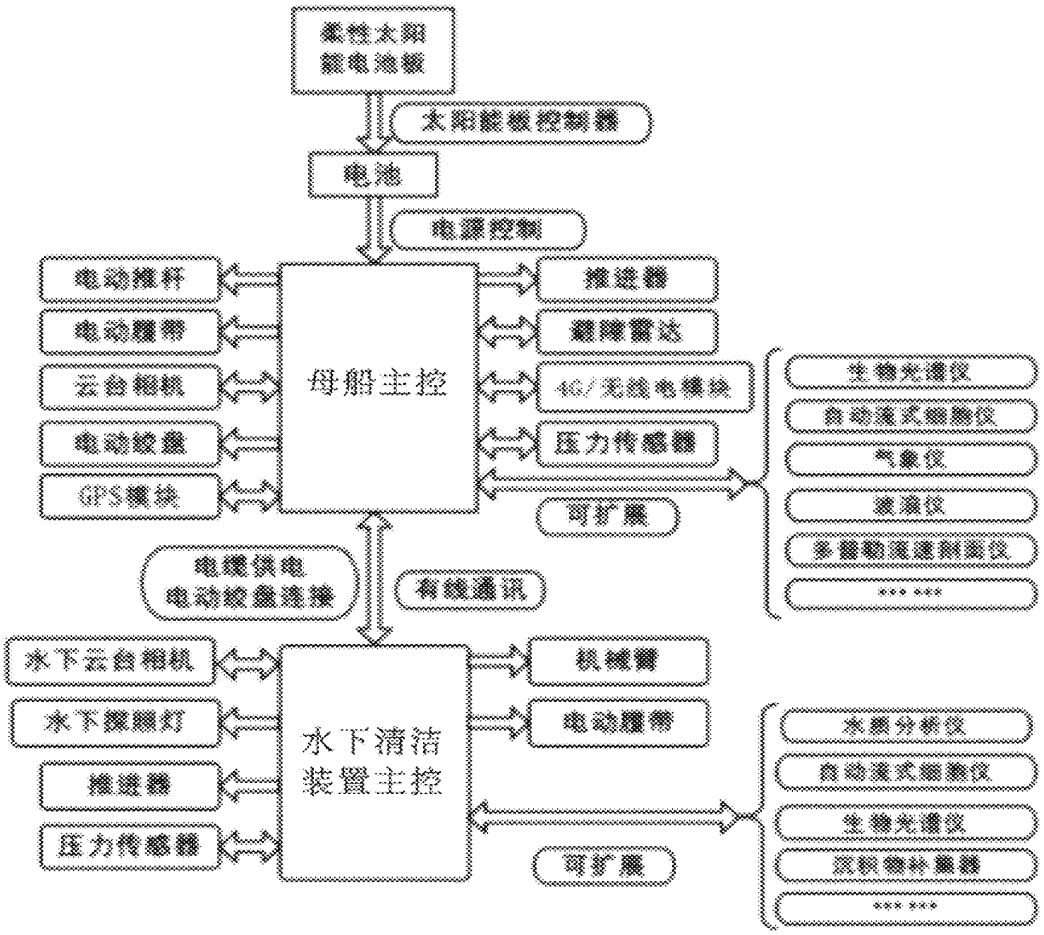


图8

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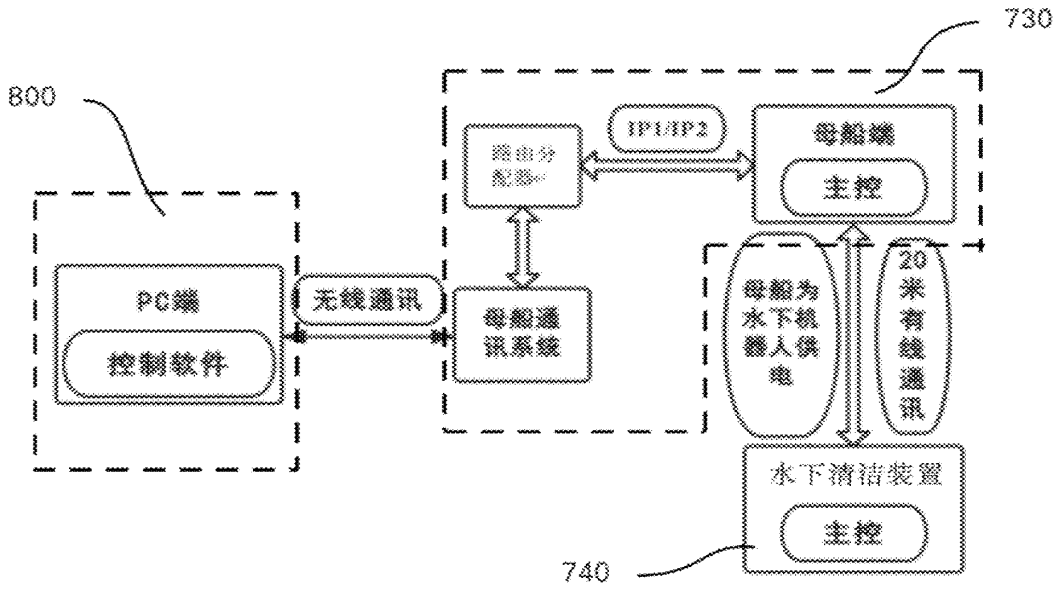


图9

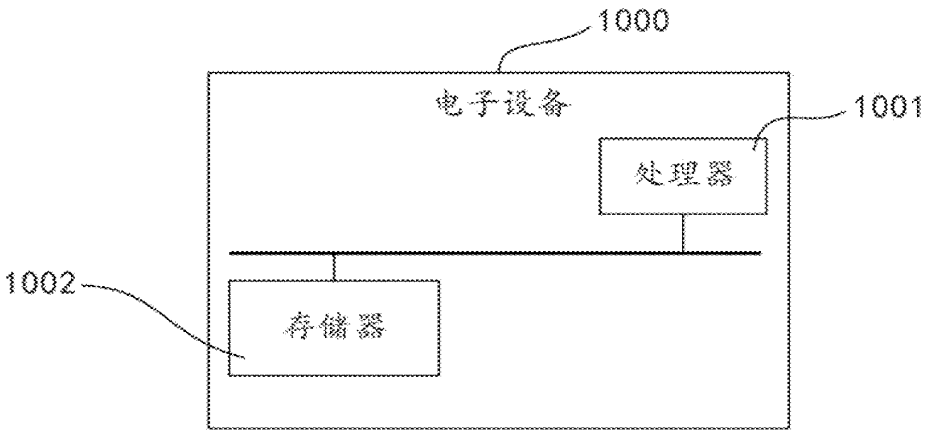


图10

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Espacenet

CN112936313A Water intelligent purification robot based on machine recognition

Applicants: UNIV GUIZHOU ENGINEERING SCIENCE

Inventors: YANG YUNGAO,YI CHUANMEI,LI XIANGCHUN,PENG ZHUANXIN,TIAN RENYONG,RUAN SHIKANG,GAO TONG

Classifications:
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Water intelligent purification robot based on machine recognition

Abstract

The invention discloses a water intelligent purification robot based on machine recognition. The water intelligent purification robot comprises a cleaning assembly and an emergency rescue assembly. The cleaning assembly comprises a reinforcing frame, I-shaped steel, a collecting frame, a rotating frame, a leakage net and a drive device, the collecting frame is fixedly arranged at the edge of the outer wall of the rotating frame, the leakage net is fixedly arranged at the edge of the outer wall of the collecting frame, the cross section of the collecting frame is in an L shape, and the drive device is rotationally arranged in the center of one side of the outer wall of the rotating frame through a rotating shaft. Through the cleaning assembly, the emergency rescue assembly and a driving assembly, garbage collection and water purification can be achieved at the same time, a water body of a water source center is detected through a detection assembly while garbage is collected, the detection precision to the water body is guaranteed, the water body detection convenience is improved, an unmanned aerial vehicle is carried, and self-help rescue of the water robot is achieved; and through a mechanical arm, the rotating frame, the collecting frame and the leakage net, the collecting efficiency of large garbage and the rescue efficiency of people falling into water can be improved, and the rescue efficiency can be improved.

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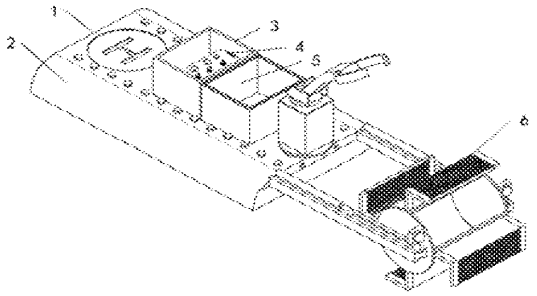
权利要求书2页 说明书4页 附图6页

(54) 发明名称

一种基于机器识别的水上智能净化机器人

(57) 摘要

本发明公开了一种基于机器识别的水上智能净化机器人，包括清洁组件与急救组件，清洁组件包括加强架、工型钢、收集架、旋转架、漏网与驱动装置，收集架固定设置于旋转架的外壁边缘处，漏网固定设置于收集架的外壁边缘处，收集架的横截面呈L状，驱动装置通过转轴转动设置于旋转架的外壁一侧中心处。通过清洁组件、急救组件与行驶组件，可以实现对同时实现垃圾收集和水质净化，在收集垃圾的同时，通过检测组件对水源中心的水体进行检测，保证了对水体的检测精度，提高了水体检测的便捷性，搭载无人机，实现水上机器人自助救援，通过机械手、旋转架、收集架和漏网，可以提高了大型垃圾的收集和落水人员的救援效率，提高救援的效率。



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1.一种基于机器识别的水上智能净化机器人，包括清洁组件与急救组件，其特征在于：所述清洁组件包括加强架(1)、工型钢(13)、收集架(6)、旋转架(8)、漏网(9)与驱动装置，所述收集架(6)固定设置于旋转架(8)的外壁边缘处，所述漏网(9)固定设置于收集架(6)的外壁边缘处，所述收集架(6)的横截面呈L状，所述驱动装置通过转轴转动设置于旋转架(8)的外壁一侧中心处，所述工型钢(13)共设置有两个，两个所述工型钢(13)的一端固定设置于加强架(1)的外壁边缘两侧处，以及，

所述急救组件包括磁力槽(12)、无人机组件、机械手(7)、摄像头(15)、行驶组件与检测组件，所述无人机组件设置于磁力槽(12)的内壁处，所述机械手(7)安装设置于加强架(1)的外壁边缘处，两个所述摄像头(15)分别固定设置于工型钢(13)的一端外壁顶部处。

2.根据权利要求1所述的一种基于机器识别的水上智能净化机器人，其特征在于：所述行驶组件包括浮力筒(2)、稳定块(17)、推进器(16)与减阻面(14)，所述浮力筒(2)共设置有两个，两个所述浮力筒(2)的外壁顶部通过螺栓安装设置于加强架(1)的外壁底部处，所述稳定块(17)共设置有两个，两个所述稳定块(17)分别固定设置于浮力筒(2)的外壁底部处，每个所述稳定块(17)的横截面呈类三角状，所述减阻面(14)开设于稳定块(17)的外壁边缘处，所述推进器(16)的外壁顶部通过螺栓安装设置于加强架(1)的外壁底部处。

3.根据权利要求1所述的一种基于机器识别的水上智能净化机器人，其特征在于：所述检测组件包括PH加测装置、浑浊度装置与含氧量装置。

4.根据权利要求1所述的一种基于机器识别的水上智能净化机器人，其特征在于：所述工型钢(13)的一端外壁中心处通过转轴转动设置于旋转架(8)的外壁一侧中心处。

5.根据权利要求1所述的一种基于机器识别的水上智能净化机器人，其特征在于：所述加强架(1)的外壁顶部一侧固定设置有电力箱(3)，且电力箱(3)的内壁底部嵌设有蓄电池(4)。

6.根据权利要求1所述的一种基于机器识别的水上智能净化机器人，其特征在于：所述加强架(1)的外壁顶部固定设置有收集箱(5)，且收集箱(5)的内壁套设有垃圾收集袋。

7.根据权利要求1所述的一种基于机器识别的水上智能净化机器人，其特征在于：所述工型钢(13)的内壁两侧均滑动嵌设有限制块(10)，且限制块(10)的外壁一侧中心处固定设置有安装管(11)。

8.根据权利要求7所述的一种基于机器识别的水上智能净化机器人，其特征在于：所述安装管(11)的外壁滑动套设有垃圾收集网。

9.根据权利要求1所述的一种基于机器识别的水上智能净化机器人，其特征在于：所述浮力筒(2)的横截面呈半圆状。

10.一种基于机器识别的水上智能净化机器人，其特征在于，使用了根据权利要求1-9中任意一项所述的一种基于机器识别的水上智能净化机器人的使用方法，包括：

S1、开机寻找垃圾、随后通过检测组件对设定要素进行检测，水质较差时，启动净化装置，对水源进行净化；

S2、工作一段时间后，进入自检循环，判定电量，不足时直接返回岸边，电量充足时，检测是否失控；

S3、确定失控后，释放无人机，通过人工干预返回岸边，没有失控则通过摄像头(15)对工作环境进行检测，检测大型垃圾或者落水人员；

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S4、返回岸边后，对电源和推进装置进行检修和维护。

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一种基于机器识别的水上智能净化机器人

技术领域

[0001] 本发明属于垃圾处理技术领域，具体为一种基于机器识别的水上智能净化机器人。

背景技术

[0002] 垃圾是人类日常生活和生产中产生的固体废弃物，由于排出量大，成分复杂多样，且具有污染性、资源性和社会性，需要无害化、资源化、减量化和社会化处理，如不能妥善处理，就会污染环境，影响环境卫生，浪费资源，破坏生产生活安全，破坏社会和谐，垃圾处理就是要把垃圾迅速清除，并进行无害化处理，最后加以合理地利用，当今广泛应用的垃圾处理方法是卫生填埋、高温堆肥和焚烧，垃圾处理的目的是无害化、资源化和减量化。

[0003] 目前对于自然水体的清洁，多数需要工人开船进行捞取和收集，对于大型的垃圾，整体的收集效率较好，但是小型的垃圾，往往无法保证及时收集，当对水源进行检测时，往往需要单独进行取样，导致了水体检测便捷性和精确度较差。

发明内容

[0004] 本发明的目的在于：通过清洁组件、急救组件与行驶组件，可以实现对同时实现垃圾收集和水质净化，在收集垃圾的同时，通过检测组件对水源中心的水体进行检测，保证了对水体的检测精度，提高了水体检测的便捷性，搭载无人机，实现水上机器人自助救援，通过机械手、旋转架、收集架和漏网，可以提高了大型垃圾的收集和落水人员的救援效率，提高救援的效率。

[0005] 本发明采用的技术方案如下：一种基于机器识别的水上智能净化机器人，包括清洁组件与急救组件，所述清洁组件包括加强架、工型钢、收集架、旋转架、漏网与驱动装置，所述收集架固定设置于旋转架的外壁边缘处，所述漏网固定设置于收集架的外壁边缘处，所述收集架的横截面呈L状，所述驱动装置通过转轴转动设置于旋转架的外壁一侧中心处，所述工型钢共设置有两个，两个所述工型钢的一端固定设置于加强架的外壁边缘两侧处，以及，

[0006] 所述急救组件包括磁力槽、无人机组件、机械手、摄像头、行驶组件与检测组件，所述无人机组件设置于磁力槽的内壁处，所述机械手安装设置于加强架的外壁边缘处，两个所述摄像头分别固定设置于工型钢的一端外壁顶部处。

[0007] 进一步的，所述行驶组件包括浮力筒、稳定块、推进器与减阻面，所述浮力筒共设置有两个，两个所述浮力筒的外壁顶部通过螺栓安装设置于加强架的外壁底部处，所述稳定块共设置有两个，两个所述稳定块分别固定设置于浮力筒的外壁底部处，每个所述稳定块的横截面呈类三角状，所述减阻面开设于稳定块地外壁边缘处，所述推进器的外壁顶部通过螺栓安装设置于加强架的外壁底部处。

[0008] 进一步的，所述检测组件包括PH加测装置、浑浊度装置与含氧量装置。

[0009] 进一步的，所述工型钢的一端外壁中心处通过转轴转动设置于旋转架的外壁一侧

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中心处。

[0010] 进一步的，所述加强架的外壁顶部一侧固定设置有电力箱，且电力箱的内壁底部嵌设有蓄电池。

[0011] 进一步的，所述加强架的外壁顶部固定设置有收集箱，且收集箱的内壁套设有垃圾收集袋。

[0012] 进一步的，所述工型钢的内壁两侧均滑动嵌设有限制块，且限制块地外壁一侧中心处固定设置有安装管。

[0013] 进一步的，所述安装管的外壁滑动套设有垃圾收集网。

[0014] 进一步的，所述浮力筒的横截面呈半圆状。

[0015] 一种基于机器识别的水上智能净化机器人，使用了根据权利要求1-9中任意一项所述的一种基于机器识别的水上智能净化机器人的使用方法，包括：

[0016] 步骤一、开机寻找垃圾、随后通过检测组件对设定要素进行检测，水质较差时，启动净化装置，对水源进行净化。

[0017] 步骤二、工作一段时间后，进入自检循环，判定电量，不足时直接返回岸边，电量充足时，检测是否失控。

[0018] 步骤三、确定失控后，释放无人机，通过人工干预返回岸边，没有失控则通过摄像头对工作环境进行检测，检测大型垃圾或者落水人员。

[0019] 步骤四、返回岸边后，对电源和推进装置进行检修和维护。

[0020] 综上所述，由于采用了上述技术方案，本发明的有益效果是：

[0021] 本发明中，通过清洁组件、急救组件与行驶组件，可以实现对同时实现垃圾收集和水质净化，在收集垃圾的同时，通过检测组件对水源中心的水体进行检测，保证了对水体的检测精度，提高了水体检测的便捷性，搭载无人机，实现水上机器人自助救援，通过机械手、旋转架、收集架和漏网，可以提高了大型垃圾的收集和落水人员的救援效率，提高救援的效率。

附图说明

[0022] 图1为本发明的使用方法示意图；

[0023] 图2为本发明的立体图；

[0024] 图3为本发明旋转架的立体图；

[0025] 图4为本发明磁力槽的立体图；

[0026] 图5为本发明的侧视图；

[0027] 图6为本发明的俯视图；

[0028] 图7为本发明推进器的侧视图；

[0029] 图8为本发明漏网的侧视图；

[0030] 图9为本发明机械手的侧视图；

[0031] 图10为本发明的仰视图。

[0032] 图中标记：1、加强架；2、浮力筒；3、电力箱；4、蓄电池；5、收集箱；6、收集架；7、机械手；8、旋转架；9、漏网；10、限制块；11、安装管；12、磁力槽；13、工型钢；14、减阻面；15、摄像头；16、推进器；17、稳定块。

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具体实施方式

[0033] 为了使本发明的目的、技术方案及优点更加清楚明白，以下结合附图及实施例，对本发明进行进一步详细说明。应当理解，此处所描述的具体实施例仅用以解释本发明，并不用于限定本发明。

[0034] 实施例一，参照图1到图10：一种基于机器识别的水上智能净化机器人，包括清洁组件与急救组件，清洁组件包括加强架1、工型钢13、收集架6、旋转架8、漏网9与驱动装置，收集架6固定设置于旋转架8的外壁边缘处，漏网9固定设置于收集架6的外壁边缘处，收集架6的横截面呈L状，驱动装置通过转轴转动设置于旋转架8的外壁一侧中心处，工型钢13共设置有两个，两个工型钢13的一端固定设置于加强架1的外壁边缘两侧处，以及，急救组件包括磁力槽12、无人机组件、机械手7、摄像头15、行驶组件与检测组件，无人机组件设置于磁力槽12的内壁处，机械手7安装设置于加强架1的外壁边缘处，两个摄像头15分别固定设置于工型钢13的一端外壁顶部处，通过加强架1，可以保证浮力筒2的稳定，不会因为捞取垃圾或者救援，导致发生倾覆的问题，通过收集架6、旋转架8和漏网9，可以实现高效的水面垃圾捞取和集中，提高了垃圾的收集效率，通过工型钢13，可以提高捞取垃圾的稳定性，避免产生结构疲劳，通过机械手7，可以实现高效的大型垃圾捞取，或者协助落水者的救助，通过摄像头15，可以实现对工作环境的情况进行采集，协助使用者进行实际情况的判定。

[0035] 实施例二，参照图1到图10：行驶组件包括浮力筒2、稳定块17、推进器16与减阻面14，浮力筒2共设置有两个，两个浮力筒2的外壁顶部通过螺栓安装设置于加强架1的外壁底部处，稳定块17共设置有两个，两个稳定块17分别固定设置于浮力筒2的外壁底部处，每个稳定块17的横截面呈类三角状，减阻面14开设于稳定块17的外壁边缘处，推进器16的外壁顶部通过螺栓安装设置于加强架1的外壁底部处，检测组件包括PH加测装置、浑浊度装置与含氧量装置，工型钢13的一端外壁中心处通过转轴转动设置于旋转架8的外壁一侧中心处，加强架1的外壁顶部一侧固定设置有电力箱3，且电力箱3的内壁底部嵌设有蓄电池4，加强架1的外壁顶部固定设置有收集箱5，且收集箱5的内壁套设有垃圾收集袋，工型钢13的内壁两侧均滑动嵌设有限制块10，且限制块10的外壁一侧中心处固定设置有安装管11，安装管11的外壁滑动套设有垃圾收集网，浮力筒2的横截面呈半圆状。通过推进器16，可以实现高效的行驶驱动，保证机器人的行动便捷性，通过稳定块17，可以降低水中的行驶阻力，通过减阻面14，可以进一步降低行驶阻力，通过限制块10和安装管11，可以将垃圾收集网进行安装固定，保证可以储存大量的水中垃圾。

[0036] 实施例三，参照图1到图10：一种基于机器识别的水上智能净化机器人，使用了根据权利要求1-9中任意一项的一种基于机器识别的水上智能净化机器人的使用方法，包括：步骤一、开机寻找垃圾、随后通过检测组件对设定要素进行检测，水质较差时，启动净化装置，对水源进行净化，步骤二、工作一段时间后，进入自检循环，判定电量，不足时直接返回岸边，电量充足时，检测是否失控，步骤三、确定失控后，释放无人机，通过人工干预返回岸边，没有失控则通过摄像头15对工作环境进行检测，检测大型垃圾或者落水人员，步骤四、返回岸边后，对电源和推进装置进行检修和维护。

[0037] 使用时，开机寻找垃圾、通过浮力筒2和加强架1，对设备进行安装，随后将推进器16启动，带动浮力筒2和加强架1开设运转，通过驱动装置，带动旋转架8旋转，使得收集架6和漏网9实现高效的水面垃圾收集，通过收集箱5和安装管11上的垃圾收集网进行储存，随

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后通过检测组件对设定要素进行检测，水质较差时，启动净化装置，对水源进行净化，工作一段时间后，进入自检循环，判定电量，不足时直接返回岸边，电量充足时，检测是否失控，确定失控后，释放无人机，通过人工干预返回岸边，没有失控则通过摄像头15对工作环境进行检测，检测大型垃圾或者落水人员，通过机械手7对大型垃圾和落水人员进行协助，返回岸边后，对蓄电池4和推进器16进行检修和维护，该机器人下水后，用遥控器开机，机器人自行识别垃圾、收集垃圾，并以一定频率与遥控器互通信号，确保机器人受控，一旦信号错误，表明机器人不再受控，立即释放无人机，岸边工作人员使用遥控器收回无人机，正常情况下，机器人在垃圾收满后返回岸边，当机器人发现较大体积垃圾，无法收集时，或者有人员落水时，立即驱动机械手7，对目标进行抓取，并释放无人机，岸边工作人员使用遥控器收回无人机，在收集过程中，实时检测水质，对水质较差水域，投放无污染，无害化学净化颗粒物进行水质净化。

[0038] 以上仅为本发明的较佳实施例而已，并不用以限制本发明，凡在本发明的精神和原则之内所作的任何修改、等同替换和改进等，均应包含在本发明的保护范围之内。

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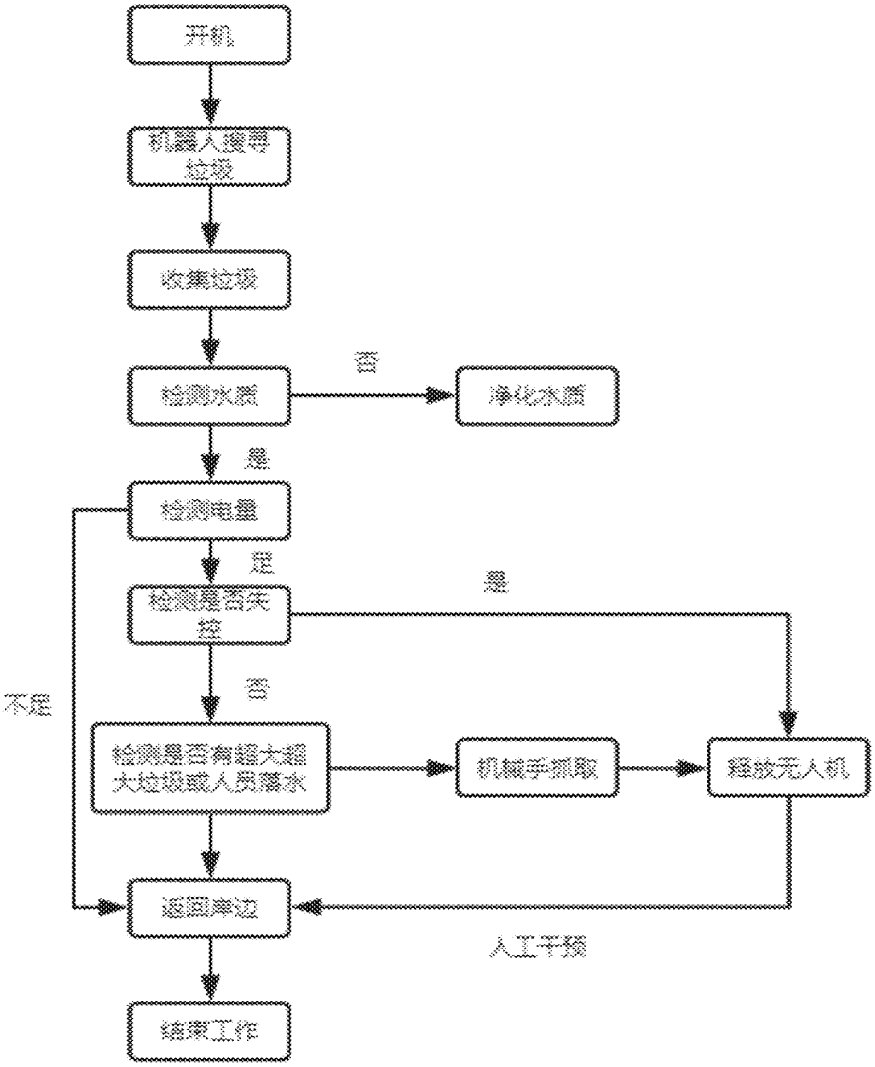


图1

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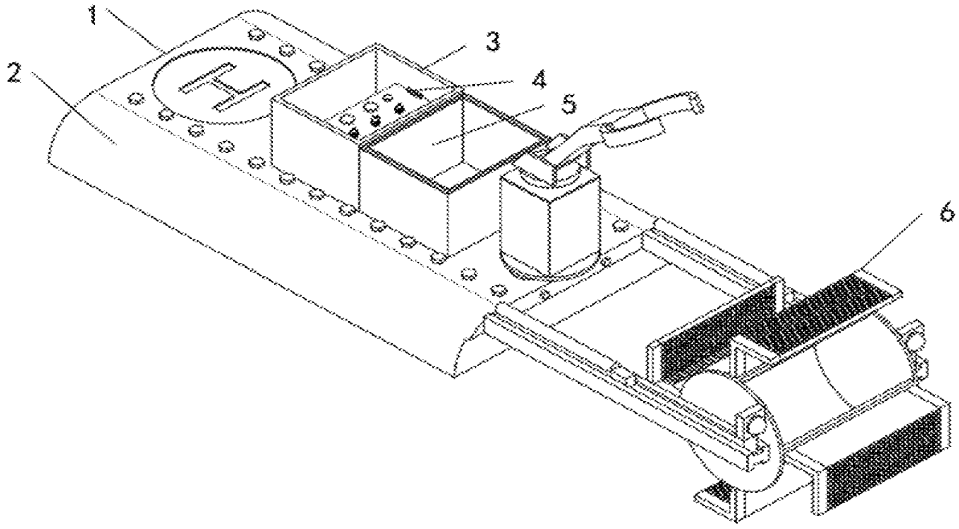


图2

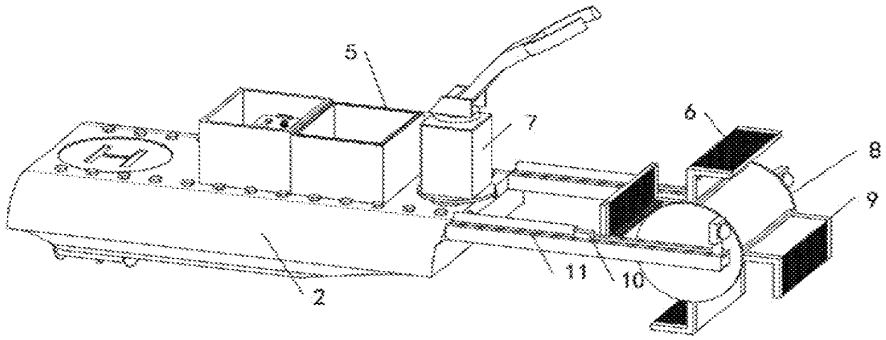


图3

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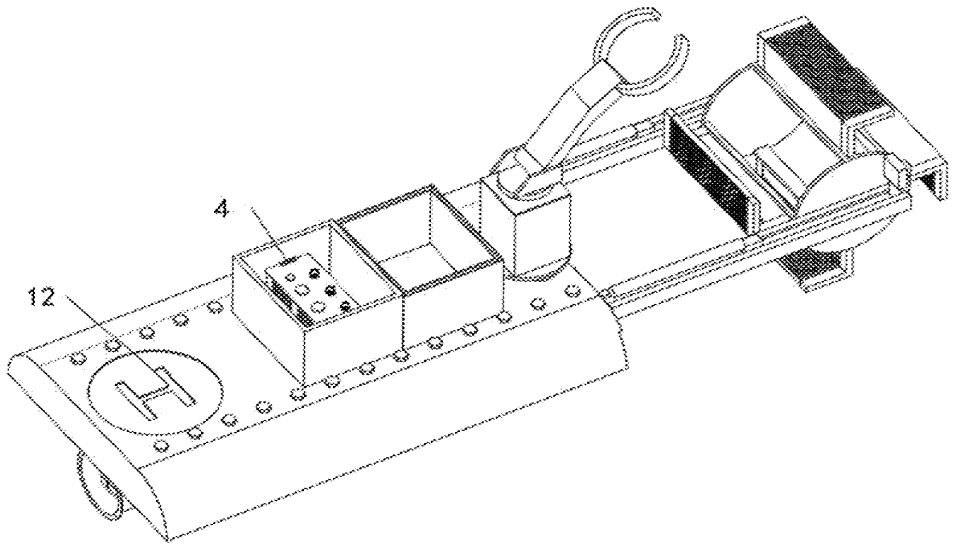


图4

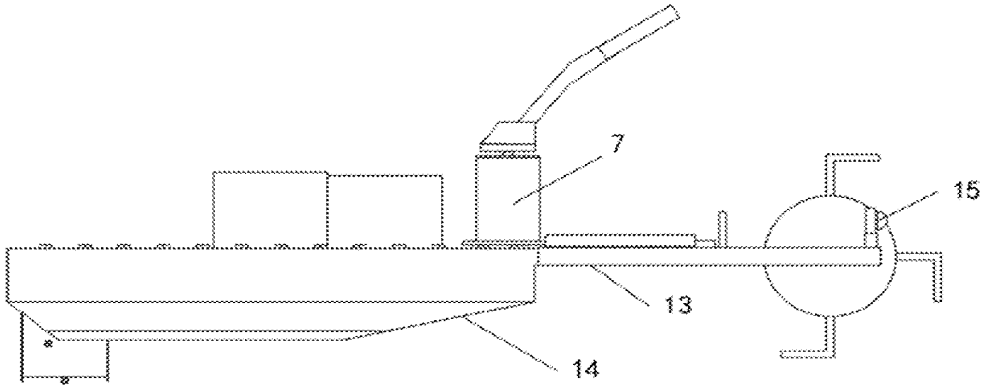


图5

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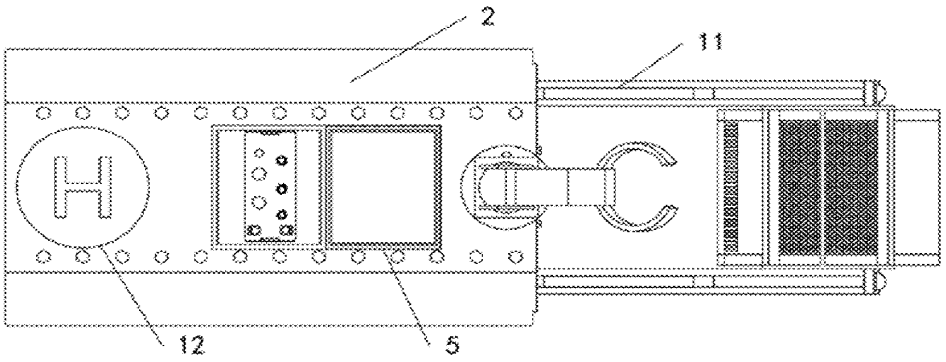


图6

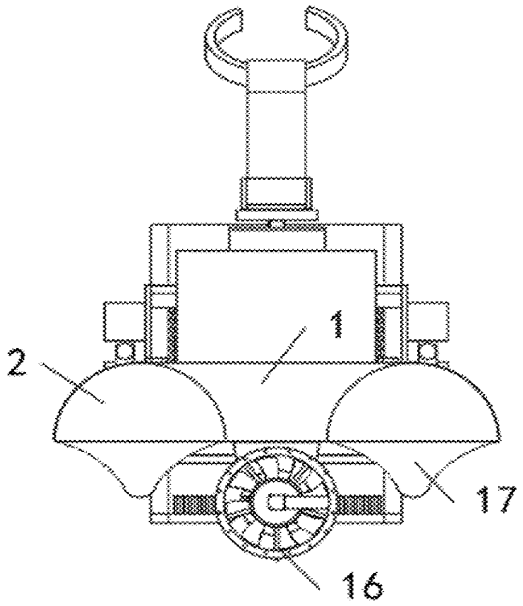


图7

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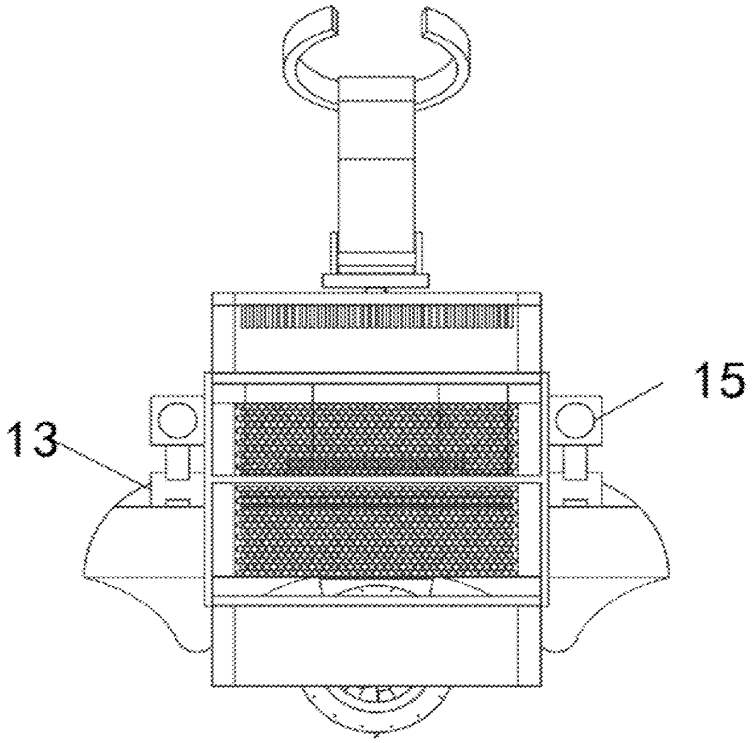


图8

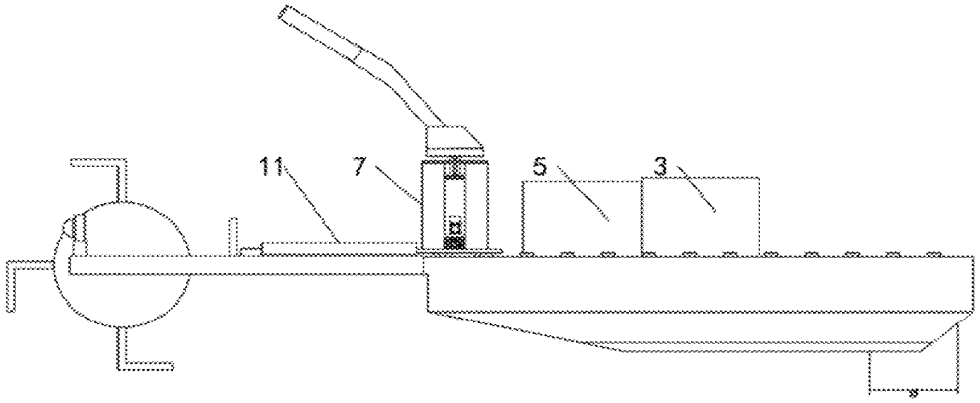


图9

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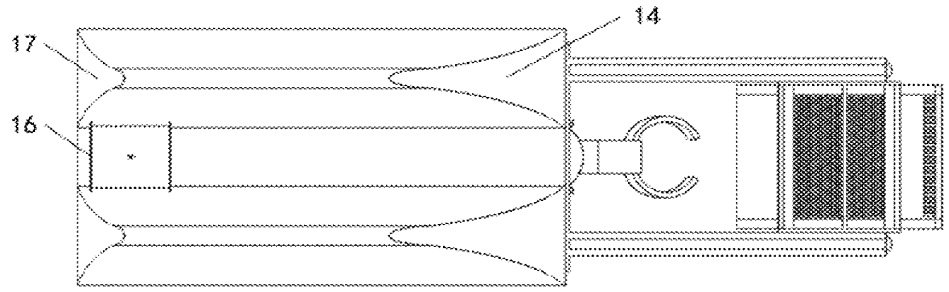


图10

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Espacenet

CN214996404U Novel swimming pool cleaning and rescuing device

Applicants: UNIV DALIAN JIAOTONG

Inventors: SHAN YANG,ZHANG TENG,LI YUANCHENG

Classifications:
IPC ***B63C9/00; E04H4/00; E04H4/14; E04H4/16;***

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Application: CN202121470797U·2021-06-30

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Published as: CN214996404U

Novel swimming pool cleaning and rescuing device

Abstract

The utility model discloses a novel swimming pool cleaning rescue device which comprises a main body device sealing shell, semi-hidden rescue handrails are fixedly connected to the two sides of the main body device sealing shell, an exhaust port is formed in one side of the top end of the main body device sealing shell, and a rescue alarm is fixedly installed on the other side of the top end of the main body device sealing shell. The novel swimming pool cleaning and rescuing device comprises a main body device sealing shell, a solar charging panel is fixedly mounted in the middle of the top end of the main body device sealing shell, and a mounting base is fixedly connected to the bottom of the inner wall of the main body device sealing shell. And meanwhile, if a person drowns in the swimming pool, the device can automatically sense the drowning action of the person, so that an alarm is given out, the semi-hidden rescue handrail extends out for rescue, and safety personnel are reminded to rescue the drowning person.

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(19) 中华人民共和国国家知识产权局

(12) 实用新型专利

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E04H 4/16 (2006.01)
E04H 4/14 (2006.01)
B63C 9/00 (2006.01)

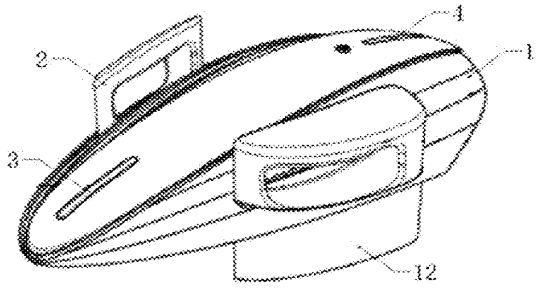
权利要求书1页 说明书3页 附图1页

(54) 实用新型名称

一种新型泳池清洁救援装置

(57) 摘要

本实用新型公开了一种新型泳池清洁救援装置，包括主体装置密封外壳，主体装置密封外壳的两侧均固定连接有半隐藏救援扶手，主体装置密封外壳顶端的一侧开设有排气口，主体装置密封外壳顶端的另一侧固定安装有救援警报器，主体装置密封外壳顶端的中部固定安装有太阳能充电板，主体装置密封外壳内壁的底部固定连接有安装底座，本实用新型一种新型泳池清洁救援装置，装置能够把小型垃圾、浮沫等污染物快速吸入到产品内部的过滤网中，对局部水质量进行一个清洁的作用，同时在泳池中假如有人溺水，装置能自动感应人溺水动作，从而发出警报并且伸出半隐藏救援扶手进行救援，提醒安全人员对溺水人员进行救援。



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1.一种新型泳池清洁救援装置，包括主体装置密封外壳(1)，其特征在于：所述主体装置密封外壳(1)的两侧均固定连接有半隐藏救援扶手(2)，所述主体装置密封外壳(1)顶端的一侧开设有排气口(3)，所述主体装置密封外壳(1)顶端的另一侧固定安装有救援警报器(4)，所述主体装置密封外壳(1)顶端的中部固定安装有太阳能充电板(5)，所述主体装置密封外壳(1)内壁的底部固定连接有安装底座(6)，所述安装底座(6)的顶部固定连接有垃圾收纳盒(7)，所述垃圾收纳盒(7)的顶部固定设置有清洁架体(8)，所述清洁架体(8)的顶部固定安装有风扇(9)，所述主体装置密封外壳(1)远离支撑柱(12)的一端开设有仿鱼鳃式进水口(10)。

2.根据权利要求1所述的一种新型泳池清洁救援装置，其特征在于：所述主体装置密封外壳(1)底端的一侧开设有多个出水口(11)。

3.根据权利要求1所述的一种新型泳池清洁救援装置，其特征在于：所述主体装置密封外壳(1)底端的另一侧固定连接有支撑柱(12)。

4.根据权利要求1所述的一种新型泳池清洁救援装置，其特征在于：所述主体装置密封外壳(1)内壁的顶部固定连接有挡板(13)。

5.根据权利要求1所述的一种新型泳池清洁救援装置，其特征在于：两个所述半隐藏救援扶手(2)的内部均开设有通槽。

6.根据权利要求1所述的一种新型泳池清洁救援装置，其特征在于：所述主体装置密封外壳(1)包括防锈层(101)和基层(102)，所述防锈层(101)的内侧固定连接有基层(102)。

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一种新型泳池清洁救援装置

技术领域

[0001] 本实用新型涉及泳池清洁救援技术领域，具体为一种新型泳池清洁救援装置。

背景技术

[0002] 现有的泳池清洁产品大多数不满足救援的一个功能，并且在对浮沫等污染物的感应上面延迟大，效率低，无法达到预期的一个清洁效果。

实用新型内容

[0003] 本实用新型的目的在于提供一种新型泳池清洁救援装置，以解决上述背景技术中提出的现有的泳池清洁产品大多数不满足救援的一个功能，并且在对浮沫等污染物的感应上面延迟大，效率低，无法达到预期的一个清洁效果的问题。

[0004] 为实现上述目的，本实用新型提供如下技术方案：一种新型泳池清洁救援装置，包括主体装置密封外壳，所述主体装置密封外壳的两侧均固定连接有半隐藏救援扶手，所述主体装置密封外壳顶端的一侧开设有排气口，所述主体装置密封外壳顶端的另一侧固定安装有救援警报器，所述主体装置密封外壳顶端的中部固定安装有太阳能充电板，所述主体装置密封外壳内壁的底部固定连接有安装底座，所述安装底座的顶部固定连接有垃圾收纳盒，所述垃圾收纳盒的顶部固定设置有清洁架体，所述清洁架体的顶部固定安装有风扇，所述主体装置密封外壳远离支撑柱的一端开设有仿鱼鳃式进水口。

[0005] 作为本实用新型的一种优选技术方案，所述主体装置密封外壳底端的一侧开设有多个出水口。

[0006] 作为本实用新型的一种优选技术方案，所述主体装置密封外壳底端的另一侧固定连接有支撑柱。

[0007] 作为本实用新型的一种优选技术方案，所述主体装置密封外壳内壁的顶部固定连接有挡板。

[0008] 作为本实用新型的一种优选技术方案，两个所述半隐藏救援扶手的内部均开设有通槽。

[0009] 作为本实用新型的一种优选技术方案，所述主体装置密封外壳包括防锈层和基层，所述防锈层的内侧固定连接有基层。

[0010] 与现有技术相比，本实用新型的有益效果是：装置能够把小型垃圾、浮沫等污染物快速吸入到产品内部的过滤网中，对局部水质量进行一个清洁的作用，同时在泳池中假如有人溺水，装置能自动感应人溺水动作，从而发出警报并且伸出半隐藏救援扶手进行救援，提醒安全人员对溺水人员进行救援。

附图说明

[0011] 图1为本实用新型的结构示意图；

[0012] 图2为本实用新型的主体装置密封外壳内部结构示意图；

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[0013] 图3为本实用新型的主体装置密封外壳结构示意图。

[0014] 图中：1、主体装置密封外壳；101、防锈层；102、基层；2、半隐藏救援扶手；3、排气口；4、救援警报器；5、太阳能充电板；6、安装底座；7、垃圾收纳盒；8、清洁架体；9、风扇；10、仿鱼鳃式进水口；11、出水口；12、支撑柱；13、挡板。

具体实施方式

[0015] 下面将结合本实用新型实施例中的附图，对本实用新型实施例中的技术方案进行清楚、完整地描述，显然，所描述的实施例仅仅是本实用新型一部分实施例，而不是全部的实施例。基于本实用新型中的实施例，本领域普通技术人员在没有做出创造性劳动前提下所获得的所有其他实施例，都属于本实用新型保护的范围。

[0016] 请参阅图1-3，本实用新型提供了一种新型泳池清洁救援装置，包括主体装置密封外壳1，主体装置密封外壳1的两侧均固定连接有半隐藏救援扶手2，主体装置密封外壳1顶端的一侧开设有排气口3，主体装置密封外壳1顶端的另一侧固定安装有救援警报器4，主体装置密封外壳1顶端的中部固定安装有太阳能充电板5，主体装置密封外壳1内壁的底部固定连接有安装底座6，安装底座6的顶部固定连接有垃圾收纳盒7，垃圾收纳盒7的顶部固定设置有清洁架体8，清洁架体8的顶部固定安装有风扇9，主体装置密封外壳1远离支撑柱12的一端开设有仿鱼鳃式进水口10。

[0017] 优选的，主体装置密封外壳1底端的一侧开设有多个出水口11，便于装置进行最后的出水工作。

[0018] 优选的，主体装置密封外壳1底端的另一侧固定连接有支撑柱12，清洁救援装置可以通过支撑柱12进行安装和固定工作。

[0019] 优选的，主体装置密封外壳1内壁的顶部固定连接有挡板13，挡板13可以将一部分的垃圾进行阻挡，这样便于风扇9和清洁架体8对垃圾进行收集和清理。

[0020] 优选的，两个半隐藏救援扶手2的内部均开设有通槽，便于溺水者用手拿住半隐藏救援扶手2。

[0021] 优选的，主体装置密封外壳1包括防锈层101和基层102，防锈层101的内侧固定连接有基层102，防锈层101由不锈钢制成，基层102聚乙烯制成，使得主体装置密封外壳1具有防锈性，长时间主体装置密封外壳1泡在水中不容易生锈。

[0022] 具体使用时，本实用新型一种新型泳池清洁救援装置，当感应到水中污染物之后，该产品能够快速移动到污染物处，利用气压原理，此时内部的风扇9会产生强大的吸力，把小型垃圾、浮沫等污染物快速吸入到产品内部的过滤网中，对局部水质量进行一个清洁的作用，然后经过二层过滤网过滤，清理产生的垃圾将会自动收纳进入垃圾收纳盒7，过滤完成的泳池水通过产品底部进行排出，如此往返，能够对整个泳池都进行比较全面的清洁消毒，同时在泳池中假如有人溺水，装置能自动感应人溺水动作，从而发出警报并且伸出半隐藏救援扶手2进行救援，提醒安全人员对溺水人员进行救援。工作完成后将有专门工作人员对垃圾收纳盒7中的垃圾处理以及进行充电保养，主体装置密封外壳1包括防锈层101和基层102，防锈层101的内侧固定连接有基层102，防锈层101由不锈钢制成，基层102聚乙烯制成，使得主体装置密封外壳1具有防锈性，长时间主体装置密封外壳1泡在水中不容易生锈。

[0023] 尽管参照前述实施例对本实用新型进行了详细的说明，对于本领域的技术人员来

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说，其依然可以对前述各实施例所记载的技术方案进行修改，或者对其中部分技术特征进行等同替换，凡在本实用新型的精神和原则之内，所做的任何修改、等同替换、改进等，均应包含在本实用新型的保护范围之内。

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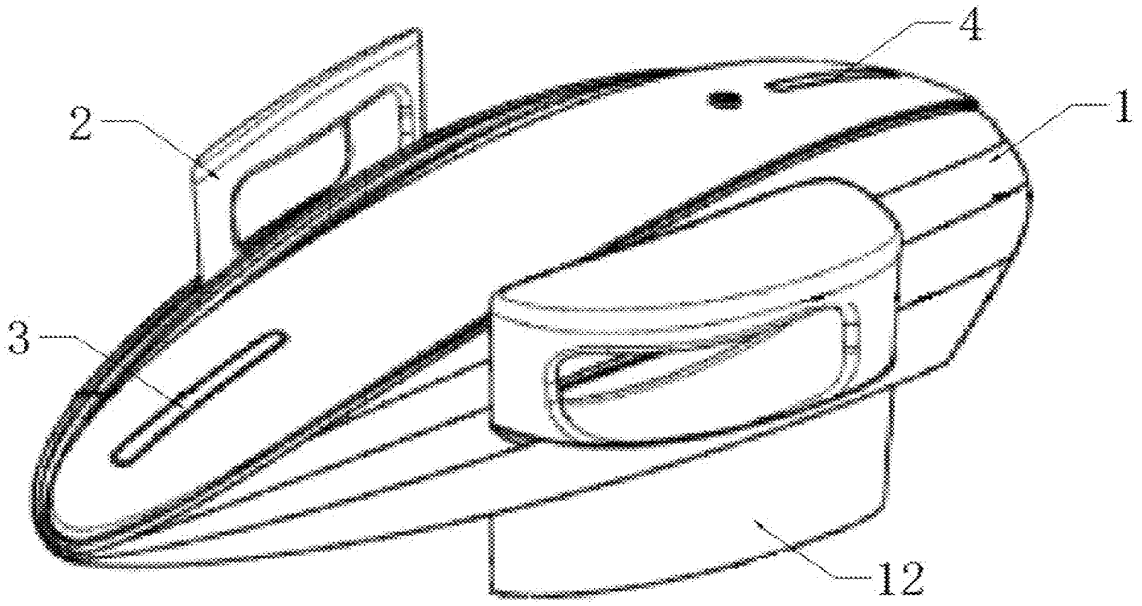


图1

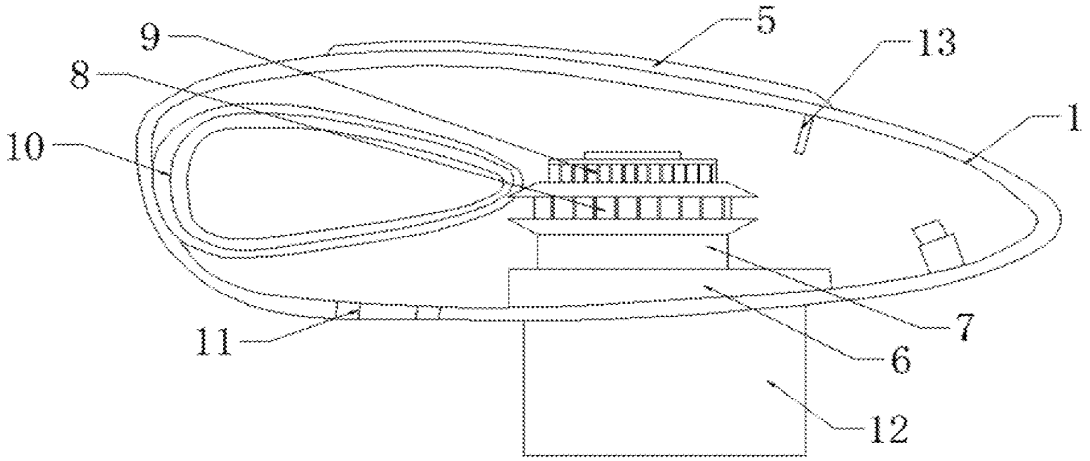


图2

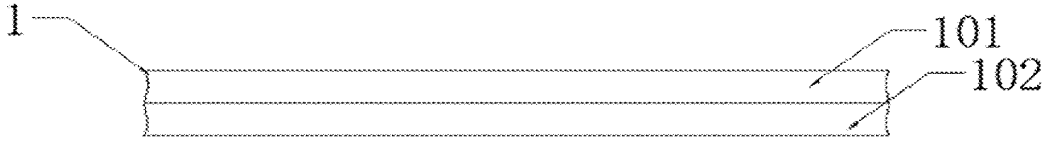


图3

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APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
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Title of Invention

POOL ROBOT CONTROL METHOD AND APPARATUS, STORAGE MEDIUM, AND POOL ROBOT

Application Information

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CONFIRMATION #	7873	FILED BY	Wanying Li
PATENT CENTER #	73719084	FILING DATE	09/28/2025
CUSTOMER #	204084	FIRST NAMED INVENTOR	Shilei ZHANG
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	-

Documents

TOTAL DOCUMENTS: 5

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
FOR1_19342629.pdf	57	Foreign Reference	3691 KB
FOR2_19342629.pdf	142	Foreign Reference	7834 KB
NPL1_19342629.pdf	11	Non Patent Literature	501 KB
NPL2_19342629.pdf	20	Non Patent Literature	1110 KB
2025-12-22_ids_19342629.pdf	6	Information Disclosure Statement (IDS) Form (SB08)	1318 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
FOR1_19342629.pdf	73B8C56AF5095FC1E2361E91088526D02955462C59809D7882

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Espacenet

CN113653020A Full-water-layer intelligent cleaning robot and cleaning method

Applicants: NAT UNIV DEFENSE TECHNOLOGY PLA

Inventors: ZHONG YUXUAN,ZHANG ZHONGTIAN,CHEN ZIHANG,GONG ZHENYU,LI YANG,YUAN QILU,WANG XIN,ZHANG YU

Classifications:
IPC ***E02B15/10;***

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Full-water-layer intelligent cleaning robot and cleaning method

Abstract

The invention relates to a full-water-layer intelligent cleaning robot and a cleaning method. The full-water-layer intelligent cleaning robot comprises a robot body (1), a supporting unit (2) installed on the robot body (1), power units (3) installed on the supporting unit (2) and at least one cleaning assembly (4). In the vertical direction, hanging mechanisms (5) are correspondingly arranged on the upper side and the lower side of the supporting unit (2), and the cleaning assembly (4) is selectively and detachably connected with the hanging mechanisms (5) on any side of the supporting unit (2). In the horizontal direction, the power units (3) are correspondingly arranged on the left side and the right side of the supporting unit (2) and used for driving the robot body (1) to move in the vertical direction and/or the horizontal direction. The full-water-layer intelligent cleaning robot can perform operation in working environments of water layers such as water surface, water and water bottom, and can quickly and efficiently perform water body cleaning work.

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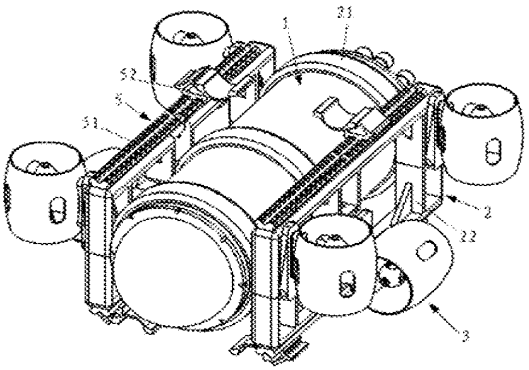
权利要求书4页 说明书12页 附图9页

(54) 发明名称

一种全水层智能清洁机器人及清洁方法

(57) 摘要

本发明涉及一种全水层智能清洁机器人及清洁方法，全水层智能清洁机器人，包括：机器人主体(1)，安装在所述机器人主体(1)上的支承单元(2)，安装在所述支承单元(2)上的动力单元(3)，至少一种清洁组件(4)；沿竖直方向，所述支承单元(2)的上下两侧分别设置有挂载机构(5)，所述清洁组件(4)可选择的与所述支承单元(2)任一侧的所述挂载机构(5)可拆卸地的连接；沿水平方向，所述动力单元(3)在所述支承单元(2)的左右两侧分别设置，用于驱动所述机器人主体(1)在竖直方向和/或水平方向移动。本发明可在包括水面，水中和水底等各个水层的工作环境下执行作业，可快速高效的进行水体清洁工作。



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1.一种全水层智能清洁机器人，其特征在于，包括：机器人主体(1)，安装在所述机器人主体(1)上的支承单元(2)，安装在所述支承单元(2)上的动力单元(3)，至少一种清洁组件(4)；

沿竖直方向，所述支承单元(2)的上下两侧分别设置有挂载机构(5)，所述清洁组件(4)可选择的与所述支承单元(2)任一侧的所述挂载机构(5)可拆卸地的连接；

沿水平方向，所述动力单元(3)在所述支承单元(2)的左右两侧分别设置，用于驱动所述机器人主体(1)在竖直方向和/或水平方向移动。

2.根据权利要求1所述的全水层智能清洁机器人，其特征在于，所述挂载机构(5)包括：两对共四个分别置于所述机器人主体(1)上下两侧的相互平行的支承导轨(51)，与所述支承导轨(51)滑动连接的滑块组件(52)；

每个所述支承导轨(51)上可拆卸地设置至少一个所述滑块组件(52)；

沿所述支承导轨(51)的长度方向，在所述支承导轨(51)上阵列设置有多个定位槽(511)；

所述滑块组件(52)包括：用于与所述支承导轨(51)相互配合的咬合连接部(521)，设置在所述咬合连接部(521)的限位件(522)，以及固定连接在所述咬合连接部(521)上且用于固定所述清洁组件(4)的固定连接部(523)；

所述限位件(522)与所述咬合连接部(521)可拆卸地连接，用于限制所述咬合连接部(521)与所述支承导轨(51)的连接位置。

3.根据权利要求2所述的全水层智能清洁机器人，其特征在于，所述支承单元(2)包括：主体连接件(21)，以及设置在所述主体连接件(21)相对两侧的支撑框架(22)；

所述动力单元(3)安装在所述支撑框架(22)远离所述主体连接件(21)的一侧；

所述挂载机构(5)的支承导轨(51)固定安装在所述支撑框架(22)的上下两侧。

4.根据权利要求3所述的全水层智能清洁机器人，其特征在于，所述机器人主体(1)包括：防水舱(11)，设置在所述防水舱(11)内的内置支架(12)，以及安装在所述内置支架(12)上的电控单元(13)；

所述支承单元(2)的主体连接件(21)套设在所述防水舱(11)的外侧，所述支承单元(2)的支撑框架(22)在所述防水舱(11)的相对两侧平行设置。

5.根据权利要求3或4所述的全水层智能清洁机器人，其特征在于，所述防水舱(11)包括：筒体(111)，设置在所述筒体(111)一端的前罩(112)，设置在所述筒体(111)另一端且用于连接所述电控单元(13)、所述动力单元(3)和所述清洁组件(4)的电连接面板(113)；

所述筒体(111)和所述前罩(112)均采用透明亚克力材质制成；

所述内置支架(12)为中空的筒状体；

沿所述内置支架(12)的轴向，在所述内置支架(12)的侧壁上设置有两个开口凹槽(121)；

沿所述内置支架(12)的轴向，所述开口凹槽(121)分别以所述内置支架(12)的端部起始且向相互靠近的方向延伸；

所述内置支架(12)上还设置有支撑组件(122)，且所述支撑组件(122)与所述开口凹槽(121)相对应的在所述内置支架(12)的端部设置；

所述电连接面板(113)上设置有用于控制所述全水层智能清洁机器人启停的控制开关

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(1131)、多个电连接端口(1132),以及用于检测所述防水舱(11)气密性的有气密性检测头(1133)。

6.根据权利要求5所述的全水层智能清洁机器人,其特征在于,所述电控单元(13)包括:单片机主板,舵机(131),安装在所述舵机(131)上的全景摄像头(132),陀螺仪(133),深度及温度传感器(134),电源(135);

所述舵机(131)和所述全景摄像头(132)设置在所述内置支架(12)的支撑组件(122)上侧,且所述全景摄像头(132)与所述防水舱(11)的前罩(112)相邻设置;

所述舵机(131)可驱动所述全景摄像头(132)自由转动;

所述陀螺仪(133),所述深度及温度传感器(134)固定支撑在所述内置支架(12)的支撑组件(122)上侧,且所述陀螺仪(133),所述深度及温度传感器(134)与所述防水舱(11)的电连接面板(113)相邻设置;

所述单片机主板包括:用于控制所述全水层智能清洁机器人执行目标识别和清洁作业的目标跟随模块,用于控制所述全水层智能清洁机器人在无可识别目标状态下自主执行清洁作业的自由探索模块;

所述电源(135)固定支撑在所述支撑组件(122)的下侧,且所述电源(135)为可充电电源;

所述电源(135)采用在所述防水舱(11)内布置太阳能电板进行充电或者通过所述电连接面板(113)上的电连接端口连接外部供电。

7.根据权利要求6所述的全水层智能清洁机器人,其特征在于,所述清洁组件(4)具有四种,分别为水面清洁装置(41),水中清洁装置(42),用于封闭水域的第一水底清洁装置(43),以及用于开放水域或管道的第二水底清洁装置(44);

所述水面清洁装置(41)包括:第一泵体(411),与所述第一泵体(411)入口相连接的第一收集管(412),与所述泵体(411)出口相连接的收集装置,以及设置于所述泵体(411)上用于与所述支承单元(2)相连接的第一挂载结构(413);

所述收集装置可挂载在所述支承单元(2)上,或者设置于地面上;

所述水中清洁装置(42)包括:第二泵体(421),与所述第二泵体(421)入口相连接的第一储污盒(422),与所述第一储污盒(422)相连接的第二收集管(423),以及设置于所述泵体(411)上用于与所述支承单元(2)相连接的第二挂载结构(424);

所述第一储污盒(422)与所述第二泵体(421)入口之间设置有过滤网;

所述第一储污盒(422)具有至少一个空腔,且在所述第一储污盒(422)的部分或全部空腔内填充有活性炭;

所述第一水底清洁装置(43)包括:第三泵体(431),与所述第三泵体(431)入口相连接支撑管路(432),与所述支撑管路(432)相连接的第二储污盒(433),与所述第二储污盒(433)相连接的安全刮片(434),以及设置于所述泵体(431)上用于与所述支承单元(2)相连接的第三挂载结构(435);

所述支撑管路(432)与所述第三泵体(431)相连接的位置之间设置有过滤网;

所述安全刮片(434)所述第二储污盒(433)相连接的位置设置有用于与所述第二储污盒(433)相连通的刮片开口(434a);

所述安全刮片(434)采用硬质橡胶或弹性树脂材质制成;

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所述第二水底清洁装置(44)包括:可相互靠近或远离的平行夹爪(441),用于控制所述平行夹爪(441)相对运动的驱动组件,以及用于与所述支承单元(2)相连接的第四挂载结构(442)。

8.一种采用权利要求1至7任一项所述的全水层智能清洁机器人的清洁方法,包括:

S1.确定清洁作业区域及目标任务需求,选择相应的清洁组件(4)并安装在所述支承单元(2)上,并将所述清洁组件(4)与机器人主体(1)上的电连接面板(113)电连接;

S2.对所述机器人主体(1)的气密性进行检测,若所述机器人主体(1)的气密性满足要求则,执行步骤S3;

S3.开启所述电连接面板(113)上的控制开关(1131),并将所述全水层智能清洁机器人切换至相应的工作模式,待所述全水层智能清洁机器人重置且自定义记录初始参数后,将其整体平稳放入水中;其中,所述工作模式包括:水域巡检模式和管道巡检模式;

S4.所述全水层智能清洁机器人基于所述机器人主体(1)的电控单元(13)自主开展清洁。

9.根据权利要求8所述的清洁方法,其特征在于,步骤S4中,所述全水层智能清洁机器人基于所述机器人主体(1)的电控单元(13)自主开展清洁的步骤中,根据识别出的目标进行污物分类并根据所述目标的污物分类结果确定相应的运行速度执行清洁作业,包括:

S41.采集所述目标的目标物图像;

S42.将所述目标物图像的背景干扰及噪点过滤掉并进行图像分割生成目标物子图;

S43.将各个目标物子图的RGB图像分别转化为LAB色彩模型与HSI色彩模型,并将颜色分量的平均值作为颜色特征值;其中,将各个目标物子图的RGB图像转化为LAB色彩模型时,将RGB颜色空间转换到XYZ颜色空间,之后再把XYZ颜色空间转换到LAB颜色空间;

S44.将所述颜色特征值输入预先完成训练的机器学习分类模型,得到各个所述目标的污物分类结果,根据所述污物分类结果确定相应的运行速度执行清洁作业;其中,所述机器学习分类模型在预先的训练过程中建立了各类型污物的颜色特征值和各类型污物分类结果之间的映射;

所述机器学习分类模型为SVM分类器,其通过以下步骤训练获得,包括:

S01.采集所述目标的目标物图像构建训练集和测试集,并分别为所述训练集和所述测试集附加标签;

S02.利用所述训练集及其标签并采用遗传算法对所述SVM分类器进行参数寻优确定RBF核函数中的c惩罚参数和g核函数参数,用于将在低维空间线性不可分的所述训练集中的数据通过所述RBF核函数c映射到高维的特征空间变成线性可分;

S03.根据寻优确定的所述RBF核函数的c惩罚参数和g核函数参数,利用所述训练集及其标签对所述SVM分类器进行训练,然后利用所述测试集测试所述SVM分类器的分类结果的标准率,如果所述标准率满足要求则完成所述SVM分类器的训练生成所述机器学习分类模型,否则继续执行步骤S01至步骤S03直至所述标准率满足要求。

10.根据权利要求9所述的清洁方法,其特征在于,步骤S4中,所述全水层智能清洁机器人基于所述机器人主体(1)的电控单元(13)自主开展清洁的步骤中,若所述全水层智能清洁机器人执行水下管道巡检作业,则包括:

S001.获取所述电控单元(13)采集的目标物图像;

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S002.先对所述目标物图像进行高斯模糊和降噪处理；

S003.对处理后的所述目标物图像进行腐蚀与膨胀处理，得到拟合图形，将所述拟合图形与附着物外形做比较，鉴别是否为需要处理的垃圾；其中，所述全水层智能清洁机器人通过矩形图像的拟合，获得所巡检的管道的中心线以及偏移角，并基于所述中心线和所述偏移角的数据进行管道巡检。

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一种全水层智能清洁机器人及清洁方法

技术领域

[0001] 本发明涉及特种机器人领域，尤其涉及一种全水层智能清洁机器人及清洁方法。

背景技术

[0002] 随着工业的迅速发展，水体污染都愈发严重，而人们对水体质量的要求又在不断提高。但是人工清洁耗时耗力，且常常无法达到预期的清洁效果，一些复杂水域人力无法到达。尤其是公共水域环境由于长期处于无人值守状态，更难以实时进行清理保障，容易发生众多状况，影响其正常自然状态或使用保障。因此，水层清理是目标前进行水域维护的主要工作之一。

[0003] 目前，室内水域的清扫需要将水域排空进行清扫，人力物力消耗较大，工作量累积严重，无法实时高效清理。对于开放水域，则需要人工着水服进行作业或使用打捞船，作业难度高、工作量繁重且危险系数高。此外，由于在水域中存在水面、水中、水底不同位置均有不同程度、不同类型的污染物，进而通过简单的人工清理并不能达到全面的清理效果。

[0004] 针对上述情况，现在市面上也出现了一些进行水体清洁的机器人，但这些机器人具有自主性不高和应用局限，仅能完成特定的任务，适用范围小。

发明内容

[0005] 本发明的目的在于提供一种全水层智能清洁机器人及清洁方法，解决适用范围小的问题。

[0006] 为实现上述发明目的，本发明提供一种全水层智能清洁机器人，包括：机器人主体，安装在所述机器人主体上的支承单元，安装在所述支承单元上的动力单元，至少一种清洁组件；

[0007] 沿竖直方向，所述支承单元的上下两侧分别设置有挂载机构，所述清洁组件可选择的与所述支承单元任一侧的所述挂载机构可拆卸地的连接；

[0008] 沿水平方向，所述动力单元在所述支承单元的左右两侧分别设置，用于驱动所述机器人主体在竖直方向和/或水平方向移动。

[0009] 根据本发明的一个方面，所述挂载机构包括：两对共四个分别置于机器人主体上下两侧的相互平行的支承导轨，与所述支承导轨滑动连接的滑块组件；

[0010] 每个所述支承导轨上可拆卸地设置至少一个所述滑块组件；

[0011] 沿所述支承导轨的长度方向，在所述支承导轨上阵列设置有多个定位槽；

[0012] 所述滑块组件包括：用于与所述支承导轨相互配合的咬合连接部，设置在所述咬合连接部的限位件，以及固定连接在所述咬合连接部上且用于固定所述清洁组件的固定连接部；

[0013] 所述限位件与所述咬合连接部可拆卸地连接，用于限制所述咬合连接部与所述支承导轨的连接位置。

[0014] 根据本发明的一个方面，所述支承单元包括：主体连接件，以及设置在所述主体连

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接件相对两侧的支撑框架；

[0015] 所述动力单元安装在所述支撑框架远离所述主体连接件的一侧；

[0016] 所述挂载机构的支承导轨固定安装在所述支撑框架的上下两侧。

[0017] 根据本发明的一个方面，所述机器人主体包括：防水舱，设置在所述防水舱内的内置支架，以及安装在所述内置支架上的电控单元；

[0018] 所述支承单元的主体连接件套设在所述防水舱的外侧，所述支承单元的支撑框架在所述防水舱的相对两侧平行设置。

[0019] 根据本发明的一个方面，所述防水舱包括：筒体，设置在所述筒体一端的前罩，设置在所述筒体另一端且用于连接所述电控单元、所述动力单元和所述清洁组件的电连接面板；

[0020] 所述筒体和所述前罩均采用透明亚克力材质制成；

[0021] 所述内置支架为中空的筒状体；

[0022] 沿所述内置支架的轴向，在所述内置支架的侧壁上设置有两个开口凹槽；

[0023] 沿所述内置支架的轴向，所述开口凹槽分别以所述内置支架的端部起始且向相互靠近的方向延伸；

[0024] 所述内置支架上还设置有支撑组件，且所述支撑组件与所述开口凹槽相对应的在所述内置支架的端部设置；

[0025] 所述电连接面板上设置有用于控制所述全水层智能清洁机器人启停的控制开关、多个电连接端口，以及用于检测所述防水舱气密性的有气密性检测头。

[0026] 根据本发明的一个方面，所述电控单元包括：单片机主板，舵机，安装在所述舵机上的全景摄像头，陀螺仪，深度及温度传感器，电源；

[0027] 所述舵机和所述全景摄像头设置在所述内置支架的支撑组件上侧，且所述全景摄像头与所述防水舱的前罩相邻设置；

[0028] 所述舵机可驱动所述全景摄像头自由转动；

[0029] 所述陀螺仪，所述深度及温度传感器固定支撑在所述内置支架的支撑组件上侧，且所述陀螺仪，所述深度及温度传感器与所述防水舱的电连接面板相邻设置；

[0030] 所述单片机主板包括：用于控制所述全水层智能清洁机器人执行目标识别和清洁作业的目标跟随模块，用于控制所述全水层智能清洁机器人在无可识别目标状态下自主执行清洁作业的自由探索模块；

[0031] 所述电源固定支撑在所述支撑组件的下侧，且所述电源为可充电电源；

[0032] 所述电源采用在所述防水舱内布置太阳能电板进行充电或者通过所述电连接面板上的电连接端口连接外部供电。

[0033] 根据本发明的一个方面，所述清洁组件具有四种，分别为水面清洁装置，水中清洁装置，用于封闭水域的第一水底清洁装置，以及用于开放水域或管道的第二水底清洁装置；

[0034] 所述水面清洁装置包括：第一泵体，与所述第一泵体入口相连接的第一收集管，与所述泵体出口相连接的收集装置，以及设置于所述泵体上用于与所述支承单元相连接的第一挂载结构；

[0035] 所述收集装置可挂载在所述支承单元上，或者设置于地面上；

[0036] 所述水中清洁装置包括：第二泵体，与所述第二泵体入口相连接的第一储污盒，与

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所述第一储污盒相连接的第二收集管，以及设置于所述泵体上用于与所述支承单元相连接的第二挂载结构；

[0037] 所述第一储污盒与所述第二泵体入口之间设置有过滤网；

[0038] 所述第一储污盒具有至少一个空腔，且在所述第一储污盒的部分或全部空腔内填充有活性炭；

[0039] 所述第一水底清洁装置包括：第三泵体，与所述第三泵体入口相连接支撑管路，与所述支撑管路相连接的第二储污盒，与所述第二储污盒相连接的安全刮片，以及设置于所述泵体上用于与所述支承单元相连接的第三挂载结构；

[0040] 所述支撑管路与所述第三泵体相连接的位置之间设置有过滤网；

[0041] 所述安全刮片所述第二储污盒相连接的位置设置有用于与所述第二储污盒相连通的刮片开口；

[0042] 所述安全刮片采用硬质橡胶或弹性树脂材质制成；

[0043] 所述第二水底清洁装置包括：可相互靠近或远离的抓取工作部平行放置的平行夹爪，用于控制所述抓取工作部平行放置平行夹爪相对运动的驱动组件，以及用于与所述支承单元相连接的第四挂载结构。

[0044] 为实现上述发明目的，本发明提供一种采用前述全水层智能清洁机器人的清洁方法，包括：

[0045] S1.确定清洁作业区域及目标任务需求，选择相应的清洁组件并安装在所述支承单元上，并将所述清洁组件与机器人主体上的电连接面板电连接；

[0046] S2.对所述机器人主体的气密性进行检测，若所述机器人主体的气密性满足要求则，执行步骤S3；

[0047] S3.开启所述电连接面板上的控制开关，并将所述全水层智能清洁机器人切换至相应的工作模式，待所述全水层智能清洁机器人重置且自定义记录初始参数后，将其整体平稳放入水中；其中，所述工作模式包括：水域巡检模式和管道巡检模式；

[0048] S4.所述全水层智能清洁机器人基于所述机器人主体的电控单元自主开展清洁。

[0049] 根据本发明的一个方面，步骤S4中，所述全水层智能清洁机器人基于所述机器人主体的电控单元自主开展清洁的步骤中，根据识别出的目标进行污物分类并根据所述目标的污物分类结果确定相应的运行速度执行清洁作业，包括：

[0050] S41.采集所述目标的目标物图像；

[0051] S42.将所述目标物图像的背景干扰及噪点过滤掉并进行图像分割生成目标物子图；

[0052] S43.将各个目标物子图的RGB图像分别转化为LAB色彩模型与HSI色彩模型，并将颜色分量的平均值作为颜色特征值；其中，将各个目标物子图的RGB图像转化为LAB色彩模型时，将RGB颜色空间转换到XYZ颜色空间，之后再把XYZ颜色空间转换到LAB颜色空间；

[0053] S44.将所述颜色特征值输入预先完成训练的机器学习分类模型，得到各个所述目标的污物分类结果，根据所述污物分类结果确定相应的运行速度执行清洁作业；其中，所述机器学习分类模型在预先的训练过程中建立了各类型污物的颜色特征值和各类型污物分类结果之间的映射；

[0054] 所述机器学习分类模型为SVM分类器，其通过以下步骤训练获得，包括：

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[0055] S01.采集所述目标的目标物图像构建训练集和测试集，并分别为所述训练集和所述测试集附加标签；

[0056] S02.利用所述训练集及其标签并采用遗传算法对所述SVM分类器进行参数寻优确定RBF核函数中的c惩罚参数和g核函数参数，用于将在低维空间线性不可分的所述训练集中的数据通过所述RBF核函数c映射到高维的特征空间变成线性可分；

[0057] S03.根据寻优确定的所述RBF核函数的c惩罚参数和g核函数参数，利用所述训练集及其标签对所述SVM分类器进行训练，然后利用所述测试集测试所述SVM分类器的分类结果的标准率，如果所述标准率满足要求则完成所述SVM分类器的训练生成所述机器学习分类模型，否则继续执行步骤S01至步骤S03直至所述标准率满足要求。

[0058] 根据本发明的一个方面，步骤S4中，所述全水层智能清洁机器人基于所述机器人主体的电控单元自主开展清洁的步骤中，若所述全水层智能清洁机器人执行水下管道巡检作业，则包括：

[0059] S001.获取所述电控单元采集的目标物图像；

[0060] S002.先对所述目标物图像进行高斯模糊和降噪处理；

[0061] S003.对处理后的所述目标物图像进行腐蚀与膨胀处理，得到拟合图形，将所述拟合图形与附着物外形做比较，鉴别是否为需要处理的垃圾；其中，所述全水层智能清洁机器人通过矩形图像的拟合，获得所巡检的管道的中心线以及偏移角，并基于所述中心线和所述偏移角的数据进行管道巡检。

[0062] 根据本发明的一种方案，本发明的机器人具有轻质灵活、可完成全水层清洁任务、耗能低等的优点，而且还可实现全自主运行的智能水层清洁，极大的解决了水体清洁的任务。此外，机器人结构小巧、功能多样、续航能力强，操作灵活，具有广阔的应用前景。

[0063] 根据本发明的一种方案，可在包括水面，水中和水底等各个水层的工作环境下执行作业，可快速高效的进行水体清洁工作。

[0064] 根据本发明的一种方案，本发明的机器人具有实施成本低、作业效率高、安全可靠的优点，同时，本发明的机器人还具有自主搜索目标物、自主探索未知水域的能力。

[0065] 根据本发明的一种方案，可其通过不同的清洁模块，完成水面油污吸除，水中杂质、漂浮物过滤、水底清洁等功能，达到了便捷、灵活、高效的水体清洁效果。

[0066] 根据本发明的一种方案，本发明的机器人外部有不同的接口，可根据不同的工作环境加不同的外设，如配有特制的机械臂与视觉系统来抓取水面上及水中的垃圾，还可装配活性炭盒进行水中等悬浊物的清理，也可利用螺旋桨加压潜入水底，配合刮片、滚轴等外挂的清理器来清除附着在水底的杂物。

[0067] 根据本发明的一种方案，本发明的机器人可以实现对水下管道，泳池，或是开放水域的全方面清理，完全不需人的控制，且动力单元能够实现在不同方位的驱动，使机器人能够自如灵活的在水下运动，实现无死角清洁。

[0068] 根据本发明的一种方案，本发明的机器人所采用的原材料绿色环保，主体结构部件均使用可回收可降解的塑料制成，即使在机器人报废后也不会对环境造成污染。

[0069] 根据本发明的一种方案，本发明的机器人在具备全水层清洁与自动识别能力的同时，其还可通过不同的外设工具，实现对不同种类污染物的有效处理。

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附图说明

[0070] 图1是示意性表示根据本发明的一种实施方式的全水层智能清洁机器人的结构图；

[0071] 图2是示意性表示根据本发明的一种实施方式的全水层智能清洁机器人的俯视图；

[0072] 图3是示意性表示根据本发明的一种实施方式的支承单元的结构图；

[0073] 图4是示意性表示根据本发明的一种实施方式的动力单元在支撑框架上的分布结构图；

[0074] 图5是示意性表示根据本发明的一种实施方式的主体连接件的结构图；

[0075] 图6是示意性表示根据本发明的一种实施方式的支撑框架的结构图；

[0076] 图7是示意性表示根据本发明的一种实施方式的竖直挂件的结构图；

[0077] 图8是示意性表示根据本发明的一种实施方式的水平挂件的结构图；

[0078] 图9是示意性表示根据本发明的一种实施方式的支承导轨与支撑框架的安装结构图；

[0079] 图10是示意性表示根据本发明的一种实施方式的挂载机构的结构图；

[0080] 图11是示意性表示根据本发明的一种实施方式的电控单元的结构图；

[0081] 图12是示意性表示根据本发明的一种实施方式的防水舱的结构图；

[0082] 图13是示意性表示根据本发明的一种实施方式的电连接面板的结构图；

[0083] 图14是示意性表示根据本发明的一种实施方式的内置支架的结构图；

[0084] 图15是示意性表示根据本发明的一种实施方式的水面清洁装置的结构图；

[0085] 图16是示意性表示根据本发明的一种实施方式的水中清洁装置的结构图；

[0086] 图17是示意性表示根据本发明的一种实施方式的第一水底清洁装置的结构图；

[0087] 图18是示意性表示根据本发明的一种实施方式的第二水底清洁装置的结构图；

[0088] 图19是示意性表示根据本发明的一种实施方式的全水层智能清洁机器人沿管路的巡视图。

具体实施方式

[0089] 为了更清楚地说明本发明实施方式或现有技术中的技术方案，下面将对实施方式中所需要使用的附图作简单地介绍。显而易见地，下面描述中的附图仅仅是本发明的一些实施方式，对于本领域普通技术人员而言，在不付出创造性劳动的前提下，还可以根据这些附图获得其他的附图。

[0090] 在针对本发明的实施方式进行描述时，术语“纵向”、“横向”、“上”、“下”、“前”、“后”、“左”、“右”、“竖直”、“水平”、“顶”、“底”、“内”、“外”所表达的方位或位置关系是基于相关附图所示的方位或位置关系，其仅是为了便于描述本发明和简化描述，而不是指示或暗示所指的装置或元件必须具有特定的方位、以特定的方位构造和操作，因此上述术语不能理解为对本发明的限制。

[0091] 下面结合附图和具体实施方式对本发明作详细地描述，实施方式不能在此一一赘述，但本发明的实施方式并不因此限定于以下实施方式。

[0092] 结合图1和图2所示，根据本发明的一种实施方式，本发明的一种全水层智能清洁

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机器人，包括：机器人主体1，安装在主体1上的支承单元2，安装在支承单元2上的动力单元3，至少一种清洁组件4。在本实施方式中，沿竖直方向，支承单元2的上下两侧分别设置有挂载机构5，清洁组件4可选择的与支承单元2任一侧的挂载机构5可拆卸地的连接。在本实施方式中，沿水平方向，动力单元3在支承单元2的左右两侧分别设置，用于驱动机器人主体1在竖直方向和/或水平方向移动。

[0093] 结合图1和图2所示，根据本发明的一种实施方式，动力单元3为多个螺旋桨推进结构构成。在本实施方式中，动力单元3在整个全水层智能清洁机器人上设置有六个螺旋桨推进结构，其中，四个动力单元3在全水层智能清洁机器人的周围对称分布用于实现全水层智能清洁机器人在竖直方向的运动，两个动力单元3在全水层智能清洁机器人的周围对称分布用于实现全水层智能清洁机器人在水平方向的运动。需要注意的是，动力单元3可根据实际需要进行相应的设置，例如，增加或减少螺旋桨推进结构的数量，调整各螺旋桨推进结构的分布位置，或者采用其他结构提供动力。

[0094] 在本实施方式中，螺旋桨推进结构圆筒状外保护壳轴向长度为75mm，圆筒状外保护壳筒口径为62mm，工作电压为6～12V。

[0095] 结合图1、图2、图3和图4所示，根据本发明的一种实施方式，支承单元2包括：主体连接件21，以及设置在主体连接件21相对两侧的支撑框架22。在本实施方式中，动力单元3安装在支撑框架22远离主体连接件21的一侧；挂载机构5的支承导轨51固定安装在支撑框架22的上下两侧。在本实施方式中，可根据支撑框架22的长度间隔的设置多个主体连接件21，以实现其在机器人主体1上的稳定固定，不仅结构简单且连接牢固。

[0096] 结合图3和图5所示，根据本发明的一种实施方式，主体连接件21包括：第一连接部分211和第二连接部分212。第一连接部分211和第二连接部分212的端部可相互连接用于实现与机器人主体1的固定。在本实施方式中，第一连接部分211和第二连接部分212的形状可根据机器人主体1的外形相对应的设置，以实现其与机器人主体1的稳定固定。例如，机器人主体1外形呈圆柱状，则将第一连接部分211和第二连接部分212的形状分别设置为圆弧状，通过端部固定形成与机器人主体1外形相适配的圆环。

[0097] 结合图3、图4、图6、图7和图8所示，根据本发明的一种实施方式，支撑框架22为整体呈矩形的框架结构，在支撑框架22上设置有用于安装主体连接件21的安装连接部22a，第一连接部分211和第二连接部分212的端部分别通过与该安装连接部22a的连接实现整个支承单元2与机器人主体1的固定连接。在本实施方式中，动力单元3中的多个螺旋桨推进结构通过竖直挂件和水平挂件分别挂在支撑框架22上。参见图4、图6、图7和图8所示，竖直挂件与支撑框架22上处于前后位置的安装连接部22a分别对应设置，进而螺旋桨推进结构可通过该竖直挂件竖直的挂载到支撑框架22上。水平挂件与支撑框架22上处于中间位置的安装连接部22a对应设置，进而螺旋桨推进结构可通过该水平挂件水平的挂载到支撑框架22上。

[0098] 在本实施方式中，支撑框架22采用ABS材料3D打印制成，具有较强的抗冲击性能，保证了机器人在复杂水域的稳定性和可靠性。

[0099] 结合图1、图2、图9和图10所示，根据本发明的一种实施方式，挂载机构5包括：两对共四个分别置于机器人主体上下两侧的相互平行的支承导轨51，与支承导轨51滑动连接的滑块组件52。在本实施方式中，每个支承导轨51上可拆卸地设置至少一个滑块组件52；沿支承导轨51的长度方向，在支承导轨51上阵列设置有多个定位槽511。在本实施方式中，滑块

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组件52包括：用于与支承导轨51相互配合的咬合连接部521，设置在咬合连接部521的限位件522，以及固定连接在咬合连接部521上且用于固定清洁组件4的固定连接部523；在固定连接部523上设置有用于安装清洁组件4的固定承载结构，在本实施方式中，固定连接部523上的固定承载结构为两端敞开的弧面凹槽。当然，固定连接部523上的固定承载结构还可以设置为其他形状，可根据实际需要进行选择。在本实施方式中，限位件522与咬合连接部521可拆卸地连接，用于限制咬合连接部521与支承导轨51的连接位置。在本实施方式中，支承导轨51为皮卡汀尼导轨。在本实施方式中，支承导轨51采用不锈钢制成，其长度为140mm，宽度为20mm，厚度为10mm。

[0100] 根据本发明，通过采用上述设置的支承导轨51可用于灵活安装不同的外部结构，不仅固定连接结构简单，便于操作，而且还极大的减少了更换机器人外设固定和拆卸的工作量。此外，通过上述设置的支承导轨51其耐腐蚀且强度高，有效的提高了其在水中的使用寿命。

[0101] 结合图1和图11所示，根据本发明的一种实施方式，机器人主体1包括：防水舱11，设置在防水舱11内的内置支架12，以及安装在内置支架12上的电控单元13。在本实施方式中，支承单元2的主体连接件21套设在防水舱11的外侧，支承单元2的支撑框架22在防水舱11的相对两侧平行设置。

[0102] 结合图1、图11和图12所示，根据本发明的一种实施方式，防水舱11包括：筒体111，设置在筒体111一端的前罩112，设置在筒体111另一端且用于连接电控单元13、动力单元3和清洁组件4的电连接面板113。在本实施方式中，筒体111和前罩112均采用透明亚克力材质制成，且其表面均采用抛光处理，提高了透明度，保证了内置摄像头的视野清晰；同时实验规避了屈光度影响，确定了内置摄像头放置位置，减少了图像提取的变形度。在本实施方式中，防水舱11由亚克力材质圆筒制成，圆筒轴向长度为250mm，圆筒外径尺寸为130mm，圆筒内径尺寸为120mm。

[0103] 在本实施方式中，内置支架12为中空的筒状体；沿内置支架12的轴向，在内置支架12的侧壁上设置有两个开口凹槽121；沿内置支架12的轴向，开口凹槽121分别以内置支架12的端部起始且向相互靠近的方向延伸。在本实施方式中，内置支架12上还设置有支撑组件122，且支撑组件122与开口凹槽121相对应的在内置支架12的端部设置。在本实施方式中，内置支架12采用PLA材料，以3D打印为主要工艺，在保证强度的前提下，极大程度的减小了体积和重量，并有效的减少了内置支架12开裂的可能。

[0104] 如图14所示，在本实施方式中，电连接面板113上设置有用于控制全水层智能清洁机器人启停的控制开关1131、多个电连接端口1132，以及用于检测防水舱11气密性的有气密性检测头1133。其中，部分电连接端口1132用于与动力单元3相连接，动力单元3中的螺旋桨推进结构与电连接面板113上的电连接端口1132一一对应连接。此外，剩余电连接端口1132还用于与清洁组件4相连接作为通信和通电的端口，以及作为备用接口。

[0105] 如图1所示，根据本发明的一种实施方式，电控单元13包括：单片机主板，舵机131，全景摄像头132，陀螺仪133，深度及温度传感器134，电源135。在本实施方式中，全景摄像头132安装在舵机131上，且舵机131可驱动全景摄像头132自由转动。舵机131和全景摄像头132相连接后固定支撑在内置支架12的支撑组件122上侧，且舵机131和全景摄像头132与防水舱11的前罩112相邻设置，以实现全景摄像头132具有最有的拍摄视野。在本实施方式中，

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全景摄像头132为OV5647型号的摄像头，具有500W像素的全景广角，并且在舵机131的作用下其视角可达到200度，有效的提高了机器人的清洁和搜寻效率。

[0106] 在本实施方式中，陀螺仪133，深度及温度传感器134固定支撑在内置支架12的支撑组件122上侧，且陀螺仪133，深度及温度传感器134与防水舱11的电连接面板113相邻设置，用于实现与电连接面板113上的电连接端口1132相连接。在本实施方式中，陀螺仪133可采用Mpu6050六轴陀螺仪，以数字输出6轴的旋转矩阵、四元数、欧拉角格式的融合演算数据。通过输出数据判断此时机器人的姿态维持自稳和姿态调整。在本实施方式中，深度及温度传感器134可采用MS5837型号深度、温度传感器，接上电即输出当前所处环境的压力和温度，通过数据处理，将压力通过公式(如淡水的密度，重力加速度)计算出此时距水面的深度，并把深度和温度一起传到单片机主板上。

[0107] 在本实施方式中，单片机主板包括：用于控制全水层智能清洁机器人执行目标识别和清洁作业的目标跟随模块，用于控制全水层智能清洁机器人在无可识别目标状态下自主执行清洁作业的自由探索模块；在本实施方式中，单片机主板采用STM32F407型号的系列板，其提供了工作频率为168MHz的CortexTM-M4内核(具有浮点单元)的性能，能够在满足基础运动器件的基础上，留有足够的引脚来控制附加的外设，提高了机器人的兼容性。

[0108] 在本实施方式中，电源135固定支撑在支撑组件122的下侧，且电源135为可充电电源。在本实施方式中，电源135采用在防水舱11内布置太阳能电板进行充电或者通过电连接面板113上的电连接端口连接外部供电。在本实施方式中，电源135采用12V电压的锂电池。通过变压电路可转变为不同模块的工作电压，减少了多余冗杂结构，在降低了成本的同时，也提高了机器人的工作时长。

[0109] 根据本发明的一种实施方式，电控单元13还可通过无线或有线的方式将生成的数据传输智远程终端，供操作人员实时掌握机器人的各项运行数据及机器人的具体位置。

[0110] 如图16、图17、图18和图19所示，根据本发明的一种实施方式，清洁组件4具有四种，分别为水面清洁装置41，水中清洁装置42，用于封闭水域(如游泳池、染料池)的第一水底清洁装置43，以及用于开放水域(如公园水塘、河道)或管道的第二水底清洁装置44。

[0111] 参见图16所示，在本实施方式中，水面清洁装置41包括：第一泵体411，与第一泵体411入口相连接的第一收集管412，与泵体411出口相连接的收集装置，以及设置于泵体411上用于与支承单元2相连接的第一挂载结构413。在本实施方式中，第一收集管412是一个向上弯曲的管路，进而机器人装载该水面清洁装置41后，其可通过上浮至第一收集管412端部与水面接近或相平的位置即可对水面上的污物进行清除，实现相连接的收集装置的储存。

[0112] 在本实施方式中，第一挂载结构413具有两个挂载部413a，其设置数量与挂载机构5的固定连接部523相对应的设置。在本实施方式中，挂载部413a中具有柱状主体413a1和在柱状主体413a1相对两端设置的挂载盘413a2。其中，柱状主体413a1的外表面与固定连接部523的内表面相匹配，且柱状主体413a1的长度与固定连接部523相匹配，进而实现柱状主体413a1相对两端的挂载盘413a2可于固定连接部523的侧面相接触实现嵌合的限位夹紧作用。当然还可通过其他夹紧结构实现第一挂载结构413与固定连接部523的限位连接固定，在此不再赘述。

[0113] 在本实施方式中，收集装置可挂载在支承单元2上，或者通过延长的管路设置于地面上。

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[0114] 通过上述设置的水面清洁装置41，其第一泵体411可选用强力泵以实现对水面上漂浮的油污等优化物质进行收集并送至收集装置中储存，而当作业面积大时可通过延长管路的方式送至地面上的收集装置，增加实时作业效率。

[0115] 如图17所示，根据本发明的一种实施方式，水中清洁装置42包括：第二泵体421，与第二泵体421入口相连接的第一储污盒422，与第一储污盒422相连接的第二收集管423，以及设置于第二泵体421上用于与支承单元2相连接的第二挂载结构424。在本实施方式中，第二挂载结构424具有两个挂载部424a，其设置数量与挂载机构5的固定连接部523相对应的设置。在本实施方式中，挂载部424a中具有柱状主体424a1和在柱状主体424a1相对两端设置的挂载盘424a2。其中，柱状主体424a1的外表面与固定连接部523的内表面相匹配，且柱状主体424a1的长度与固定连接部523相匹配，进而实现柱状主体424a1相对两端的挂载盘424a2可于固定连接部523的侧面相接触实现嵌合的限位夹紧作用。当然还可通过其他夹紧结构实现第二挂载结构424与固定连接部523的限位连接固定，在此不再赘述。

[0116] 在本实施方式中，第一储污盒422与第二泵体421入口之间设置有过滤网。

[0117] 在本实施方式中，第一储污盒422具有至少一个空腔，且在第一储污盒422的部分或全部空腔内填充有活性炭。例如，第一储污盒422盒内设置有并排的三个平行的矩形空腔，位于中间的空腔称为动力室，两侧的空腔称为净化室，两侧的净化室内填充有活性炭，而中部的动力室与第二泵体421入口相连，提供一定的吸力，使得水流自第一储物盒422外侧流向动力室，以此方式使得水流穿过外侧活性炭，对水中色素、油渍、絮尘等污染物进行吸附清除。工作于游泳池、染料池等环境时，对水中悬浊物进行实时吸附清除，防止淤积。水中清洁装置42的运行通过机器人尾部的电连接板113上的电连接接口连接提供信号及电源。

[0118] 如图18所示，根据本发明的一种实施方式，第一水底清洁装置43包括：第三泵体431，与第三泵体431入口相连接支撑管路432，与支撑管路432相连接的第二储污盒433，与第二储污盒433相连接的安全刮片434，以及设置于第三泵体431上用于与支承单元2相连接的第三挂载结构435；在本实施方式中，第三挂载结构435具有两个挂载部435a，其设置数量与挂载机构5的固定连接部523相对应的设置。在本实施方式中，挂载部435a中具有柱状主体435a1和在柱状主体435a1相对两端设置的挂载盘435a2。其中，柱状主体435a1的外表面与固定连接部523的内表面相匹配，且柱状主体435a1的长度与固定连接部523相匹配，进而实现柱状主体435a1相对两端的挂载盘435a2可于固定连接部523的侧面相接触实现嵌合的限位夹紧作用。当然还可通过其他夹紧结构实现第三挂载结构435与固定连接部523的限位连接固定，在此不再赘述。

[0119] 在本实施方式中，支撑管路432与第三泵体431相连接的位置之间设置有过滤网；

[0120] 在本实施方式中，安全刮片434与第二储污盒433相连接的位置设置有用于与第二储污盒433相连通的刮片开口434a；其中，安全刮片434采用硬质橡胶或弹性树脂材质制成；在本实施方式中，安全刮片434包括：刮片部4341、护片部4342；护片部4342在刮片部4341相对的两端设置，且护片部4342与刮片部4341之间是具有夹角的倾斜设置。刮片开口434a设置在刮片部4341上，以实现污物向第二储污盒433输送。在本实施方式中，刮片部4341可通过管路与第二储污盒433相连，也可以直接与第二储污盒433相连。

[0121] 在本实施方式中，刮片部4341主要用于对平整的水底进行附着物的刮除，经后部

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的第三泵体431吸入第二储污盒433实现吸收过滤。

[0122] 如图19所示，根据本发明的一种实施方式，第二水底清洁装置44包括：可相互靠近或远离的平行夹爪441(该平行夹爪441的抓取工作部平行放置)，用于控制平行夹爪441相对运动(该平行夹爪441的抓取工作部平行移动)的驱动组件，以及用于与支承单元2相连接的第四挂载结构442。在本实施方式中，平行夹爪441为平行爪结构，驱动组件为舵机结构。其中，通过机械结构将舵机旋转运动转换为平行夹爪441的相对运动，以实现物体的夹取和释放。在本实施方式中，第四挂载结构442具有至少一个挂载部，其设置数量可根据安装需要进行相应设置。在本实施方式中，挂载部中具有柱状主体和在柱状主体442a1相对两端设置的挂载盘。其中，柱状主体的外表面与固定连接部523的内表面相匹配，且柱状主体的长度与固定连接部523相匹配，进而实现柱状主体相对两端的挂载盘可于固定连接部523的侧面相接触实现嵌合的限位夹紧作用。当然还可通过其他夹紧结构实现第四挂载结构442与固定连接部523的限位连接固定，在此不再赘述。

[0123] 在本实施方式中，第二水底清洁装置44中的平行夹爪441可根据需要通过3D打印获得并进行更换。

[0124] 根据上述设置的第二水底清洁装置44通过平行运动实现物体的夹取有利于稳定抓取目标。当工作于水下管道环境时，针对管道上附着物进行抓取；工作与开放水域如公园池塘环境时，针对水中、水面垃圾进行抓取。通过机器人尾部的电连接面板113上的电连接接口连接提供信号及电源。

[0125] 如图1所示，根据本发明的一种实施方式，本发明的一种采用前述全水层智能清洁机器人的清洁方法，包括：

[0126] S1.确定清洁作业区域及目标任务需求，选择相应的清洁组件4并安装在支承单元2上，并将清洁组件4与机器人主体1上的电连接面板113电连接；

[0127] S2.对机器人主体1的气密性进行检测，若机器人主体1的气密性满足要求则，执行步骤S3；

[0128] S3.开启电连接面板113上的控制开关1131，并将全水层智能清洁机器人切换至相应的工作模式，待全水层智能清洁机器人重置且自定义记录初始参数后，将其整体平稳放入水中；其中，工作模式包括：水域巡检模式和管道巡检模式；

[0129] S4.全水层智能清洁机器人基于机器人主体1的电控单元13自主开展清洁。

[0130] 根据本发明的一种实施方式，步骤S1中，选定所需要的清洁组件4后，根据清洁组件4上挂载结构(如第一挂载结构413、第二挂载结构424等)中的挂载部的数量选择在挂载机构5上设置的滑块组件52的数量，将滑块组件52与清洁组件4上挂载结构相连接，然后通过滑块组件52上的咬合连接部521插入至支承导轨51上，调整合适位置后通过固定限位件522将其在支承导轨51上的位置进行固定。在本实施方式中，固定限位件522可采用螺栓或其他结构所实现。

[0131] 在本实施方式中，在完成清洁组件4在挂载机构5上位置固定的情况下，通过机器人尾部的电连接板113上的相应电连接端口1132与该清洁组件4相连接，以实现机器人主体1对清洁组件4的控制

[0132] 根据本发明的一种实施方式，步骤S2中，对机器人主体1的气密性进行检测的步骤中，通过配套设置的气密性检测工具所实现。在本实施方式中，将安装在电连接面板113上

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的气密性检测头1133旋拧开启，插入气密性检测工具中的抽气枪，将机器人主体1内部的空气抽出。而在抽气枪尾部连接有一水封罐，待内部空气抽尽后，观察水封罐，若15-30分钟后，水封罐内水位线没有超过3mm的变化，则可认为机器人主体1气密性支持下水工作。

[0133] 根据本发明的一种实施方式，步骤S3中，开启电连接面板113上的控制开关1131，并将全水层智能清洁机器人切换至相应的工作模式，观察动力单元3是否正常运行，观察电控单元13中的舵机131是否正常运行，以及观察全景摄像头132回传图像是否正常，完毕即可由机器人自主开展后续工作。然后，待全水层智能清洁机器人重置且自定义记录初始参数后，将其整体平稳放入水中；其中，工作模式包括：水域巡检模式和管道巡检模式。

[0134] 根据本发明的一种实施方式，步骤S4中，全水层智能清洁机器人基于机器人主体1的电控单元13自主开展清洁的步骤中，其通过目标跟随模块内置的目标跟随算法执行目标识别和清洁作业，然后通过自由探索模块内置的内生激励探索算法进行自主的在目标水域内探索不同区域并结合目标识别自主进行。在本实施方式中，在执行目标识别的过程中，通过电控单元13中的舵机131驱动全景摄像头132在事视野范围内进行图像采集，然后对采集的图像进行处理，若识别到目标(即垃圾)，则全景摄像头132跟随目标，同时驱动机器人靠近，进行抓取动作。若当前位置无可识别目标，则依据内生激励探索算法，机器人前往下一目标位置，重复以上过程。

[0135] 如图1所示，根据本发明的一种实施方式，步骤S4中，全水层智能清洁机器人基于机器人主体1的电控单元13自主开展清洁的步骤中，根据识别出的目标进行污物分类并根据目标的污物分类结果确定相应的运行速度执行清洁作业，包括：

[0136] S41.采集目标的目标物图像；

[0137] S42.将目标物图像的背景干扰及噪点过滤掉并进行图像分割生成目标物子图；

[0138] S43.将各个目标物子图的RGB图像分别转化为LAB色彩模型与HSI色彩模型，并将颜色分量的平均值作为颜色特征值；其中，将各个目标物子图的RGB图像转化为LAB色彩模型时，将RGB颜色空间转换到XYZ颜色空间，之后再把XYZ颜色空间转换到LAB颜色空间；

[0139] S44.将颜色特征值输入预先完成训练的机器学习分类模型，得到各个目标的污物分类结果，根据污物分类结果确定相应的运行速度执行清洁作业；其中，机器学习分类模型在预先的训练过程中建立了各类型污物的颜色特征值和各类型污物分类结果之间的映射。

[0140] 在本实施方式中，机器学习分类模型为SVM分类器，其通过以下步骤训练获得，包括：

[0141] S01.采集目标的目标物图像构建训练集和测试集，并分别为训练集和测试集附加标签；

[0142] S02.利用训练集及其标签并采用遗传算法对SVM分类器进行参数寻优确定RBF核函数中的c惩罚参数和g核函数参数，用于将在低维空间线性不可分的训练集中的数据通过RBF核函数c映射到高维的特征空间变成线性可分；其中，采用遗传算法对SVM分类器进行参数寻优确定RBF核函数c惩罚参数和g核函数参数的步骤包括：(1)准备样本数据；(2)遗传算法内部参数初始化；(3)产生参数对，使用交叉验证，在训练集上搜寻适应度最佳的参数；(4)使用最优参数，重新训练，根据训练结果，生成机器自主评判预测模型。根据工作反馈，得到评判向量，将其带入机器自主评判预测模型，得到支持向量机的预测模型，且机器根据计算结果进行下一步工作；

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[0143] S03.根据寻优确定的RBF核函数的c惩罚参数和g核函数参数，利用训练集及其标签对SVM分类器进行训练，然后利用测试集测试SVM分类器的分类结果的标准率，如果标准率满足要求则完成SVM分类器的训练生成机器学习分类模型，否则继续执行步骤S01至步骤S03直至标准率满足要求。

[0144] 在本实施方式中，机器学习分类模型可进行五个等级污物分类的识别。其中在训练SVM分类器的过程中需要采集5种污物等级不同的目标物图像信息，并分别对其图像进行标定，用均值滤波将灰尘等造成的背景干扰及噪点过滤掉，进行图像分割后进行训练。

[0145] 如图19所示，根据本发明的一种实施方式，步骤S4中，全水层智能清洁机器人基于机器人主体1的电控单元13自主开展清洁的步骤中，若全水层智能清洁机器人执行水下管道巡检作业，则包括：

[0146] S001.获取电控单元13采集的目标物图像；其中，opencv提供了能够应用于此项目识别工作的函数库，采用opencv库中特定库函数对目标图像进行形态学的处理，然后进行判断。

[0147] S002.先对目标物图像进行高斯模糊和降噪处理；

[0148] S003.对处理后的目标物图像进行腐蚀与膨胀处理，得到拟合图形，将拟合图形反馈至电控单元13中的处理器，与前期内置的基本类的附着物外形做比较，根据图像拟合程度鉴别是否为需要处理的垃圾；其中，执行巡检判断管路的工作时，全景摄像头转动至其中轴线与水平面呈约45°向下的方向，此时机器人可获取当前管道图像以及部分前方视野；进而机器人预先根据目标管道的材质、颜色选定特征值，对前方视野采集图像，转换灰度图像并在获取灰度值后与内置信息进行比对，处理并反馈管道位置信息。在本实施方式中，基于反馈的管道位置信息获取管道外形图像，全水层智能清洁机器人通过矩形图像的拟合，获得所巡检的管道的中心线以及偏移角，并基于中心线和偏移角的数据进行管道巡检。

[0149] 上述内容仅为本发明的具体方案的例子，对于其中未详尽描述的设备和结构，应当理解为采取本领域已有的通用设备及通用方法来予以实施。

[0150] 以上所述仅为本发明的一个方案而已，并不用于限制本发明，对于本领域的技术人员来说，本发明可以有各种更改和变化。凡在本发明的精神和原则之内，所作的任何修改、等同替换、改进等，均应包含在本发明的保护范围之内。

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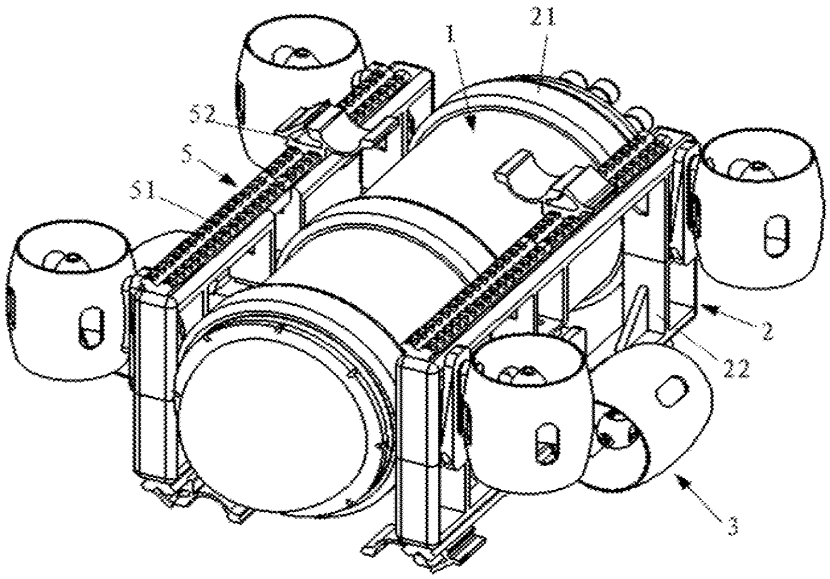


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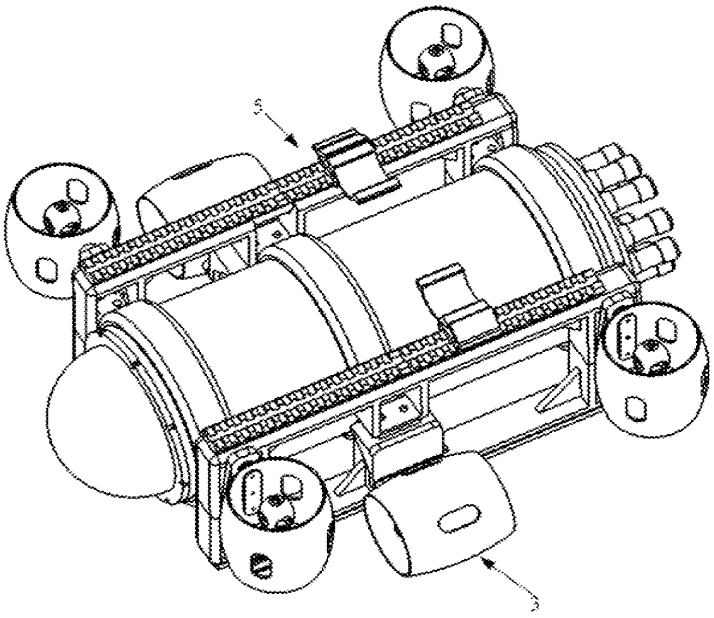


图2

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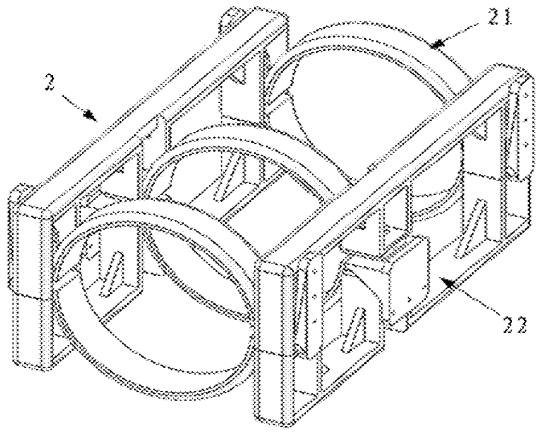


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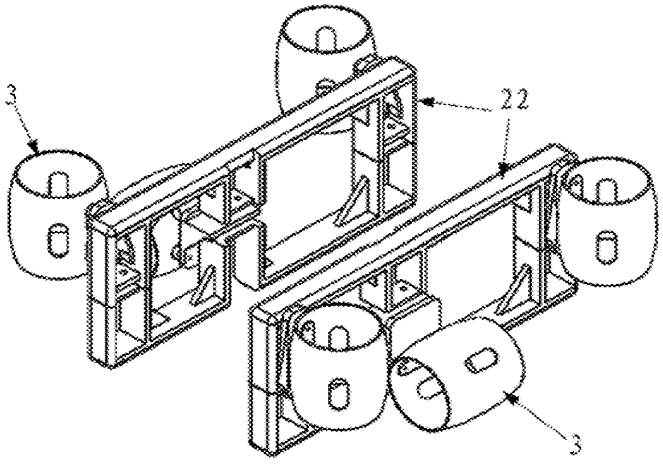


图4

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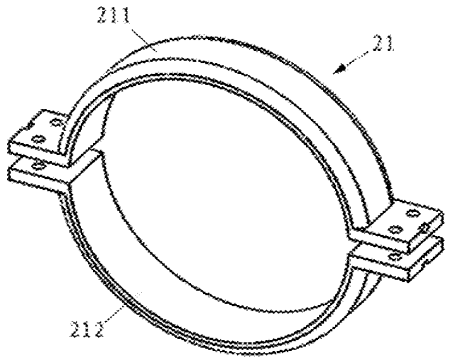


图5

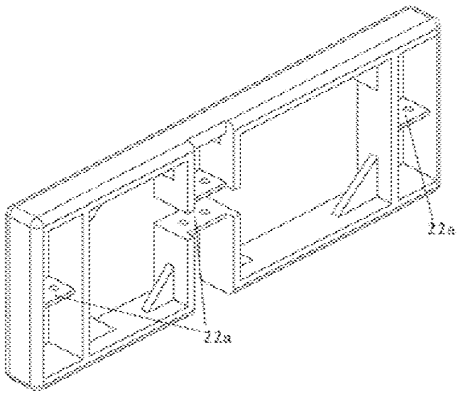


图6

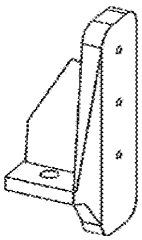


图7

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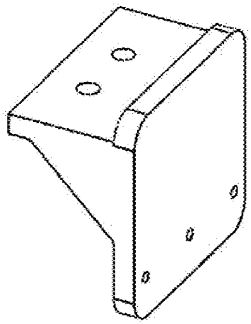


图8

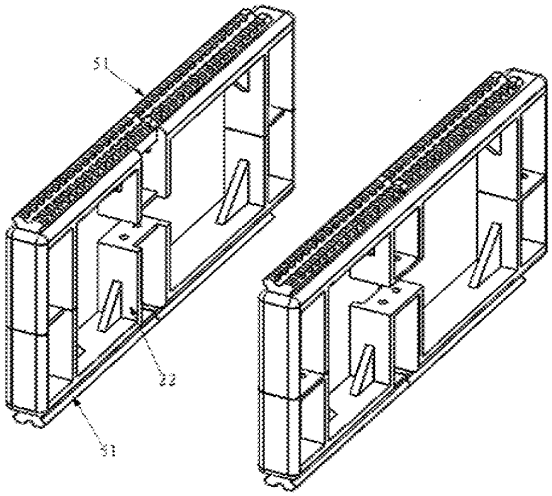


图9

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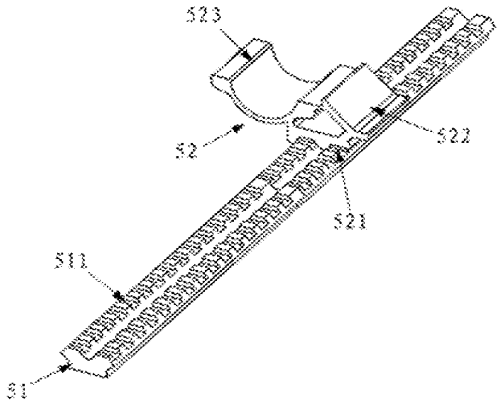


图10

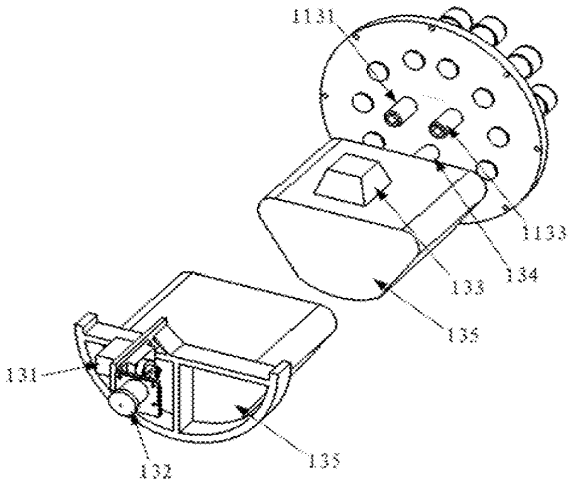


图11

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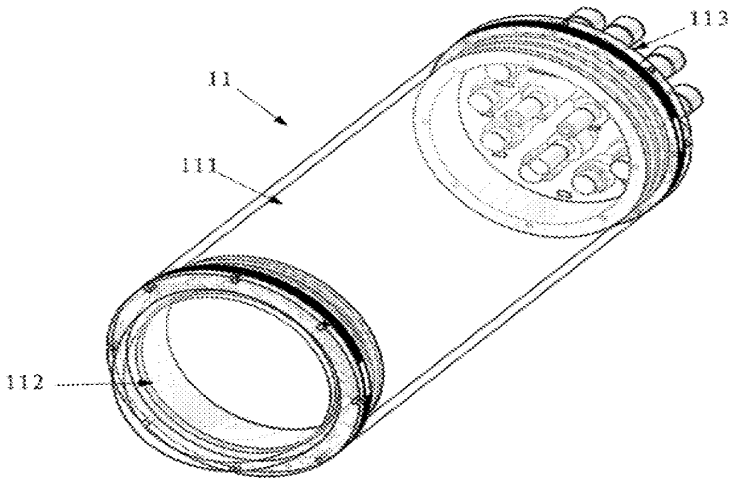


图12

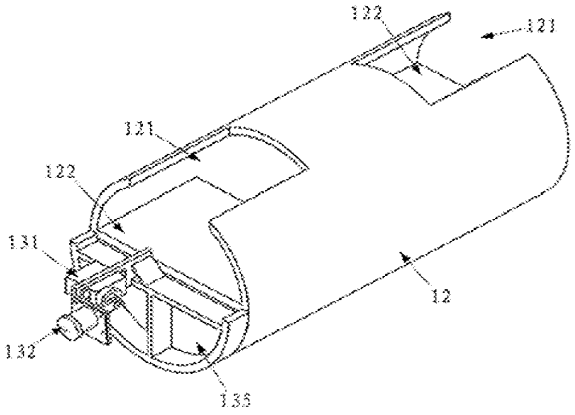


图13

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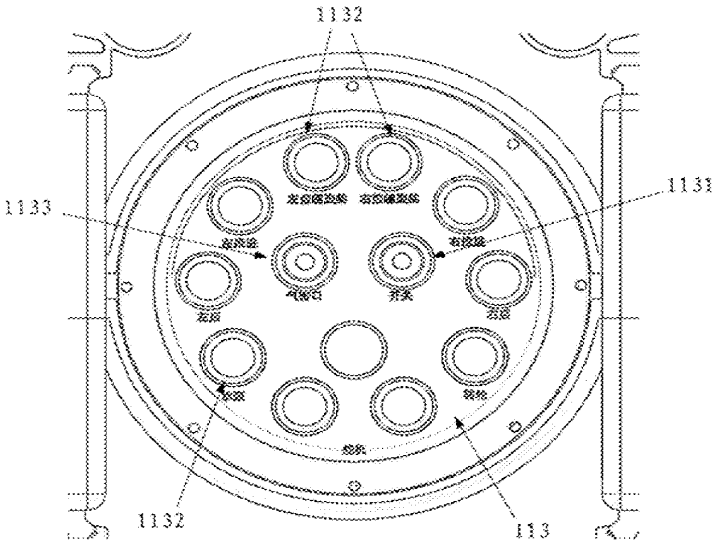


图14

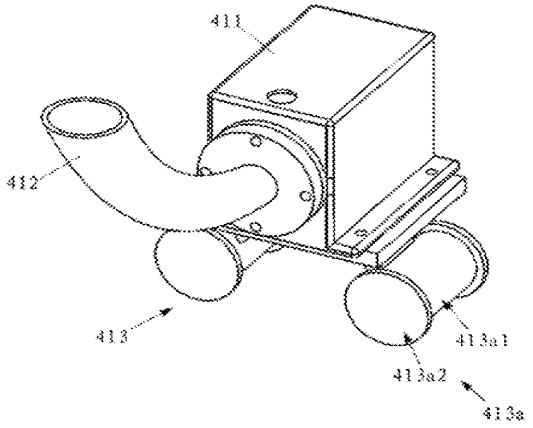


图15

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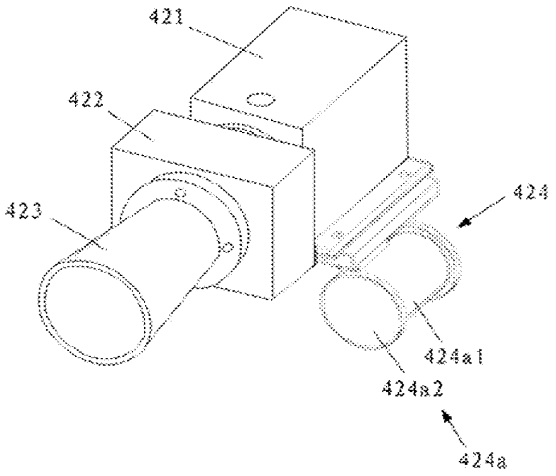


图16

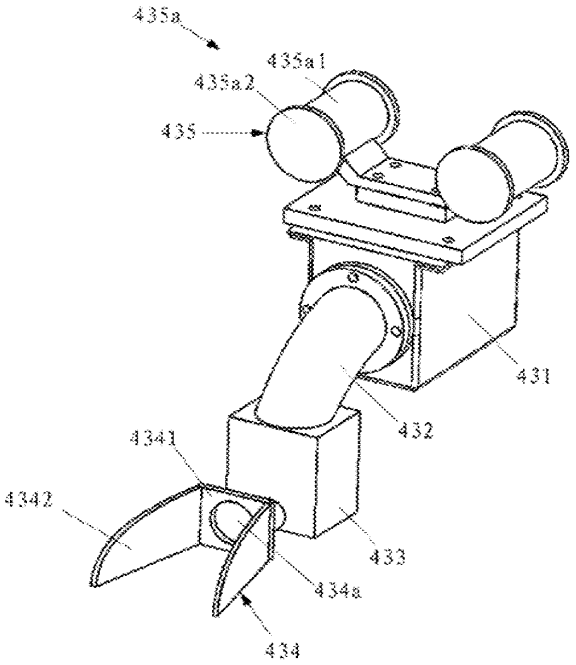


图17

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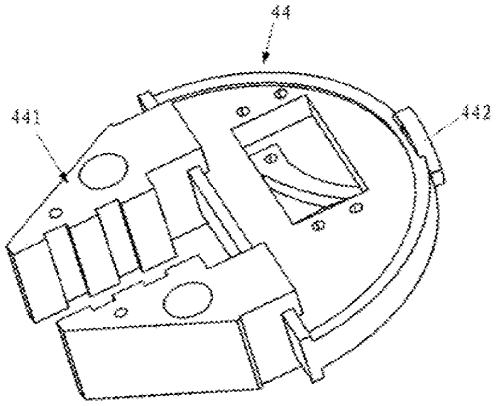


图18

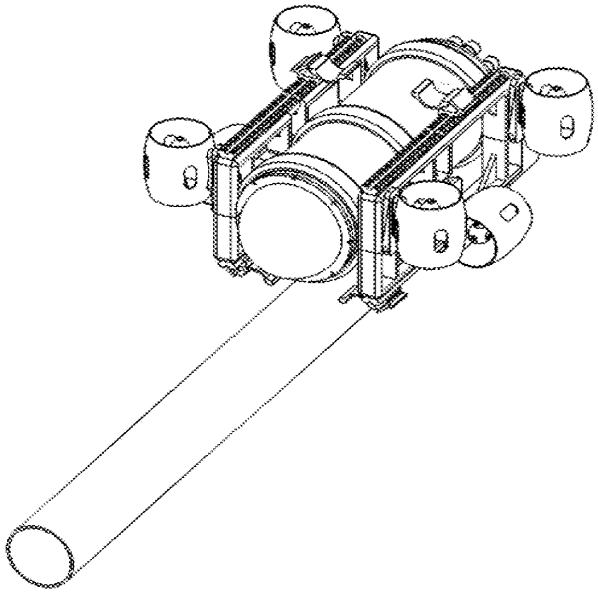


图19

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Espacenet

CN114995381A Robot random inspection method based on image recognition

Applicants: STATE GRID SHANGHAI MUNICIPAL ELECTRIC POWER CO

Inventors: ZHOU CHAOJIE,HUANG JIANYONG,WANG MAOYE,MAO XIAOLIANG,SHI HUI,ZHU LICHAO,YAN JUN

Classifications:
IPC ***G05D1/02;***

CPC **G05D1/0214 (CN); G05D1/0221 (CN); G05D1/0253 (CN);** Y02P90/02 (EP);

Priorities: CN202210443843A 2022-04-25

Application: CN202210443843A·2022-04-25

Publication: CN114995381A·2022-09-02

Published as: CN114995381A;**CN114995381B**

Robot random inspection method based on image recognition

Abstract

The invention relates to a robot random inspection method based on image recognition, which is realized by a plurality of inspection robots arranged in a target inspection area. Each facility in the target inspection area is configured with a safety function that the safety value of the facility changes along with time and an inspection function that changes according to the inspection condition when the facility is inspected; each inspection robot completes single inspection based on a pre-configured optimal inspection line; then selecting facilities meeting inspection setting requirements in a random manner according to a set sequence for subsequent inspection, in each inspection, acquiring inspection results of the facilities in a quick image recognition manner, executing corresponding subsequent processing according to the inspection results, updating safety values of the facilities based on the inspection function, and synchronizing the safety values to each inspection robot; and substituting the safety value into the safety function. Compared with the prior art, the system has the advantages that flexible inspection can be realized, functions are diversified, and the inspection efficiency is improved.

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专利代理师 翁惠瑜

(51)Int.Cl.
G05D 1/02(2020.01)

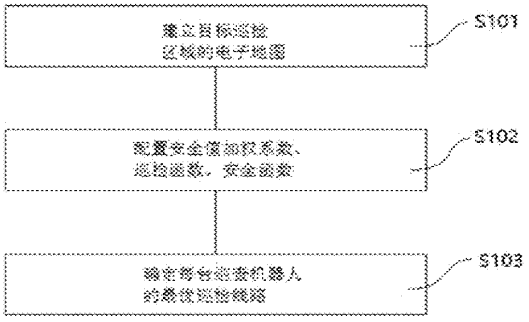
权利要求书2页 说明书6页 附图2页

(54)发明名称

一种基于图像识别的机器人随机巡检方法

(57)摘要

本发明涉及一种基于图像识别的机器人随机巡检方法，该方法由目标巡检区域内布置的若干台巡检机器人实现，目标巡检区域内每一设施配置有该设施的安全值随着时间变化的安全函数和巡检设施时根据巡检状况变化的巡检函数：各巡检机器人先基于预先配置的最优巡检线路完成单次巡检，然后按设定排序以随机方式选择符合巡检设定要求的设施进行后续巡检，在每次巡检中，采用快速图像识别方式获取设施的巡检结果，根据巡检结果执行相应后续处理，并基于所述巡检函数更新各设施的安全值，同步至每个巡检机器人，并将该安全值代入所述安全函数。与现有技术相比，本发明具有可实现灵活巡检、功能多样、提高巡检效率等优点。



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1.一种基于图像识别的机器人随机巡检方法，其特征在于，该方法由目标巡检区域内布置的若干台巡检机器人实现，目标巡检区域内每一设施配置有该设施的安全值随着时间变化的安全函数和巡检设施时根据巡检状况变化的巡检函数；

该方法包括以下步骤：

各巡检机器人先基于预先配置的最优巡检线路完成单次巡检，然后按设定排序以随机方式选择符合巡检设定要求的设施进行后续巡检，在每次巡检中，采用快速图像识别方式获取设施的巡检结果，根据巡检结果执行相应后续处理，并基于所述巡检函数更新各设施的安全值，同步至每个巡检机器人，并将该安全值代入所述安全函数。

2.根据权利要求1所述的基于图像识别的机器人随机巡检方法，其特征在于，所述快速图像识别具体为：

对检测位的设施进行一段时间内的多张图像拍摄，去除环境影响后得到设施的静态图像，从所述静态图像获取当前设施的实时特征数据，将该实时特征数据与预存储的常态时特征数据进行对比，判断对比结果是否大于设定阈值，若是，则产生追查报警信号，若否，则将巡检后设施的安全值根据巡检函数进行更新。

3.根据权利要求2所述的基于图像识别的机器人随机巡检方法，其特征在于，产生所述追查报警信号后，将当前时间段内拍摄的所述多张图像上传至分析服务器，所述分析服务器采用精细图像识别方式进行对比复查，判断对比复查结果是否大于设定阈值，若是，则由分析服务器或巡检机器人上报设施名称，若否，则巡检机器人将巡检后设施的安全值根据巡检函数进行更新。

4.根据权利要求1所述的基于图像识别的机器人随机巡检方法，其特征在于，所述巡检函数的表达式为：

$A_n=J+K\cdot Tp\cdot Lm/Lp\cdot Tm$

其中，A_n为当前设施更新后的安全值，Tp为巡检机器人在停留区域内的停留时间，所述停留区域基于每一设施的巡检中心划分，所述巡检中心指设施对应的最佳巡检位置，Tm为巡检机器人在停留区域内的设定最长停留时间，Lm为停留区域最远端与巡检中心的距离，Lp为最长时间停留位置与巡检中心的距离差，K为设施的安全值加权系数，J为当前设施此次更新前的安全值。

5.根据权利要求1所述的基于图像识别的机器人随机巡检方法，其特征在于，所述安全函数的表达式为：

$A_n=A_{n-1}\cdot t(1-t\hat{}Q1)\hat{}(1/Q2)$，

其中，t为当前设施未巡检的时间值与当前设施设定的最长检测间隙的比值，若当前设施未巡检的时间值大于等于当前设施设定的最长检测间隙，则t取值为1，Q1和Q2均为安全函数的调节值，各个设施根据重要程度对应设置有对应的调节值，A_{n-1}为上一计算间隔时的安全值，A_n为当前的安全值。

6.根据权利要求1所述的基于图像识别的机器人随机巡检方法，其特征在于，所述设定排序采用如下方式确定：

遍历计算各设施的巡检分值Pt：$Pt=Ar/Ta$，其中，Ar为设施的安全值的最大提升值，Ta为巡检所需要消耗的总时间；

以所述巡检分值Pt对所有待巡检的设施进行排序。

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7.根据权利要求6所述的基于图像识别的机器人随机巡检方法，其特征在于，计算所述巡检分值时，针对单个设施或一个设施组进行计算，相应地，以所述巡检分值对所有单个设施或所有设施组进行排序，所述设施组通过聚类分析划分。

8.根据权利要求6所述的基于图像识别的机器人随机巡检方法，其特征在于，遍历的设施为未巡检时间大于设定值的设施。

9.根据权利要求1所述的基于图像识别的机器人随机巡检方法，其特征在于，所述符合巡检设定要求的设施满足的条件为：

若确定执行选择的下一次巡检，则所有的设施的安全值均大于人工设定的阈值，且所有的设施的安全值的和也大于人工设定的阈值和。

10.根据权利要求4所述的基于图像识别的机器人随机巡检方法，其特征在于，所述设施上对应的最佳巡检位置设置有一个用于拍摄的二维码，巡检机器人根据拍摄的二维码的缩放比例核对最长时间停留位置与巡检中心的距离差Lp。

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一种基于图像识别的机器人随机巡检方法

技术领域

[0001] 本发明属于一种智能巡检方法，涉及一种基于图像识别的机器人随机巡检方法。

背景技术

[0002] 机器人具有感知、决策、执行等基本特征，可以辅助甚至替代人类完成危险、繁重、复杂的工作，提高工作效率与质量，服务人类生活，扩大或延伸人的活动及能力范围。随着智能控制技术、传感器技术以及能源等各个领域方面的发展，越来越多的自主运行机器人被应用于各个工业和家用场景。其中，巡检机器人是实现电力系统巡检作业自动化的重要执行单元，巡检机器人的移动属性决定其适合采用无缆化的电池供电。

[0003] 目前，常见的巡检机器人都是包括一个底盘和一个摄像台的方式进行巡检，一般性的巡检过程需要人工安排确定的固定路线进行巡检，如果发现存在问题，直接进行报警。那么此类技术存在的问题主要是，巡检的线路固定，如果涉及到带有保安性质的巡检则存在安全漏洞，第二，就是巡检的过程中，对于设施的状态监测较少，如果不是配置专业监测设备的话，一般只有视频、图像回传等简单功能，需要人工进行检测。

发明内容

[0004] 本发明的目的就是为了克服上述现有技术存在的缺陷而提供一种可实现灵活巡检、功能多样、提高巡检效率的基于图像识别的机器人随机巡检方法。

[0005] 本发明的目的可以通过以下技术方案来实现：

[0006] 一种基于图像识别的机器人随机巡检方法，该方法由目标巡检区域内布置的若干台巡检机器人实现，目标巡检区域内每一设施配置有该设施的安全值随着时间变化的安全函数和巡检设施时根据巡检状况变化的巡检函数；

[0007] 该方法包括以下步骤：

[0008] 各巡检机器人先基于预先配置的最优巡检线路完成单次巡检，然后按设定排序以随机方式选择符合巡检设定要求的设施进行后续巡检，在每次巡检中，采用快速图像识别方式获取设施的巡检结果，根据巡检结果执行相应后续处理，并基于所述巡检函数更新各设施的安全值，同步至每个巡检机器人，并将该安全值代入所述安全函数。

[0009] 作为优选，所述快速图像识别具体为：

[0010] 对检测位的设施进行一段时间内的多张图像拍摄，去除环境影响后得到设施的静态图像，从所述静态图像获取当前设施的实时特征数据，将该实时特征数据与预存储的常态时特征数据进行对比，判断对比结果是否大于设定阈值，若是，则产生追查报警信号，若否，则将巡检后设施的安全值根据巡检函数进行更新。

[0011] 作为优选，产生所述追查报警信号后，将当前时间段内拍摄的所述多张图像上传至分析服务器，所述分析服务器采用精细图像识别方式进行对比复查，判断对比复查结果是否大于设定阈值，若是，则由分析服务器或巡检机器人上报设施名称，若否，则巡检机器人将巡检后设施的安全值根据巡检函数进行更新。

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[0012] 作为优选，所述巡检函数的表达式为：

[0013] $A_n = J+K \cdot Tp \cdot Lm/Lp \cdot Tm$

[0014] 其中，A_n为当前设施更新后的安全值，Tp为巡检机器人在停留区域内的停留时间，所述停留区域基于每一设施的巡检中心划分，所述巡检中心指设施对应的最佳巡检位置，Tm为巡检机器人在停留区域内的设定最长停留时间，Lm为停留区域最远端与巡检中心的距离，Lp为最长时间停留位置与巡检中心的距离差，K为设施的安全值加权系数，J为当前设施此次更新前的安全值。

[0015] 作为优选，所述安全函数的表达式为：

[0016] $A_n = A_{n-1} \cdot t(1-t\hat{}Q1)\hat{}(1/Q2)$，

[0017] 其中，t为当前设施未巡检的时间值与当前设施设定的最长检测间隙的比值，若当前设施未巡检的时间值大于等于当前设施设定的最长检测间隙，则t取值为1，Q1和Q2均为安全函数的调节值，各个设施根据重要程度对应设置有对应的调节值，A_{n-1}为上一计算间隔时的安全值，A_n为当前的安全值。

[0018] 作为优选，所述设定排序采用如下方式确定：

[0019] 遍历计算各设施的巡检分值Pt：$Pt = Ar/Ta$，其中，Ar为设施的安全值的最大提升值，Ta为巡检所需要消耗的总时间；

[0020] 以所述巡检分值Pt对所有待巡检的设施进行排序。

[0021] 作为优选，计算所述巡检分值时，针对单个设施或一个设施组进行计算，相应地，以所述巡检分值对所有单个设施或所有设施组进行排序，所述设施组通过聚类分析划分。

[0022] 作为优选，遍历的设施为未巡检时间大于设定值的设施。

[0023] 作为优选，所述符合巡检设定要求的设施满足的条件为：

[0024] 若确定执行选择的下一次巡检，则所有的设施的安全值均大于人工设定的阈值，且所有的设施的安全值的和也大于人工设定的阈值和。

[0025] 作为优选，所述设施上对应的最佳巡检位置设置有一个用于拍摄的二维码，巡检机器人根据拍摄的二维码的缩放比例核对最长时间停留位置与巡检中心的距离差Lp。

[0026] 与现有技术相比，本发明具有以下有益效果：

[0027] 1、本发明除了首次巡检路线外，采用了随机的巡检路线，在保证随机性的同时也能照顾到绝大多数的设施，设施的巡检间隔都能够保持在一个稳定的范围，从而保证在巡检区域内的一个大致的稳定性，随机线路的巡检也不会对别有用心的人留出固定的时间，因此安全性相较以往有一定的提升，解决了现有技术存在巡检的线路固定，如果涉及到带有保安性质的巡检则存在安全漏洞的问题。

[0028] 2、本发明在每次巡检后更新各设施的安全值，基于设施的实时状态随机选择巡检路线，有效提高巡检可靠性。

[0029] 3、本发明采用了图像识别技术，由于机器人本身不适合高精度的图像识别，因此本发明中机器人担任简单的图像识别，功能多样，获取图像后初步检查，没有问题就进行下一步骤，如果存在有异常则上报服务器，由服务器进行处理，这样的方式，降低了机器人和云服务器的两方面压力，同时，由于机器人和服务器采用了同样的计算模型，服务器中获取的特征数据还可以对机器人中存储的特征数据进行更新，从而达到了快速巡检和精度判断两不误的情况，另外一些简单的数字识别，则无需经过服务器直接可以进行识别确认，解决

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了巡检的过程中，对于设施的状态监测较少，如果不是配置专业监测设备的话，只能通过人工进行检测问题。

附图说明

[0030] 图1为本发明的初始化步骤一种流程示意图；

[0031] 图2为本发明的日常巡检步骤一种流程示意图；

[0032] 图3为本发明的追查报警步骤一种流程示意图；

[0033] 图4为本发明的随机选择步骤一种流程示意图。

具体实施方式

[0034] 下面结合附图和具体实施例对本发明进行详细说明。本实施例以本发明技术方案为前提进行实施，给出了详细的实施方式和具体的操作过程，但本发明的保护范围不限于下述的实施例。

[0035] 本实施例提供一种基于图像识别的机器人随机巡检方法，该方法由目标巡检区域内布置的若干台巡检机器人实现，目标巡检区域内每一设施配置有该设施的安全值随着时间变化的安全函数和巡检设施时根据巡检状况变化的巡检函数。具体地，该方法包括只在需要初始时候执行的初始化步骤和日常巡检所采用的日常巡检步骤。

[0036] 如图1所示，初始化步骤包括：

[0037] S101、建立目标巡检区域的电子地图，确定电子地图内的可通行的道路和待巡检的设施；

[0038] S102、对目标巡检区域内的设施按照重要程度分别配置设施的安全值加权系数，以及该设施的安全值随着时间变化的安全函数和巡检设施时根据巡检状况设置的巡检函数；

[0039] S103、根据人工设定的方式，确定每台巡查机器人的最优巡检线路。

[0040] 设施对应的最佳巡检位置设为巡检中心，根据巡检中心划设有停留区域，根据巡检机器人在停留区域内的停留时间Tp、巡检机器人在停留区域内的设定最长停留时间Tm、停留区域最远端与巡检中心的距离Lm，最长时间停留位置与巡检中心的距离差Lp，通过巡检函数计算并更新当前设施的安全值A_n，巡检函数表示为：

[0041] $A_n=J+K\cdot Tp\cdot Lm/Lp\cdot Tm$，

[0042] 上式中，K为人工设定的对每个设施单独配置的安全值加权系数，J为巡检机器人到达区域后拍摄第一张照片或录入第一帧数据即获取的基础安全值。

[0043] 设施上对应的最佳巡检位置设置有一个用于拍摄的二维码，巡检机器人根据拍摄的二维码的缩放比例核对最长时间停留位置与巡检中心的距离差Lp。所述拍摄的二维码的信息中至少包含有一个拍摄照片并加载水印的命令，巡检机器人根据二维码的信息执行对应的命令。二维码的设置，可以在录像的过程中起到抓拍的作用，能够进行变焦拍摄，通过变焦拍摄的方式达到更好的图像识别效果。

[0044] 本发明中，为了确保整体巡检的覆盖性，保证各个设施位置巡检强度，一般机器人都是视频拍摄，不采用变焦方式拍摄，因此确定了拍摄距离和清晰度相关，本发明中，拍摄时间较长，且拍摄清晰度高，可以辅助图像识别确定当前设施的安全性，由于大部分设施例

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如围栏、道路等的安全性都是安全和不安全两种，因此图像的质量就是安全性的直观表示，因此，采用在需要对重点的设施如变压器进行检测的时候，可以在快速移动过程中对围栏、道路进行拍摄，那么对于这些设施的安全性巡检就该给与较低的评价，而相应的，如果对于变压器这样的设施进行一段时间的定点拍摄，去除了干扰，发现没有异常，那么就该给与变压器较高的安全评价，从而可以延长巡检的间隔。

[0045] 设施安全值随着时间变化的安全函数为：

[0046] $A_n=A_{n-1}\cdot t(1-t\hat{}Q1)\hat{}(1/Q2)$，

[0047] 上式中，t为当前设施未巡检的时间值与当前设施设定的最长检测间隙的比值，若当前设施未巡检的时间值大于等于当前设施设定的最长检测间隙，则t取值为1，Q1和Q2均为安全函数的调节值，各个设施根据重要程度对应设置有对应的调节值，A_{n-1}为拟制的上一计算间隔时的设施安全值。

[0048] 如图2所示，日常巡检步骤包括：

[0049] S201、第一次日常巡检时，按照巡查机器人的最优巡检线路进行完整的单次巡检；

[0050] S202、巡检机器人巡检完每一个设施后都根据巡检结果进行后续处理，若巡检中通过快速图像识别有发现明显差异，则启动追查报警步骤，若巡检中通过快速图像识别没有发现明显差异，则将巡检后设施的安全值根据巡检函数进行更新，并将该设施安全值代入安全函数进行计算，然后所有巡检机器人更新各个设施的安全值；

[0051] S203、每次按照设定的排序以随机方式选择符合巡检设定要求的设施，巡检完成后重复执行步骤S202。

[0052] 上述步骤S202中，快速图像识别包括以下步骤：

[0053] 针对若干设定的重点设施，巡检机器人存储有常态时图像的特征数据，巡检机器人到达预定的检测位后对重点设施进行图像获取，通过一段时间的多张图像拍摄，然后去除环境影响后得到设施的静态图像，将静态图像进行预处理，得到当前重点设施的当前特征数据，将当前图像的特征数据与常态时图像的特征数据进行对比，若对比结果不存在大于设定阈值的明显差异，则将巡检后设施的安全值根据巡检函数进行更新，若对比结果存在大于等于设定阈值的明显差异，则启动追查报警步骤。

[0054] 如图3所示，启动追查报警步骤包括：

[0055] S301、将当前时间段内拍摄的多张图像上传至分析服务器，所述分析服务器采用与巡检机器人相同算法、深度更深算法模型；

[0056] S302、由分析服务器，对图像去除环境影响，得到设施的静态图像，将静态图像进行处理，得到当前重点设施的当前特征数据，将当前图像的特征数据与常态时图像的特征数据进行对比复查；若对比复查结果不存在大于设定阈值的明显差异，则发回信号至巡检机器人，巡检机器人将巡检后设施的安全值根据巡检函数进行重置，若对比复查结果不存在大于等于设定阈值的明显差异，则由分析服务器或巡检机器人上报拍摄的设施名称。

[0057] 本发明中，采用的图像识别技术可以是神经网络技术，巡检机器人的神经网络深度相对较低，而服务器中神经网络深度较深，两者相通，可以由服务器对巡检机器人的神经网络进行更新。

[0058] 在步骤S203中，各个设施随着时间的推移，检测的需求会逐步提高，但是各个设施的下降程度速度以及最长检测间隔都不相同，因此需要对不同的需求进行排序，从而确定

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巡检机器人的下一个巡检目标。

[0059] 如图4所示，筛选下一个巡检目标的具体流程包括以下步骤：

[0060] S401、以巡检分值Pt为排序对象，选择排名靠前的若干个设施作为备选；

[0061] S402、在所有备选的设施或设施组中筛选符合巡检设定要求的设施；

[0062] S403、以随机方式选取下一个巡检目标。

[0063] 在步骤S401中，计算巡检分值Pt可针对单个设施进行计算，也可针对设施组进行计算。以单个设施计算的具体过程包括：

[0064] 首先假设目标设施为被选择的下一次巡检设施，然后计算该设施的安全值的最大提升值Ar，以及巡检所需要消耗的总时间Ta，然后通过下式计算该设施的巡检分值Pt，Pt＝Ar/Ta；

[0065] 遍历所有的待巡检设施，按照巡检分值Pt排序，选择排名靠前的若干个设施作为备选。

[0066] 以设施组进行计算的具体过程包括：

[0067] 首先假设若干个目标设施为一组被选择的后续连续巡检的设施组，然后计算上述若干个设施的安全值的最大提升值Ar，以及巡检所需要消耗的总时间Ta，然后通过下式计算该设施的巡检分值Pt，Pt＝Ar/Ta；

[0068] 遍历所有的待巡检设施组，按照巡检分值Pt排序，选择排名靠前的若干个设施组作为备选。

[0069] 本实施例中，设施组的生成是由聚类算法根据各设施的种类和距离维度聚类获得的。聚类的维度包括设施的种类、距离也可以包括其他内容，通过种类的区分将大部分重点设施和道路围栏等设施进行了区分，然后将重点设施根据距离进行聚类，确定重点设施的中心位置，然后通过设施组的方式，可以帮助巡检机器人降低随机查找下一个检测点的难度，能快速发现下一个检测点。

[0070] 上述步骤S401中，需要遍历的是未巡检时间大于设定值的待巡检设施或设施组。

[0071] 在步骤S402中，在所有备选的设施或设施组中进行筛选，筛选条件为：若确定执行选择的下一次巡检，则所有的设施的安全值均大于人工设定的阈值，且所有的设施的安全值的和也大于人工设定的阈值和。

[0072] 巡检机器人去除不符合筛选条件的备选设施或设施组，然后在步骤S403中以随机方式选择符合巡检设定要求的设施。

[0073] 本发明的主要发明点由两个第一是采用了随机的巡检路线，在保证随机性的同时也能照顾到绝大多数的设施，设施的巡检间隔都能够保持在一个稳定的范围，从而保证在巡检区域内的一个大致的稳定性，随机线路的巡检也不会对别有用心的人留出固定的时间，因此安全性相较以往有一定的提升，同时，本发明采用了图像识别技术，由于机器人本身不适合高精度的图像识别，因此本发明中机器人担任简单的图像识别，获取图像后初步检查，没有问题就进行下一步骤，如果存在有异常则上报服务器，由服务器进行处理，这样的方式，降低了机器人和云服务器的两方面压力，同时，由于机器人和服务器采用了同样的计算模型，服务器中获取的特征数据还可以对机器人中存储的特征数据进行更新，从而达到了快速巡检和精度判断两不误的情况，另外一些简单的数字识别，则无需经过服务器直接可以进行识别确认。在本发明中，图像识别部分属于现有技术。

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[0074] 上述功能如果以软件功能单元的形式实现并作为独立的产品销售或使用时，可以存储在一个计算机可读取存储介质中，计算机可读取存储介质可设置于各巡检机器人中。基于这样的理解，本发明的技术方案本质上或者说对现有技术做出贡献的部分或者该技术方案的部分可以以软件产品的形式体现出来，该计算机软件产品存储在一个存储介质中，包括若干指令用以使得一台计算机设备(可以是个人计算机，服务器，或者网络设备等)执行本发明各个实施例所述方法的全部或部分步骤。而前述的存储介质包括：U盘、移动硬盘、只读存储器(ROM，Read-Only Memory)、随机存取存储器(RAM，Random Access Memory)、磁碟或者光盘等各种可以存储程序代码的介质。

[0075] 以上详细描述了本发明的较佳具体实施例。应当理解，本领域的普通技术人员无需创造性劳动就可以根据本发明的构思作出诸多修改和变化。因此，凡本技术领域中技术人员依本发明的构思在现有技术的基础上通过逻辑分析、推理或者有限的实验可以得到的技术方案，皆应在由权利要求书所确定的保护范围内。

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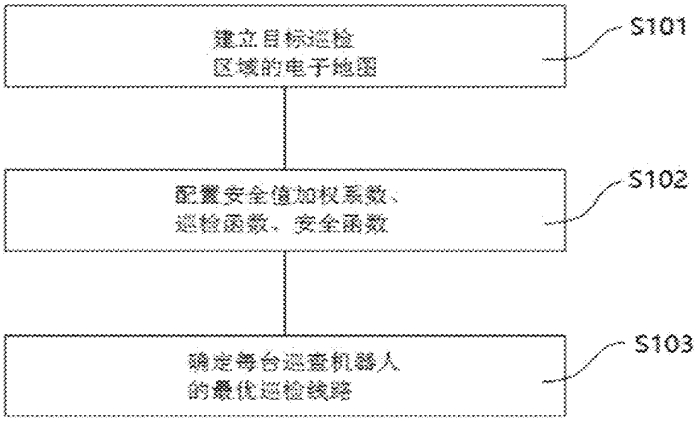


图1

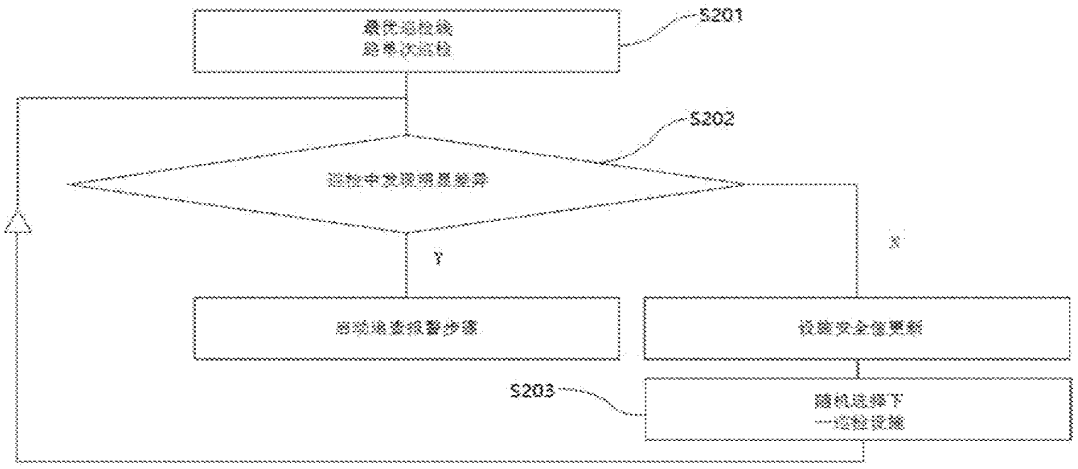


图2

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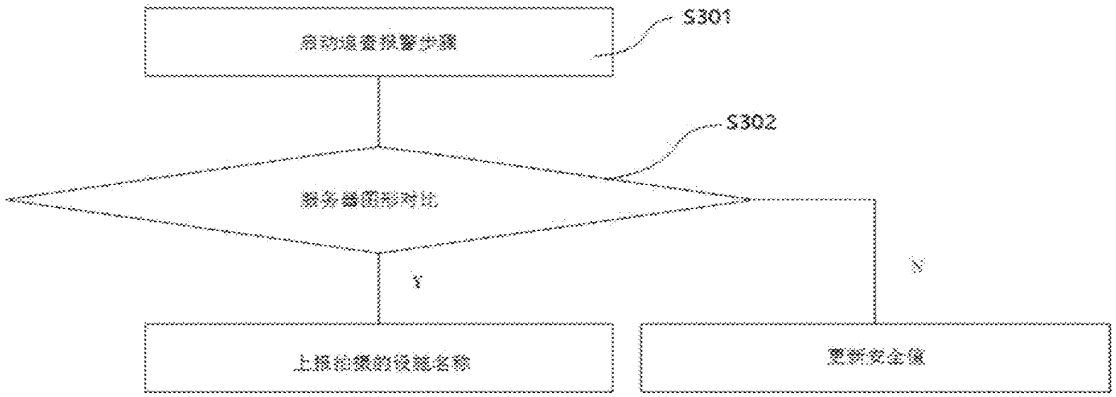


图3

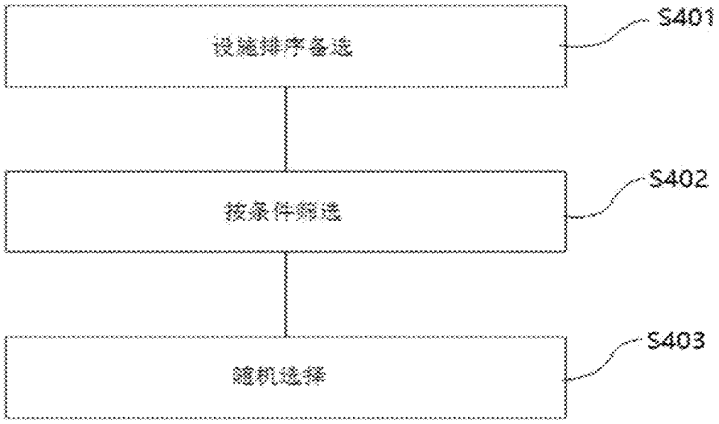


图4

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Espacenet

CN115517581A Method and device for executing ground cleaning task

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Method and device for executing ground cleaning task

Abstract

The invention relates to a method and device for executing a ground cleaning task, and relates to the technical field of intelligent manufacturing, and the method comprises the steps that a floor sweeping robot obtains the ground cleaning task, multiple to-be-cleaned areas are determined, and the multiple to-be-cleaned areas are distributed on one or more floors; the sweeping robot plans at least one task execution route for connecting all the to-be-cleaned areas in series according to the current position of the sweeping robot and the distribution positions of the to-be-cleaned areas; for each task execution route, the sweeping robot counts pure moving road sections in the task execution routes, and the pure moving road sections comprise stair climbing road sections and flat ground road sections; the sweeping robot determines the total movement energy consumption of each task execution route based on preset stair climbing unit energy consumption and ground movement unit energy consumption; and the sweeping robot executes the ground cleaning task based on the target task execution route with the lowest total movement energy consumption. According to the invention, the floor cleaning efficiency can be improved, and the cleaning cost is reduced.

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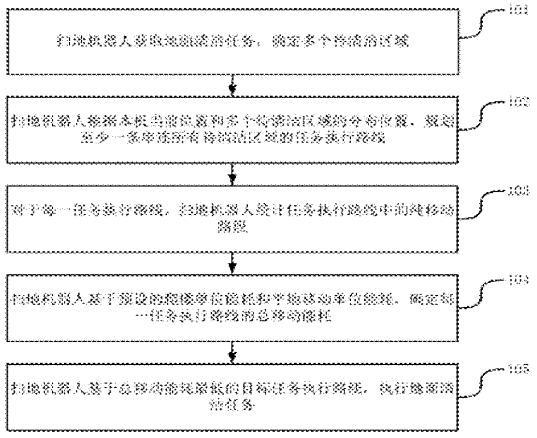
权利要求书2页 说明书11页 附图5页

(54)发明名称

一种执行地面清洁任务的方法和装置

(57)摘要

本申请涉及一种执行地面清洁任务的方法和装置，涉及智能制造技术领域，所述方法包括：扫地机器人获取地面清洁任务，确定多个待清洁区域，多个待清洁区域分布在一个或多个楼层；扫地机器人根据本机当前位置和多个待清洁区域的分布位置，规划至少一条串连所有待清洁区域的任务执行路线；对于每一任务执行路线，扫地机器人统计任务执行路线中的纯移动路段，纯移动路段包括爬楼路段和平地路段；扫地机器人基于预设的爬楼单位能耗和平地移动单位能耗，确定每一任务执行路线的总移动能耗；扫地机器人基于总移动能耗最低的目标任务执行路线，执行地面清洁任务。采用本申请，可以提高地面清洁效率，降低清洁成本。



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1.一种执行地面清洁任务的方法，其特征在于，所述方法包括：

扫地机器人获取地面清洁任务，确定多个待清洁区域，所述多个待清洁区域分布在一个或多个楼层；

所述扫地机器人根据本机当前位置和所述多个待清洁区域的分布位置，规划至少一条串连所有所述待清洁区域的任务执行路线；

对于每一所述任务执行路线，所述扫地机器人统计所述任务执行路线中的纯移动路段，所述纯移动路段包括爬楼路段和平地路段；

所述扫地机器人基于预设的爬楼单位能耗和平地移动单位能耗，确定每一所述任务执行路线的总移动能耗；

所述扫地机器人基于所述总移动能耗最低的目标任务执行路线，执行所述地面清洁任务。

2.根据权利要求1所述的方法，其特征在于，所述扫地机器人根据本机当前位置和所述多个待清洁区域的分布位置，规划至少一条串连所有所述待清洁区域的任务执行路线，包括：

所述扫地机器人根据本机当前位置和所述多个待清洁区域的分布位置以及每个所述待清洁区域的区域形状，规划至少一条串连所有所述待清洁区域的任务执行路线。

3.根据权利要求1所述的方法，其特征在于，所述扫地机器人包含独立驱动的前部，中部和后部；

所述方法还包括：

对于爬楼路径中每一上行台阶，所述扫地机器人驱动所述前部抬升，并前进以使所述前部落在所述台阶上；

所述扫地机器人驱动所述中部的底面抬升至与所述前部的底面持平，并前进以使所述中部落在所述台阶上；

所述扫地机器人驱动所述后部的底面抬升至与所述中部的底面持平，并前进以使所述后部落在所述台阶上。

4.根据权利要求1所述的方法，其特征在于，所述扫地机器人包含独立驱动的前部，中部和后部；

所述方法还包括：

对于爬楼路径中每一下行台阶，所述扫地机器人前进以使所述前部完全悬空后，驱动所述前部降低落在所述台阶上；

所述扫地机器人继续前进以使所述中部完全悬空后，驱动所述中部降低落在所述台阶上；

所述扫地机器人继续前进以使所述后部完全悬空后，驱动所述后部降低落在所述台阶上。

5.根据权利要求3或4所述的方法，其特征在于，所述前部、中部和后部的底面分别设置有测距传感器，分别用于检测所述前部、中部和后部的底面与地面间的距离。

6.根据权利要求5所述的方法，其特征在于，所述方法还包括：

在爬楼过程中，所述扫地机器人记录已爬台阶的台阶高度；

若落在所述台阶前所述前部抬升或降低的高度与所述台阶高度不一致，所述扫地机器

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人则沿台阶边缘方向平移预设距离后，重新驱动所述前部以使所述前部落在所述台阶上。

7.根据权利要求3或4所述的方法，其特征在于，所述方法还包括：

如果所述台阶属于待清洁区域，所述扫地机器人判断爬楼过程中相对所述台阶的清洁覆盖宽度；

当所述清洁覆盖宽度达到台阶深度时，所述扫地机器人沿台阶边缘方向平移以清洁所述台阶；

若所述台阶深度大于所述最大清洁覆盖宽度，所述扫地机器人则基于所述台阶宽度和所述最大清洁覆盖宽度，制定台阶清洁路线；

所述扫地机器人基于所述台阶清洁路线清洁所述台阶。

8.一种执行地面清洁任务的装置，其特征在于，所述装置包括：

区域确定模块，用于获取地面清洁任务，确定多个待清洁区域，所述多个待清洁区域分布在一个或多个楼层；

路线规划模块，用于根据本机当前位置和所述多个待清洁区域的分布位置，规划至少一条串连所有所述待清洁区域的任务执行路线；

路段统计模块，用于对于每一所述任务执行路线，统计所述任务执行路线中的纯移动路段，所述纯移动路段包括爬楼路段和平地路段；

能耗确定模块，用于基于预设的爬楼单位能耗和平地移动单位能耗，确定每一所述任务执行路线的总移动能耗；

任务执行模块，用于基于所述总移动能耗最低的目标任务执行路线，执行所述地面清洁任务。

9.一种扫地机器人，其特征在于，所述扫地机器人包括处理器和存储器，所述存储器中存储有至少一条指令、至少一段程序、代码集或指令集，所述至少一条指令、所述至少一段程序、所述代码集或指令集由所述处理器加载并执行以实现如权利要求1至7任一所述的执行地面清洁任务的方法。

10.一种计算机可读存储介质，其特征在于，所述存储介质中存储有至少一条指令、至少一段程序、代码集或指令集，所述至少一条指令、所述至少一段程序、所述代码集或指令集由处理器加载并执行以实现如权利要求1至7任一所述的执行地面清洁任务的方法。

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一种执行地面清洁任务的方法和装置

技术领域

[0001] 本申请涉及智能制造技术领域，尤其涉及一种执行地面清洁任务的方法和装置。

背景技术

[0002] 扫地机器人是一种替代人工进行地面清洁的智能机器，一般可以具备清扫、吸尘、擦地等多种功能。在清洁地面时，用户可以选择并设定需要清洁的区域，将扫地机器人置于上述区域，从而扫地机器人可以在设定的区域内自主移动，并同步对移动路径上的地面进行清洁处理。

[0003] 在使用扫地机器人的过程中，用户可以将扫地机器人携带至需要清洁的一块区域，并设定好扫地机器人的移动朝向。之后，扫地机器人可以按照该移动朝向开始移动并清洁地面，在到达区域的边界后扫地机器人可以向左或向右侧移一个机位并折返移动以及清洁地面，从而可以依此使得移动路径覆盖区域所有地面，以完成该区域内的地面清洁。

[0004] 在实现本申请的过程中，发明人发现上述技术至少存在以下问题：

每次清洁地面时，经常可能会存在多块需要清洁的区域，该多块区域分布在不同方位。故而，在对多块区域进行清洁的过程中，用户需要在一块区域清洁完成后，再携带扫地机器人前往不同的区域。这样，一方面扫地机器人在清洁完成一块区域后，需要等待用户操作才能开始下一块区域的清洁工作，地面清洁的效率较低；另一方面，整个清扫过程，用户需要频繁参与干涉，人力成本较高。

发明内容

[0005] 为了提高地面清洁效率，降低清洁成本，本申请实施例提供了一种执行地面清洁任务的方法和装置。所述技术方案如下：

第一方面，本申请实施例提供了一种执行地面清洁任务的方法，所述方法包括：

扫地机器人获取地面清洁任务，确定多个待清洁区域，所述多个待清洁区域分布在一个或多个楼层；

所述扫地机器人根据本机当前位置和所述多个待清洁区域的分布位置，规划至少一条串连所有所述待清洁区域的任务执行路线；

对于每一所述任务执行路线，所述扫地机器人统计所述任务执行路线中的纯移动路段，所述纯移动路段包括爬楼路段和平地路段；

所述扫地机器人基于预设的爬楼单位能耗和平地移动单位能耗，确定每一所述任务执行路线的总移动能耗；

所述扫地机器人基于所述总移动能耗最低的目标任务执行路线，执行所述地面清洁任务。

[0006] 基于上述技术方案，在对多块区域进行清洁时，由扫地机器人自主规划筛选任务执行路线，再按照任务执行路线清洁地面，整个过程无需用户认为干预，扫地机器人可以自行连续地完成所有区域的清洁工作，地面清洁的效率较高，能耗成本和人力成本均较低。

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[0007] 可选的，所述扫地机器人根据本机当前位置和所述多个待清洁区域的分布位置，规划至少一条串连所有所述待清洁区域的任务执行路线，包括：

所述扫地机器人根据本机当前位置和所述多个待清洁区域的分布位置以及每个所述待清洁区域的区域形状，规划至少一条串连所有所述待清洁区域的任务执行路线。

[0008] 基于上述技术方案，扫地机器人在规划任务执行路线时，可以充分考虑待清洁区域内的移动情况，从而可以得到串连所有待清洁区域的总路程更短的任务执行路线，以降低地面清洁过程的能源消耗。

[0009] 可选的，所述扫地机器人包含独立驱动的前部，中部和后部；

所述方法还包括：

对于爬楼路径中每一上行台阶，所述扫地机器人驱动所述前部抬升，并前进以使所述前部落在所述台阶上；

所述扫地机器人驱动所述中部的底面抬升至与所述前部的底面持平，并前进以使所述中部落在所述台阶上；

所述扫地机器人驱动所述后部的底面抬升至与所述中部的底面持平，并前进以使所述后部落在所述台阶上。

[0010] 基于上述技术方案，扫地机器人通过独立驱动的三个部分，将爬台阶的过程拆分为三个部分的依次抬升，从而可以实现较为稳定的上楼过程。

[0011] 可选的，所述扫地机器人包含独立驱动的前部，中部和后部；

所述方法还包括：

对于爬楼路径中每一下行台阶，所述扫地机器人前进以使所述前部完全悬空后，驱动所述前部降低落在所述台阶上；

所述扫地机器人继续前进以使所述中部完全悬空后，驱动所述中部降低落在所述台阶上；

所述扫地机器人继续前进以使所述后部完全悬空后，驱动所述后部降低落在所述台阶上。

[0012] 基于上述技术方案，扫地机器人通过独立驱动的三个部分，将爬台阶的过程拆分为三个部分的依次降低，从而可以实现较为稳定的下楼过程。

[0013] 可选的，所述前部、中部和后部的底面分别设置有测距传感器，分别用于检测所述前部、中部和后部的底面与地面间的距离。

[0014] 可选的，所述方法还包括：

在爬楼过程中，所述扫地机器人记录已爬台阶的台阶高度；

若落在所述台阶前所述前部抬升或降低的高度与所述台阶高度不一致，所述扫地机器人则沿台阶边缘方向平移预设距离后，重新驱动所述前部以使所述前部落在所述台阶上。

[0015] 基于上述技术方案，爬台阶时将前部抬升或降低的高度与记录的台阶高度进行对比，可以判断扫地机器人是否稳定落在台阶上，并配合进一步的平移调节，可以降低扫地机器人在爬台阶时，因台阶存在异物而导致攀爬过程出现异常的情况。

[0016] 可选的，所述方法还包括：

如果所述台阶属于待清洁区域，所述扫地机器人判断爬楼过程中相对所述台阶的

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清洁覆盖宽度；

当所述清洁覆盖宽度达到台阶深度时，所述扫地机器人沿台阶边缘方向平移以清洁所述台阶；

若所述台阶深度大于所述最大清洁覆盖宽度，所述扫地机器人则基于所述台阶宽度和所述最大清洁覆盖宽度，制定台阶清洁路线；

所述扫地机器人基于所述台阶清洁路线清洁所述台阶。

[0017] 基于上述技术方案，扫地机器人在爬台阶的同时，可以通过清洁覆盖宽度对台阶清洁路线进行制定，从而可以实现针对台阶的全面清洁。

[0018] 第二方面，本申请实施例提供了一种执行地面清洁任务的装置，所述装置包括：

区域确定模块，用于获取地面清洁任务，确定多个待清洁区域，所述多个待清洁区域分布在一个或多个楼层；

路线规划模块，用于根据本机当前位置和所述多个待清洁区域的分布位置，规划至少一条串连所有所述待清洁区域的任务执行路线；

路段统计模块，用于对于每一所述任务执行路线，统计所述任务执行路线中的纯移动路段，所述纯移动路段包括爬楼路段和平地路段；

能耗确定模块，用于基于预设的爬楼单位能耗和平地移动单位能耗，确定每一所述任务执行路线的总移动能耗；

任务执行模块，用于基于所述总移动能耗最低的目标任务执行路线，执行所述地面清洁任务。

[0019] 可选的，所述路线规划模块，具体用于：

根据本机当前位置和所述多个待清洁区域的分布位置以及每个所述待清洁区域的区域形状，规划至少一条串连所有所述待清洁区域的任务执行路线。

[0020] 可选的，所述装置包含独立驱动的前部，中部和后部；

所述任务执行模块，还用于：

对于爬楼路径中每一上行台阶，驱动所述前部抬升，并前进以使所述前部落在所述台阶上；

驱动所述中部的底面抬升至与所述前部的底面持平，并前进以使所述中部落在所述台阶上；

驱动所述后部的底面抬升至与所述中部的底面持平，并前进以使所述后部落在所述台阶上。

[0021] 可选的，所述装置包含独立驱动的前部，中部和后部；

所述任务执行模块，还用于：

对于爬楼路径中每一下行台阶，前进以使所述前部完全悬空后，驱动所述前部降低落在所述台阶上；

继续前进以使所述中部完全悬空后，驱动所述中部降低落在所述台阶上；

继续前进以使所述后部完全悬空后，驱动所述后部降低落在所述台阶上。

[0022] 可选的，所述前部、中部和后部的底面分别设置有测距传感器，分别用于检测所述前部、中部和后部的底面与地面间的距离。

[0023] 可选的，所述任务执行模块，还用于：

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在爬楼过程中，所述扫地机器人记录已爬台阶的台阶高度；

若落在所述台阶前所述前部抬升或降低的高度与所述台阶高度不一致，所述扫地机器人则沿台阶边缘方向平移预设距离后，重新驱动所述前部以使所述前部落在所述台阶上。

[0024] 可选的，所述任务执行模块，还用于：

如果所述台阶属于待清洁区域，所述扫地机器人判断爬楼过程中相对所述台阶的清洁覆盖宽度；

当所述清洁覆盖宽度达到台阶深度时，所述扫地机器人沿台阶边缘方向平移以清洁所述台阶；

若所述台阶深度大于所述最大清洁覆盖宽度，所述扫地机器人则基于所述台阶宽度和所述最大清洁覆盖宽度，制定台阶清洁路线；

所述扫地机器人基于所述台阶清洁路线清洁所述台阶。

[0025] 第三方面，本申请实施例提供了一种扫地机器人，所述扫地机器人包括处理器和存储器，所述存储器中存储有至少一条指令、至少一段程序、代码集或指令集，所述至少一条指令、所述至少一段程序、所述代码集或指令集由所述处理器加载并执行以实现如第一方面所述的执行地面清洁任务的方法。

[0026] 第四方面，本申请实施例提供了一种计算机可读存储介质，所述存储介质中存储有至少一条指令、至少一段程序、代码集或指令集，所述至少一条指令、所述至少一段程序、所述代码集或指令集由处理器加载并执行以实现如第一方面所述的执行地面清洁任务的方法。

[0027] 综上所述，本申请具有以下有益效果：

采用本申请公开的执行地面清洁任务的方法，在执行地面清洁任务时，扫地机器人根据多个待清洁区域在不同楼层间的分布位置，规划多条任务执行路线，并基于爬楼单位能耗和平地移动单位能耗统计每条任务执行路线上纯移动路段的总移动能耗，进而基于总移动能耗选取任务执行路线来进行地面清洁。这样，在对多块区域进行清洁时，由扫地机器人自主规划筛选任务执行路线，再按照任务执行路线清洁地面，整个过程无需用户人为干预，扫地机器人可以自行连续地完成所有区域的清洁工作，地面清洁的效率较高，能耗成本和人力成本均较低。

附图说明

[0028] 图1为本申请实施例中执行地面清洁任务的方法流程图；

图2为本申请实施例中一种任务执行路线的规划示意图；

图3为本申请实施例中一种任务执行路线的规划示意图；

图4为本申请实施例中针对上行台阶的爬楼流程图；

图5为本申请实施例中针对上行台阶的爬楼阶段图；

图6为本申请实施例中针对下行台阶的爬楼流程图；

图7为本申请实施例中针对下行台阶的爬楼阶段图；

图8为本申请实施例中执行地面清洁任务的装置结构示意图。

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具体实施方式

[0029] 为了使本申请的目的、技术方案及优点更加清楚明白，以下结合附图1-8及实施例，对本申请进行进一步详细说明。应当理解，此处所描述的具体实施例仅用以解释本申请，并不用于限定本申请。

[0030] 本申请实施例提供了一种执行地面清洁任务的方法，该方法的执行主体可以是扫地机器人，扫地机器人可以是具备地面清洁功能的智能设备，同时可以兼具定位、行进和爬楼功能等清洁辅助功能。此外，扫地机器人可以具备数据接收和数据处理功能，以接收并执行地面清洁任务。扫地机器人对地面清洁任务进行响应时，确定需要清洁的不同区域，并进一步在区域间规划移动路线，从而可以按照规划好的移动路线自行完成所有区域的地面清洁工作。上述扫地机器人可以应用于家庭、商场、公园、广场等室内室外多种场景中，本实施例中不对应用场景进行限定。

[0031] 下面将结合具体实施方式，对图1所示的处理流程进行详细的说明，内容可以如下：

步骤101，扫地机器人获取地面清洁任务，确定多个待清洁区域。

[0032] 其中，多个待清洁区域可以分布在一个或多个楼层。

[0033] 在实施中，以应用场景为多层住宅楼为例，扫地机器人的使用方可以是住宅楼的物业管理人员。物业管理人员可以使用扫地机器人对住宅楼的各楼层的地面进行清洁处理。在地面清洁开始前，物业管理人员可以预先在扫地机器人中录入多层住宅楼的地形图，地形图中可以记录有住宅楼中各个楼层内部的地形分布情况以及楼层间的楼梯分布情况。在控制扫地机器人进行地面清洁时，物业管理人员可以在上述地形图中标记出需要清洁的一个或多个区域。之后，在物业管理人员确认开始清洁后，扫地机器人可以获取到地面清洁任务，并基于物业管理人员在地形图中的标记确定出多个待清洁区域，多个待清洁区域可以视情况分布在一个或多个楼层。

[0034] 步骤102，扫地机器人根据本机当前位置和多个待清洁区域的分布位置，规划至少一条串连所有待清洁区域的任务执行路线。

[0035] 在实施中，扫地机器人在确定了多个待清洁区域后，可以进一步依据地形图确定每个待清洁区域的分布位置。在多层住宅楼中，多个待清洁区域可以是分布在不同楼层的地面区域，也可以是楼层间的楼梯区域。这样，扫地机器人可以结合本机当前位置，规划出至少一条本次地面清洁任务的任务执行路线，如图2所示，该任务执行路线可以以本机当前位置作为路线起点，串连通过所有待清洁区域。此处，本机当前位置可以由扫地机器人基于室内定位技术得到，本实施例不对室内定位技术进行限定。

[0036] 可选的，在规划任务执行路线时，还可以兼顾扫地机器人在待清洁区域内的行动路径，相应的，步骤102的处理可以如下：扫地机器人根据本机当前位置和多个待清洁区域的分布位置以及每个待清洁区域的区域形状，规划至少一条串连所有待清洁区域的任务执行路线。

[0037] 在实施中，考虑到待清洁区域内部的行进路线会对整体的任务执行路线产生影响，因此扫地机器人在规划任务执行路线时，可以综合考虑本机当前位置、多个待清洁区域的分布位置，以及每个待清洁区域的区域形状。具体的，对于每个待清洁区域，扫地机器人可以对整体区域进行微分化，将一个区域分割为大量紧密相邻的矩形单元，进而待清洁区

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域内的移动即可以等同于在多个矩形单元间的移动。接下来，扫地机器人可以识别每个待清洁区域的出入口矩形单元，规划出至少一条以本机当前位置为起点，串连所有待清洁区域的出入口矩形单元的任务执行路线。值得一提的是，待清洁区域可以存在多个不同的出入口矩形单元，且待清洁区域的出口矩形单元和入口矩形单元可以为同一矩形单元，也可以为不同矩形单元，而开放式的待清洁区域，理论上区域边缘可以存在大量出入口矩形单元，因此可以按照其它待清洁区域的分布位置先确定该待清洁区域可选的出入口矩形单元，具体可以参考图3所示，其中包含区域1-4四个区域，区域1包含一个出入口矩形单元，区域2包含两个出入口矩形单元，区域3为开放区域，包含多个出入口矩形单元，区域4包含一个出入口矩形单元。

[0038] 步骤103，对于每一任务执行路线，扫地机器人统计任务执行路线中的纯移动路段。

[0039] 在实施中，扫地机器人在规划出至少一条任务执行路线后，可以针对每一条任务执行路线，统计任务执行路线中的纯移动路段的总长。可以理解，任务执行路线是扫地机器人在清洁多个待清洁区域时经过的所有路段之和，其中可以包含纯移动路段和清洁作业路段，而纯移动路段可以进一步包括爬楼路段和平地路段，爬楼路段即为扫地机器人上/下爬楼的一段路程，平地路段即为扫地机器人在平地上移动的一段路程。

[0040] 步骤104，扫地机器人基于预设的爬楼单位能耗和平地移动单位能耗，确定每一任务执行路线的总移动能耗。

[0041] 在实施中，扫地机器人内可以预先存储有本设备的爬楼单位能耗和平地移动单位能耗，爬楼单位能耗可以是扫地机器人平均每爬n个台阶所需消耗的能源，平地移动单位能耗可以是在平地上平均每移动指定长度所需耗费的能源。该爬楼单位能耗和平地移动单位能耗可以是扫地机器人的生产厂商在扫地机器人出厂前统一测试得到的平均值，也可以是该扫地机器人的用户在使用扫地机器人前在特定使用环境中，通过针对性的测试得到的数值。这样，基于上述爬楼单位能耗和平地移动单位能耗，扫地机器人可以计算每一任务执行路线的总移动能耗，即耗用在移动上能量总量。

[0042] 进一步的，考虑到上楼和下楼时，扫地机器人的爬楼单位能耗也可能存在不同，故而在统计总移动能耗时，可以针对上楼路段和下楼路段利用相应的爬楼单位能耗分别进行计算。

[0043] 步骤105，扫地机器人基于总移动能耗最低的目标任务执行路线，执行地面清洁任务。

[0044] 在实施中，扫地机器人在统计了所有任务执行路线的总移动能耗后，可以将总移动能耗最低的任务执行路线选定为目标任务执行路线。进而，扫地机器人可以基于目标任务执行路线，执行地面清洁任务。可以理解，地面清洁任务的执行过程可以包含纯移动阶段和清洁阶段，清洁阶段的能耗与待清洁区域的总面积有关，由于不同任务执行路线中待清洁区域的总面积一致，因此通过总移动能耗则可以准确体现各任务执行路线的总能耗之间的关系。

[0045] 可选的，扫地机器人可以包含独立驱动的前部、中部和后部三个部分，三个部分均可以单独升降，前部、中部和后部的底面分别设置有测距传感器，分别用于检测前部、中部和后部的底面与地面间的距离。基于该种设计，扫地机器人可以实现前述爬楼功能，下面针

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对上楼和下楼两种情况，分别给出了对应的执行过程：

其一，对于爬楼路径中的每一上行台阶，扫地机器人的处理可以如图4的流程所示：

步骤401，扫地机器人驱动前部抬升，并前进以使前部落在台阶上。

[0046] 在实施中，扫地机器人在执行地面清洁任务的过程中，可以通过前置的台阶检测单元(如摄像单元+图像分析单元)实时获取行进前方图像以判断前方是否存在上行台阶。当发现上行台阶，且与台阶边缘的水平距离小于预设阈值时，扫地机器人可以驱动前部抬升，并前进使得前部落在台阶上。细节而言，扫地机器人可以先将前部抬升至最高，然后前进预设距离，再降低前部以落在台阶上。进一步的，扫地机器人的前部底面可以设置有测距传感器，在降低过程中可以通过测距传感器检测前部底面与台阶间的垂直距离，当垂直距离到达指定阈值时，即可推定前部已落在台阶上。

[0047] 步骤402，扫地机器人驱动中部的底面抬升至与前部的底面持平，并前进以使中部落在台阶上。

[0048] 在实施中，扫地机器人的前部落在台阶上之后，可以继续驱动中部的底面抬升，直至与前部的底面位于同一水平面。接下来，扫地机器人可以再前进预设距离，使得中部落在台阶上。可以看到，在驱动中部抬升时，可以以前部的已抬升高度作为基准对中部进行抬升，也可以依照前部的抬升方式来实现中部的抬升。

[0049] 步骤403，扫地机器人驱动后部的底面抬升至与中部的底面持平，并前进以使后部落在台阶上。

[0050] 在实施中，扫地机器人的中部落在台阶上之后，可以按照抬升中部的方式，继续抬升后部，以使后部的底面与中部的底面位于同一水平面，继而，扫地机器人可以再次前进预设距离，使得后部落在台阶上。至此，扫地机器人完成了针对一层上行台阶的爬楼处理。

[0051] 上述过程也可以参考图5所示内容，一个上行台阶的攀爬过程可以分为7个阶段，对应上述步骤401-403的说明内容。

[0052] 其二，对于爬楼路径中的每一下行台阶，扫地机器人的处理可以如图6的流程所示：

步骤601，扫地机器人前进以使前部完全悬空后，驱动前部降低落在台阶上。

[0053] 在实施中，扫地机器人在执行地面清洁任务的过程中，可以通过前置的摄像单元实时获取行进前方图像以判断前方是否存在下行台阶。当发现下行台阶，且前部的前侧边缘悬空时，扫地机器人可以缓慢前进使得前部完全悬空，之后可以驱动前部降低以落在台阶上。细节而言，扫地机器人的前部底面前沿可以设置有测距传感器，当通过测距传感器检测到与地面距离大于预设阈值时，即可以认定前部的前侧边缘悬空，后续可以前进预设距离以使前部处于完全悬空的状态；或者，扫地机器人的前部底面后沿可以设置有测距传感器，当通过测距传感器检测到与地面距离大于预设阈值时，即可以认定前部处于完全悬空状态。之后在降低过程中可以通过测距传感器检测前部底面与台阶间的垂直距离，当垂直距离到达指定阈值时，即可推定前部已落在台阶上。

[0054] 步骤602，扫地机器人继续前进以使中部完全悬空后，驱动中部降低落在台阶上。

[0055] 在实施中，扫地机器人的前部落在台阶上之后，可以继续前进以使中部完全悬空。此处，判断中部完全悬空的方法可以与前述判断前部完全悬空的方法相同，故而不再赘述。

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接下来，扫地机器人可以驱动中部降低，使得中部落在台阶上。不难理解，在驱动中部下降时，可以以前部的已降低高度作为基准对中部进行降低，也可以依照前部的降低方式来实现中部的降低。

[0056] 步骤603，扫地机器人继续前进以使后部完全悬空后，驱动后部降低落在台阶上。

[0057] 在实施中，扫地机器人的中部落在台阶上之后，可以继续前进以使后部进入完全悬空的状态，之后可以进一步驱动后部降低，以使后部落在台阶上。后部降低的过程可以参考中部降低的过程，此处不再进行详细说明。至此，扫地机器人完成了针对一层下行台阶的爬楼处理。

[0058] 上述过程也可以参考图7所示内容，一个下行台阶的攀爬过程可以分为7个阶段，对应上述步骤601-603的说明内容。

[0059] 值得一提的是，当扫地机器人的左右侧边宽度大于台阶深度时，扫地机器人的前部和后部可以同时执行不同台阶的攀爬处理。

[0060] 另外，扫地机器人的前部、中部、后部的设定可以以前进方向而定，或者可以设定扫地机器人结构上从前之后包含一部、二部和三部，前进时一部为前部、二部为中部、三部为后部，后退时三部为前部、二部为中部、一部为后部。

[0061] 可选的，基于前部、中部和后部的底面均设置有测距传感器的结构，扫地机器人可以通过测量前部抬升或降低的高度，来稳定爬楼过程，相应的处理如下：在爬楼过程中，扫地机器人记录已爬台阶的台阶高度；若落在台阶前前部抬升或降低的高度与台阶高度不一致，扫地机器人则沿台阶边缘方向平移预设距离后，重新驱动前部以使前部落在台阶上。

[0062] 在实施中，扫地机器人在爬楼过程中，可以记录已爬台阶的台阶高度，该台阶高度可以是在预设历史时长内的已爬台阶的平均台阶高度，也可以是最近爬过的预设属两个台阶的平均台阶高度。在每爬一层台阶的过程中，扫地机器人可以记录前部落在台阶前所抬升或者降低的高度，并判断该高度是否与已记录的台阶高度一致。可以理解，在正常情况下，同一楼梯的多层台阶的台阶高度一般均保持一致，因此，若前部抬升或降低的高度与已记录的台阶高度不一致，则大概率表明前部底面落在了台阶上的障碍物上。此时，扫地机器人可以整体沿台阶边缘方向平移预设距离，再重新驱动前部以使前部落在台阶上，直至抬升或降低的高度与记录的台阶高度一致。此外，考虑到在部分情况下同一楼梯的多层台阶的台阶高度可能不一致，扫地机器人可以在爬楼时，分别在台阶最左侧、中部和最右侧三处进行爬楼尝试，如果发现三处的前部抬升或降低高度均与台阶高度不一致，且三处的前部抬升或降低高度一致，则可以执行后续爬楼处理。

[0063] 可选的，扫地机器人可以在上述爬楼的过程，同步执行台阶的清洁，相应的处理可以如下：如果台阶属于待清洁区域，扫地机器人判断爬楼过程中相对台阶的清洁覆盖宽度；当清洁覆盖宽度达到台阶深度或者最大清洁覆盖宽度时，扫地机器人沿台阶边缘方向平移以清洁台阶；若台阶深度大于最大清洁覆盖宽度，扫地机器人则基于台阶深度和最大清洁覆盖宽度，制定台阶清洁路线；扫地机器人基于台阶清洁路线清洁台阶。

[0064] 在实施中，如果某段楼梯属于待清洁区域，扫地机器人则可以在爬楼过程中同步对该楼梯的台阶进行清洁。具体的，扫地机器人在爬一个台阶时，可以实时检测扫地机器人相对台阶的清洁覆盖宽度，该清洁覆盖宽度即为扫地机器人清洁台阶时一次移动所覆盖的宽度，同理，最大清洁覆盖宽度即为扫地机器人一次移动时所能覆盖的最大宽度。若最大清

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洁覆盖宽度大于等于台阶深度，则当清洁覆盖宽度达到台阶深度时，在扫地机器人的一次平移过程中台阶的整体台面均可以得到的清洁，因此扫地机器人可以沿台阶边缘方向平移以开始清洁台阶；若最大清洁覆盖宽度小于台阶深度，扫地机器人则可以依照台阶宽度和最大清洁覆盖宽度来指定台阶清洁路线。例如，若最大清洁覆盖宽度小于台阶深度，且大于台阶深度的二分之一，则扫地机器人两次平移过程即可完成台阶整体台面的清洁，故而可以指定台阶清洁路线为先从台阶左侧边缘平移到右侧边缘，再前进指定距离，然后平移返回左侧边缘；若最大清洁覆盖宽度小于台阶深度的二分之一，且大于台阶深度的三分之一，则扫地机器人需要三次平移过程即可完成台阶整体台面的清洁，那么可以指定台阶清洁路线为先从台阶左侧边缘平移到右侧边缘，前进指定距离，平移返回左侧边缘，再次前进指定距离后，平移至右侧边缘。这样，扫地机器人可以基于制定好的台阶清洁路线清洁台阶。可以理解，对于同时需要攀爬和清洁的台阶，扫地机器人可以优先执行爬楼过程，在清洁覆盖宽度到达最大清洁覆盖宽度或者台阶深度后，扫地机器人再执行清洁过程，这样清洁和爬楼的两种行为可以互不影响。

[0065] 需要说明的是，在规划任务执行路线时，扫地机器人还可以衡量本机剩余能量和任务执行路线所需总能耗二者间的关系，并同时引入充电点的位置信息。基于此，如果本机剩余能量大于或等于任务执行路线所需总能耗，则扫地机器人可以按照步骤101至步骤105的处理执行地面清洁处理；如果本机剩余能量小于任务执行路线所需总能耗，则可以在规划任务执行路线时，加入充电点的位置信息，使得任务执行路线以扫地机器人当前位置为起点，串连所有待清洁区域，且经过一个充电点，且到达充电点前的能源消耗低于本机剩余能量。

[0066] 采用本申请公开的执行地面清洁任务的方法，在执行地面清洁任务时，扫地机器人根据多个待清洁区域在不同楼层间的分布位置，规划多条任务执行路线，并基于爬楼单位能耗和平地移动单位能耗统计每条任务执行路线上纯移动路段的总移动能耗，进而基于总移动能耗选取任务执行路线来进行地面清洁。这样，在对多块区域进行清洁时，由扫地机器人自主规划筛选任务执行路线，再按照任务执行路线清洁地面，整个过程无需用户人为干预，扫地机器人可以自行连续地完成所有区域的清洁工作，地面清洁的效率较高，能耗成本和人力成本均较低。

[0067] 基于相同的技术构思，如图8所示，本申请实施例提供了一种执行地面清洁任务的装置，所述装置包括：

区域确定模块801，用于获取地面清洁任务，确定多个待清洁区域，所述多个待清洁区域分布在一个或多个楼层；

路线规划模块802，用于根据本机当前位置和所述多个待清洁区域的分布位置，规划至少一条串连所有所述待清洁区域的任务执行路线；

路段统计模块803，用于对于每一所述任务执行路线，统计所述任务执行路线中的纯移动路段，所述纯移动路段包括爬楼路段和平地路段；

能耗确定模块804，用于基于预设的爬楼单位能耗和平地移动单位能耗，确定每一所述任务执行路线的总移动能耗；

任务执行模块805，用于基于所述总移动能耗最低的目标任务执行路线，执行所述地面清洁任务。

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[0068] 可选的，所述路线规划模块802，具体用于：

根据本机当前位置和所述多个待清洁区域的分布位置以及每个所述待清洁区域的区域形状，规划至少一条串连所有所述待清洁区域的任务执行路线。

[0069] 可选的，所述装置包含独立驱动的前部，中部和后部；

所述任务执行模块805，还用于：

对于爬楼路径中每一上行台阶，驱动所述前部抬升，并前进以使所述前部落在所述台阶上；

驱动所述中部的底面抬升至与所述前部的底面持平，并前进以使所述中部落在所述台阶上；

驱动所述后部的底面抬升至与所述中部的底面持平，并前进以使所述后部落在所述台阶上。

[0070] 可选的，所述装置包含独立驱动的前部，中部和后部；

所述任务执行模块805，还用于：

对于爬楼路径中每一下行台阶，前进以使所述前部完全悬空后，驱动所述前部降低落在所述台阶上；

继续前进以使所述中部完全悬空后，驱动所述中部降低落在所述台阶上；

继续前进以使所述后部完全悬空后，驱动所述后部降低落在所述台阶上。

[0071] 可选的，所述前部、中部和后部的底面分别设置有测距传感器，分别用于检测所述前部、中部和后部的底面与地面间的距离。

[0072] 可选的，所述任务执行模块805，还用于：

在爬楼过程中，所述扫地机器人记录已爬台阶的台阶高度；

若落在所述台阶前所述前部抬升或降低的高度与所述台阶高度不一致，所述扫地机器人则沿台阶边缘方向平移预设距离后，重新驱动所述前部以使所述前部落在所述台阶上。

[0073] 可选的，所述任务执行模块805，还用于：

如果所述台阶属于待清洁区域，所述扫地机器人判断爬楼过程中相对所述台阶的清洁覆盖宽度；

当所述清洁覆盖宽度达到台阶深度时，所述扫地机器人沿台阶边缘方向平移以清洁所述台阶；

若所述台阶深度大于所述最大清洁覆盖宽度，所述扫地机器人则基于所述台阶宽度和所述最大清洁覆盖宽度，制定台阶清洁路线；

所述扫地机器人基于所述台阶清洁路线清洁所述台阶。

[0074] 本申请实施例还提供了一种扫地机器人，所述扫地机器人包括处理器和存储器，所述存储器中存储有至少一条指令、至少一段程序、代码集或指令集，所述至少一条指令、所述至少一段程序、所述代码集或指令集由所述处理器加载并执行以实现如步骤101-步骤105所述的执行地面清洁任务的方法。

[0075] 本领域普通技术人员可以理解实现上述实施例的全部或部分步骤可以通过硬件来完成，也可以通过程序来指令相关的硬件完成，所述的程序可以存储于一种计算机可读存储介质中，上述提到的存储介质可以是只读存储器，磁盘或光盘等。

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[0076] 以上均为本申请的较佳实施例，并非依此限制本申请的保护范围，本说明书(包括摘要和附图)中公开的任一特征，除非特别叙述，均可被其它等效或者具有类似目的的替代特征加以替换。即，除非特别叙述，每个特征只是一系列等效或类似特征中的一个例子而已。

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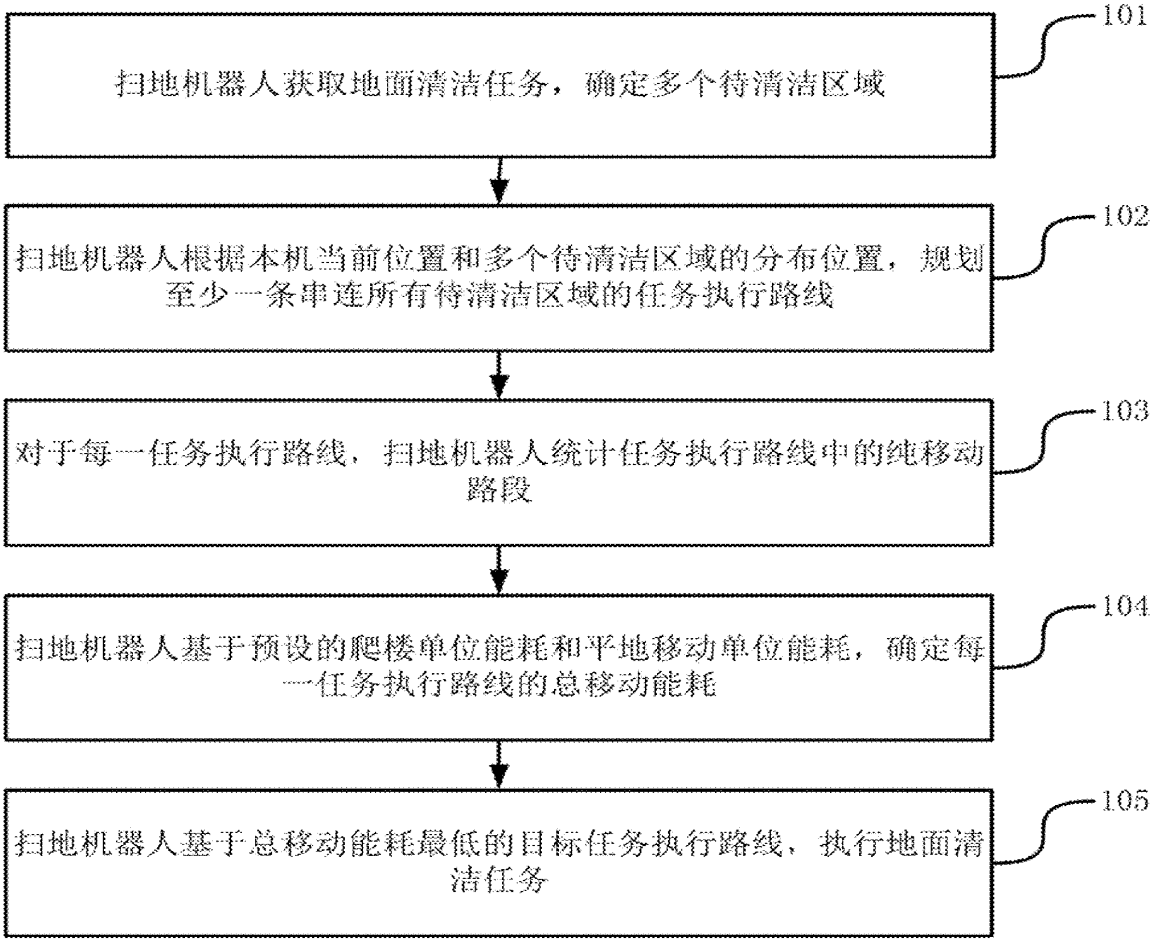


图1

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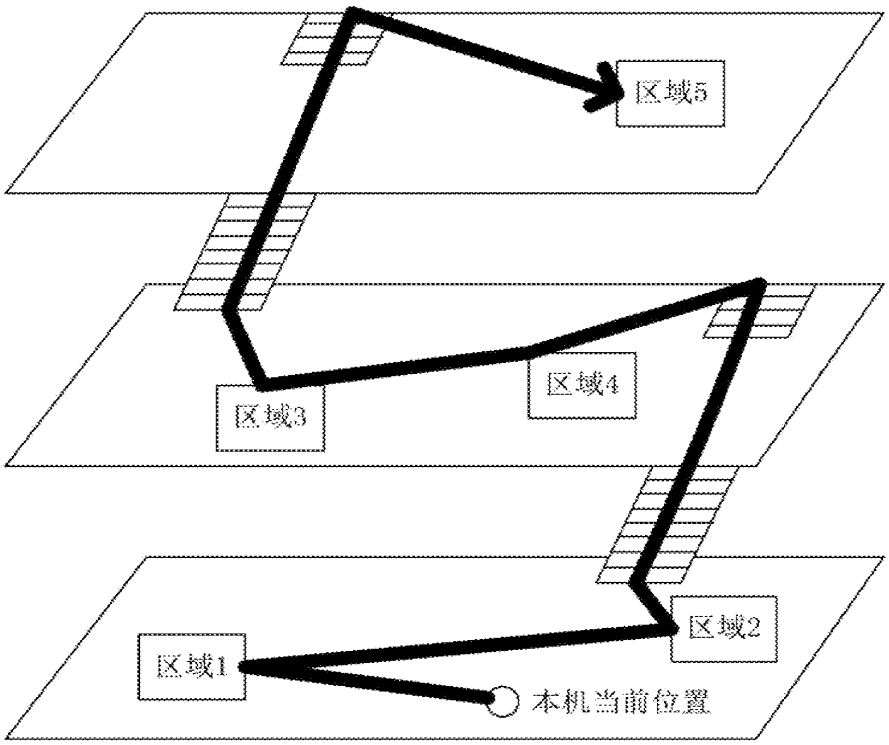


图2

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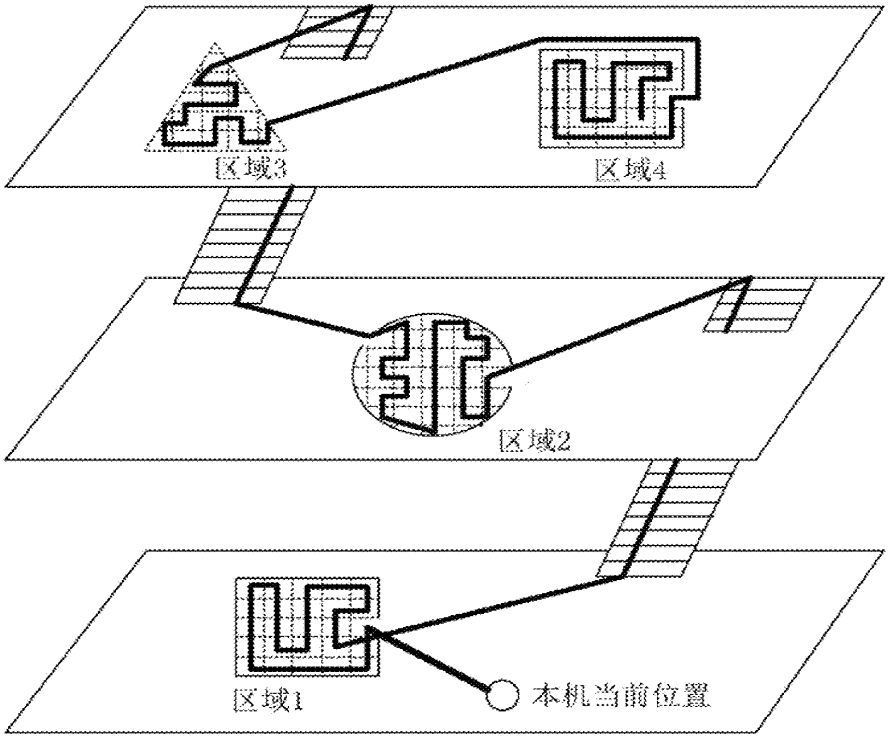


图3

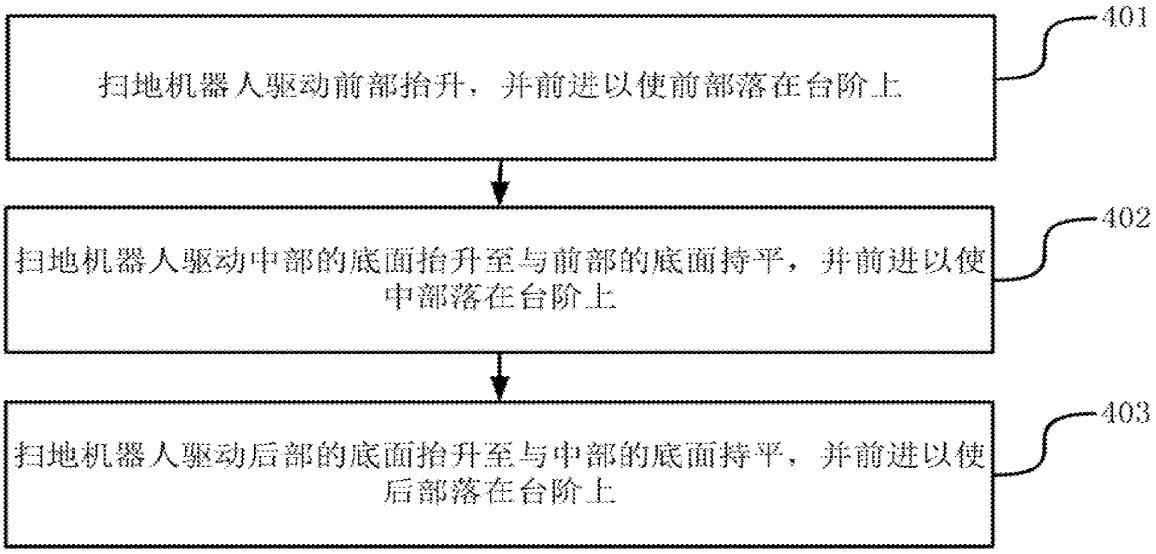


图4

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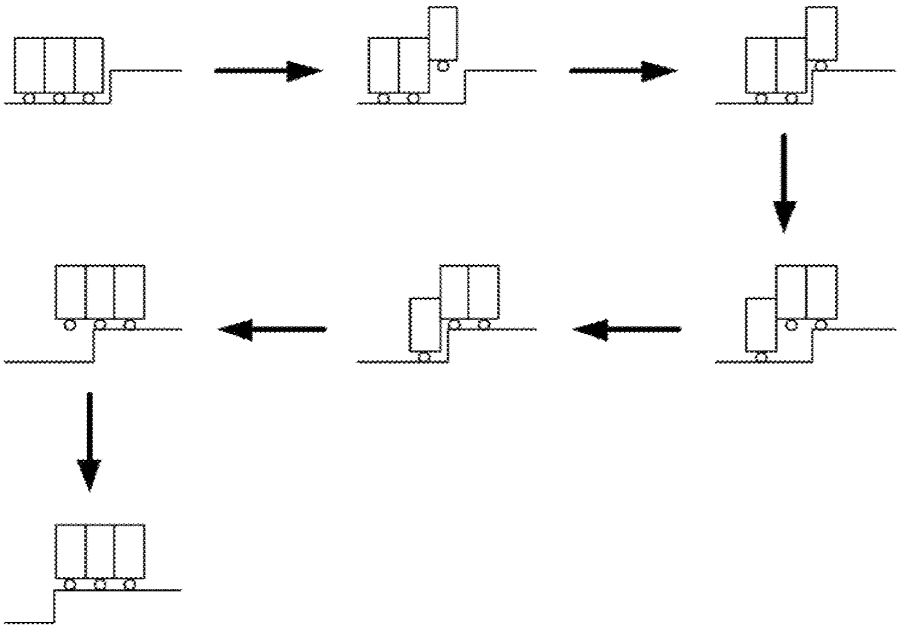


图5

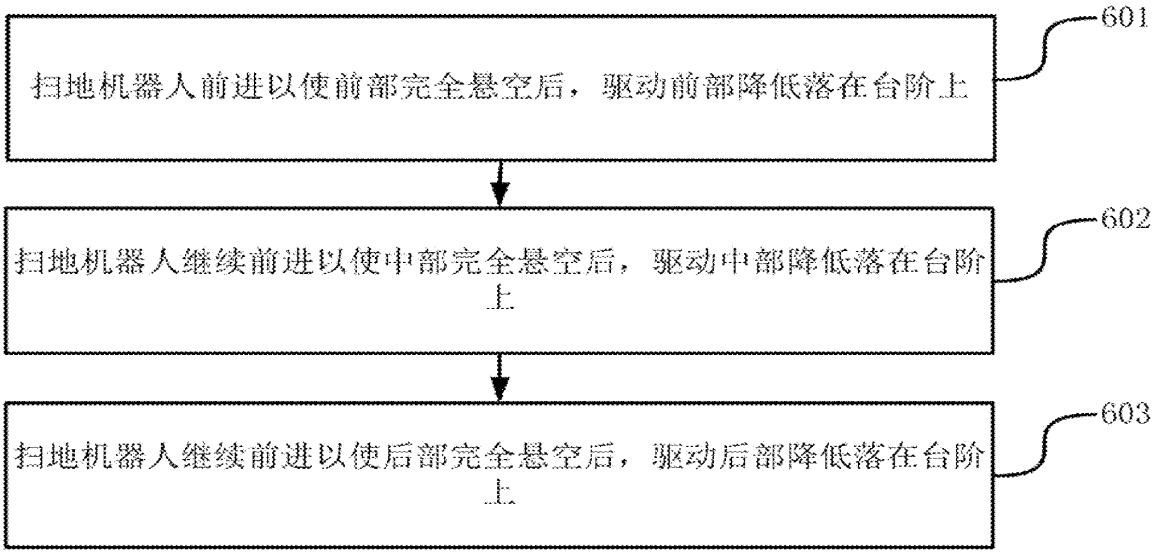


图6

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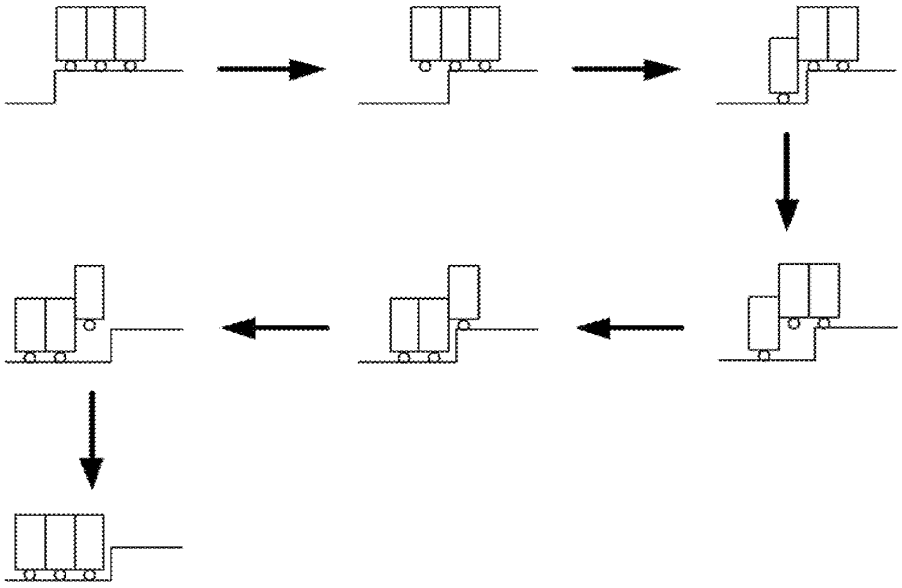


图7

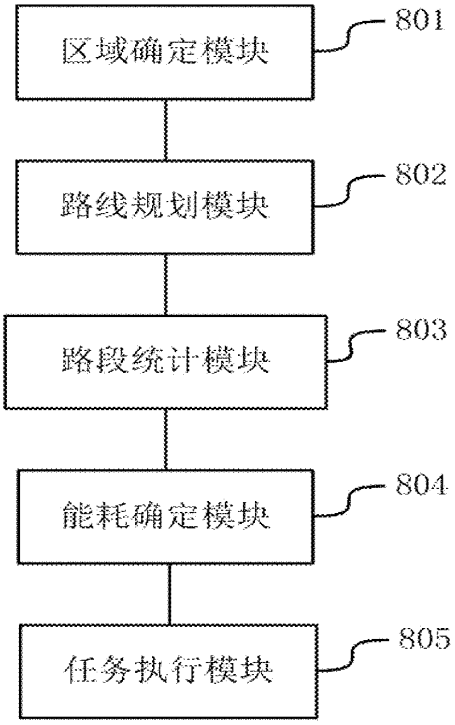


图8

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Espacenet

KR20090061355A METHOD FOR CONTROLLING DRIVING OF MOVING ROBOT AND MOVING ROBOT USING THE SAME

Applicants: POSDATA CO LTD [KR]

Inventors: KIM JONG HWA [KR]

Classifications:
IPC ***G05D1/02;***

CPC **G05D1/0214 (KR); G05D1/0246 (KR); G05D1/0274 (KR);**

Priorities: KR20070128341A 2007-12-11

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Publication: KR20090061355A·2009-06-16

Published as: **KR100933539B1;** KR20090061355A

METHOD FOR CONTROLLING DRIVING OF MOVING ROBOT AND MOVING ROBOT USING THE SAME

Abstract

A running control method of the mobile robot and mobile robot using the same are provided, which can shorten the mapping time by making the map about the movement route using the mobile robot. An image sensor(120) recognizes clearly indicating papers arranged in the environment in which the mobile robot is positioned, or takes a picture of image in the movement of the mobile robot. By using indicating papers acknowleged by the image sensor, the positioning unit(132) decides the movement route and one or more goals of the mobile robot, or determines the location of the mobile robot. By using the movement route and one or more goals determined by the positioning unit, the map drawing part(134) makes map. The memory(150) stores the map made by the map drawing part. The driving part(110) moves the mobile robot. The driving control part(136) controls the driving part and moves the mobile robot.

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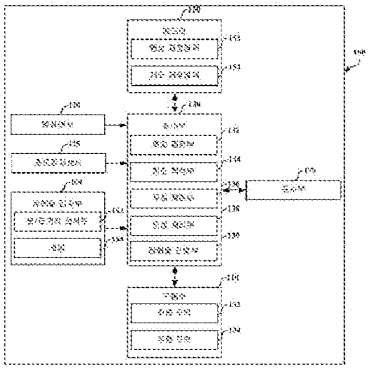
전체 청구항 수 : 총 30 항

(54) 이동로봇의 주행 제어 방법 및 이를 이용한 이동 로봇

(57) 요 약

식별지의 인식을 통해 이동로봇의 이동경로에 관한 지도를 작성하거나, 이동로봇이 위치한 환경의 조도를 고려하여 특정 객체의 영상을 인식함으로써 목적지의 위치 판단이나 장애물을 판별할 수 있는 본 발명의 일 실시예에 따른 이동로봇의 주행 제어 방법은 영상 센서를 이용하여 이동로봇이 위치한 환경에 배치된 식별지들을 인식하는 단계 상기 인식된 식별지들을 이용하여 상기 이동로봇의 이동경로 및 하나 이상의 목표점을 결정하는 단계 및 상기 이동경로 및 상기 하나 이상의 목표점을 이용하여 지도를 작성하는 단계를 포함한다.

대 표 도 - 도1



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특허청구의 범위

청구항 1

영상 센서를 이용하여 이동로봇이 위치한 환경에 배치된 식별지들을 인식하는 단계;

상기 인식된 식별지들을 이용하여 상기 이동로봇의 이동경로 및 하나 이상의 목표점을 결정하는 단계; 및

상기 이동경로 및 상기 하나 이상의 목표점을 이용하여 지도를 작성하는 단계를 포함하는 것을 특징으로 하는 이동로봇의 주행 제어 방법.

청구항 2

제1항에 있어서, 상기 이동로봇의 이동경로 및 목표점 결정단계에서, 상기 이동로봇의 이동경로 및 상기 하나 이상의 목표점은 상기 인식된 식별지의 색상 및 모양 중 적어도 하나에 따라 결정되는 것을 특징으로 하는 이동로봇의 주행 제어 방법.

청구항 3

제1항에 있어서, 상기 이동경로는 상기 인식된 식별지의 색상 및 모양 중 적어도 하나에 따라 전역 이동경로 및 지역 이동경로로 구분되고, 상기 목표점은 상기 인식된 식별지의 색상 및 모양 중 적어도 하나에 따라 전역 목표점 및 지역 목표점으로 구분되는 것을 특징으로 하는 이동로봇의 주행 제어 방법.

청구항 4

제1항에 있어서,

상기 목표점 확인을 위해 각 조도별로 촬영된 목표점 확인영상을 수집하여 상기 각 목표점과 매칭시켜 저장하는 단계;

상기 목표점에 대한 이동명령이 수신되면, 상기 작성된 지도를 참조하여 상기 목표점으로 이동하는 단계;

상기 목표점에서의 조도를 감지한 후 상기 목표점에서 영상을 촬영하는 단계; 및

상기 목표점에서의 촬영영상과 상기 목표점에 매칭되어 있는 상기 감지된 조도에서의 목표점 확인영상을 비교하여 상기 이동로봇의 위치를 판단하는 단계를 더 포함하는 것을 특징으로 하는 이동로봇의 주행 제어 방법.

청구항 5

제4항에 있어서, 상기 이동로봇의 위치 판단 단계는,

상기 목표점에서의 촬영영상 및 상기 목표점 확인영상을 전처리 하는 단계를 더 포함함으로써,

상기 전처리된 목표점에서의 촬영영상과 상기 전처리된 목표점 확인영상의 차이가 기준치 이하인 경우 상기 목표점에서의 촬영영상과 상기 목표점 확인영상을 비교하는 것을 특징으로 하는 이동로봇의 주행 제어 방법.

청구항 6

제5항에 있어서, 상기 전처리는 MCT(Modified Census Transform)를 이용하여 수행되는 것을 특징으로 하는 이동로봇의 주행 제어 방법.

청구항 7

제4항에 있어서, 상기 이동로봇의 위치 확인 단계는,

상기 목표점에서의 촬영영상 및 상기 목표점 확인영상으로부터 특징점을 추출하고, 추출된 상기 목표점에서의 촬영영상의 특징점과 상기 목표점 확인영상의 특징점을 매칭함으로써 상기 목표점 확인영상과 목표점 촬영영상을 비교하는 것을 특징으로 하는 이동로봇의 주행 제어 방법.

청구항 8

제7항에 있어서, 상기 각 영상의 특징점은 SIFT(Scale Invariant Feature Transform)을 이용하여 추출되는 것

을 특징으로 하는 이동로봇의 주행 제어 방법.

청구항 9

제4항에 있어서, 상기 이동로봇의 위치 확인 단계에서 상기 목표점에서의 촬영 영상과 상기 목표점 확인영상에 차이가 있는 경우, 상기 목표점에서의 촬영영상이 상기 목표점 확인영상과 동일해지도록 상기 이동로봇의 위치를 보정하는 단계를 더 포함하는 것을 특징으로 하는 이동로봇의 주행 제어 방법.

청구항 10

제1항에 있어서,

장애물 확인을 위해 각 조도별로 촬영된 장애물 확인영상을 수집하여 저장하는 단계;

상기 작성된 지도를 따라 이동 중에 장애물이 감지되면, 상기 장애물 감지 위치에서의 조도를 감지한 후 상기 장애물 감지 위치에서 영상을 촬영하는 단계; 및

상기 장애물 감지 위치에서의 촬영상과 상기 감지된 조도에 매칭되어 있는 상기 장애물 확인영상을 비교하여 상기 장애물을 판별하는 단계를 더 포함하는 것을 특징으로 하는 이동로봇의 주행 제어 방법.

청구항 11

제10항에 있어서, 상기 장애물 판별 단계는,

상기 장애물 감지 위치에서의 촬영영상 및 상기 장애물 확인영상을 전처리 하는 단계를 더 포함함으로써,

상기 전처리된 장애물 감지 위치에서의 촬영영상 및 상기 전처리된 장애물 확인영상의 차이가 기준치 이하인 경우 상기 장애물 감지 위치에서의 촬영영상과 상기 장애물 확인영상의 비교를 수행하는 것을 특징으로 하는 이동로봇의 주행 제어 방법.

청구항 12

제11항에 있어서, 상기 전처리는 MCT(Modified Census Transform)를 이용하여 수행되는 것을 특징으로 하는 이동로봇의 주행 제어 방법.

청구항 13

제10항에 있어서, 상기 장애물 판별 단계는,

상기 장애물 감지위치에서의 촬영영상 및 상기 장애물 확인영상으로부터 특징점을 추출하고, 추출된 상기 장애물 감지위치에서의 촬영영상의 특징점과 상기 장애물 확인영상의 특징점을 매칭함으로써 상기 장애물 감지위치에서의 촬영영상과 상기 장애물 확인영상을 비교하는 것을 특징으로 하는 이동로봇의 주행 제어 방법.

청구항 14

제13항에 있어서, 상기 각 영상의 특징점은 SIFT(Scale Invariant Feature Transform)을 이용하여 추출되는 것을 특징으로 하는 이동로봇의 주행 제어 방법.

청구항 15

제10항에 있어서,

상기 장애물이 판별되면 판별된 장애물에 따라 장애물 회피 경로를 설정하는 단계; 및

상기 설정된 회피 경로에 따라 이동하여 상기 장애물을 회피하는 단계를 더 포함하는 것을 특징으로 하는 이동로봇의 주행 제어 방법.

청구항 16

제10항에 있어서, 상기 장애물의 감지는 상기 이동로봇의 이동 중 상기 이동로봇에 장착된 각 센서에 의해 수신되는 신호 도달 거리 또는 상기 이동로봇에 장착된 범퍼로부터 수신되는 신호를 분석하여 수행되는 것을 특징으로 하는 이동로봇의 주행 제어 방법.

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청구항 17

영상센서를 통해 촬영된 확인영상을 각 조도별로 수집하는 단계;

이동로봇의 이동 중 특정 위치에서 상기 영상센서를 통해 하나 이상의 촬영영상이 수신되면, 상기 특정위치에서 감지된 조도와 매칭되어 있는 상기 확인영상을 추출하는 단계;

상기 특정위치에서 수신된 상기 하나 이상의 촬영영상 및 상기 추출된 확인영상을 전처리 하는 단계;

상기 하나 이상의 촬영영상 중 상기 전처리된 촬영영상과 상기 전처리된 확인영상의 차이가 기준치 이하인 촬영영상을 결정하는 단계; 및

상기 결정된 촬영영상과 상기 추출된 확인영상의 동일여부를 판단하는 단계를 포함하는 것을 특징으로 하는 이동로봇의 주행 제어 방법.

청구항 18

제17항에 있어서, 상기 확인영상은 상기 이동로봇의 목표점 확인을 위한 목표점 확인영상 및 상기 이동로봇이 위치한 환경에 존재하는 장애물 확인을 위한 장애물 확인영상 중 적어도 하나를 포함하는 것을 특징으로 하는 이동로봇의 주행 제어 방법.

청구항 19

제17항에 있어서, 상기 동일 여부 판단 단계는, 상기 결정된 촬영영상 및 상기 추출된 확인영상으로부터 특징점을 추출하고, 상기 결정된 촬영영상으로부터 추출된 특징점과 상기 추출된 확인영상으로부터 추출된 특징점을 매칭함으로써 상기 결정된 촬영영상과 상기 추출된 확인영상의 동일 여부를 판단하는 것을 특징으로 하는 이동로봇의 주행 제어 방법.

청구항 20

제19항에 있어서, 상기 전처리는 MCT(Modified Census Transform)를 이용하여 수행되고, 상기 특징점 추출은 SIFT(Scale Invariant Feature Transform)을 이용하여 수행되는 것을 특징으로 하는 이동로봇의 주행 제어 방법.

청구항 21

제1항 내지 제20항 중 어느 하나의 항에 기재된 이동로봇의 주행 제어방법을 수행하기 위한 프로그램이 기록된 기록매체.

청구항 22

이동로봇이 위치한 환경에 배치된 식별지들을 인식하거나, 이동로봇의 이동 중 영상을 촬영하는 영상 센서;

상기 영상 센서에 의해 인식된 식별지들을 이용하여 상기 이동로봇의 이동경로 및 하나 이상의 목표점을 결정하거나, 이동로봇의 위치를 판단하는 위치 결정부

상기 위치 결정부에 의해 결정된 상기 이동경로 및 상기 하나 이상의 목표점을 이용하여 지도를 작성하는 지도 작성부;

상기 지도 작성부에 의해 작성된 지도가 저장되는 메모리;

상기 이동로봇을 이동시키는 구동부; 및

상기 위치 결정부에 의해 결정된 이동경로 또는 상기 지도 작성부에 의해 작성된 지도에 따라 상기 이동로봇이 이동하도록 상기 구동부를 제어하는 주행 제어부를 포함하는 것을 특징으로 하는 이동로봇.

청구항 23

제22항에 있어서,

상기 위치 결정부는 상기 영상센서에 의해 인식된 식별지의 색상 및 모양 중 적어도 하나에 따라 상기 이동로봇의 이동경로 및 상기 하나 이상의 목표점을 결정하고, 상기 인식된 식별지의 색상 및 모양 중 적어도 하나에 따

라 상기 이동경로를 전역 이동경로 및 지역 이동경로로 구분하며, 상기 인식된 식별지의 색상 및 모양 중 적어도 하나에 따라 상기 목표점을 전역 목표점 및 지역 목표점으로 구분하는 것을 특징으로 하는 이동로봇.

청구항 24

제22항에 있어서,

상기 메모리에는 상기 목표점 확인을 위한 목표점 확인영상과 장애물 확인을 위한 장애물 확인 영상이 각 조 도별로 저장되어 있고, 상기 목표점 확인 영상은 상기 목표점과 매칭되어 저장되어 있는 것을 특징으로 하는 이동로봇.

청구항 25

제24항에 있어서,

상기 이동로봇이 위치한 환경의 조도를 감지하는 조도감지 센서; 및

상기 목표점으로의 이동명령에 따라 상기 이동로봇이 상기 목표점으로 이동하면 상기 목표점에 매칭되어 있는 상기 감지된 조도에서의 목표점 확인영상과 상기 영상센서를 통해 획득된 상기 목표점에서의 촬영영상을 비교하는 영상처리부를 더 포함하고,

상기 위치 결정부는 상기 영상처리부에 의한 비교결과 상기 목표점에서의 촬영 영상과 상기 목표점 확인영상에 차이가 있는 경우 상기 이동로봇의 위치를 보정하기 위한 보정 경로를 생성하여 상기 주행 제어부로 전송하는 것을 특징으로 하는 이동로봇.

청구항 26

제24항에 있어서,

상기 영상처리부는 목표점에서의 촬영영상 및 상기 목표점 확인영상을 전처리 함으로써 전처리된 목표점에서의 촬영영상 및 목표점 확인영상을 비교하는 것을 특징으로 하는 이동로봇.

청구항 27

제26항에 있어서, 상기 영상처리부는 MCT(Modified Census Transform)를 이용하여 전처리를 수행하는 것을 특징으로 하는 이동로봇.

청구항 28

제25항에 있어서,

상기 영상처리부는 상기 목표점에서의 촬영영상 및 상기 목표점 확인영상으로부터 특징점을 추출하고, 추출된 상기 목표점에서의 촬영영상의 특징점과 상기 목표점 확인영상의 특징점을 비교하는 것을 특징으로 하는 이동로봇.

청구항 29

제28항에 있어서,

상기 영상 처리부는 SIFT(Scale Invariant Feature Transform)을 이용하여 상기 목표점에서의 촬영영상과 상기 목표점 확인영상으로부터 특징점을 추출하는 것을 특징으로 하는 이동로봇.

청구항 30

제24항에 있어서,

상기 이동로봇이 위치한 환경의 조도를 감지하는 조도감지 센서;

상기 이동로봇의 이동 중 장애물의 존재여부를 감지하는 장애물 감지부;

상기 장애물 감지부에 의해 장애물이 감지되면, 상기 장애물이 감지된 위치에서의 조도에 매칭되어 있는 상기 장애물 확인영상들과 상기 영상센서를 통해 획득된 상기 장애물 감지 위치에서의 촬영영상을 비교하여 상기 장

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애물 확인영상 중 상기 장애물 촬영영상과 동일한 영상을 추출하는 영상 처리부; 및

상기 영상처리부에 의해 추출된 장애물 확인영상을 이용하여 상기 장애물 감지부에 의해 감지된 장애물을 판별하고, 판별된 장애물을 회피하기 위한 장애물 회피 경로를 생성하여 상기 주행 제어부로 전송하는 장애물 판별부를 더 포함하는 것을 특징으로 하는 이동로봇.

명 세 서

발명의 상세한 설명

기 술 분 야

<1> 본 발명은 이동 로봇에 관한 것으로서 보다 상세하게는 이동 로봇의 주행을 제어하는 방법 및 이를 이용한 이동로봇에 관한 것이다.

배 경 기 술

<2> 로봇은 산업용으로 개발되어 공장 자동화의 일환으로 사용되거나, 인간이 견딜 수 없는 극한의 환경에서 인간을 대신하여 정보를 수집하거나 채집하는데 사용되어 왔다. 최근에는 이러한 로봇의 연구가 활발해 짐에 따라 최첨단 우주개발산업에 이용되는 로봇은 물론 일상 생활에서 이용되는 로봇이 개발되기에 이르렀다. 예컨대, 일상 생활에 이용되는 로봇으로는 주택 또는 사물과 같은 일정한 구역을 청소하는 청소로봇이나, 박물관이나 대형 건물 등에서 위치를 안내하는 위치 안내로봇 등이 있다.

<3> 이동로봇은 이동로봇의 이동경로에 관한 지도를 미리 작성하고, 작성된 지도에 따라 이동한다. 이러한 지도를 작성하는 방법으로 종래에는, 이동로봇이 랜덤하게 움직이다 벽이나 장애물이 감지되는 경우 벽이나 장애물의 위치를 시작점을 기준으로 하여 기록한 후 다시 랜덤하게 움직이면서 또 다른 장애물이나 벽의 위치를 추가로 기록함으로써 지도를 작성하는 방법, 이동로봇이 벽을 따라가면서 장애물이 감지되는 경우 감지된 장애물의 위치를 기록함으로써 지도를 작성하는 방법, 및 사용자가 이동로봇이 주행해야 할 경로를 수동으로 끌고 가면서 주행해야 할 위치를 이동로봇에게 학습시키는 방법 등이 이용되었다.

<4> 그러나, 이동로봇이 랜덤하게 이동하면서 감지되는 장애물이나 벽의 위치를 기록함에 의해 지도를 작성하는 방법 및 이동로봇이 벽을 따라가면서 감지되는 장애물의 위치를 기록함에 의해 지도를 작성하는 방법은 정확성이 결여될 수 있다는 문제점이 있고, 사람이 이동로봇을 끌고 다니면서 이동로봇의 이동경로를 학습시키는 방법은 정확성은 향상시킬 수 있지만, 지도 작성이 불편할 뿐만 아니라 지도 작성에 많은 시간이 소요된다는 문제점이 있다.

<5> 한편, 이동로봇이 목적지의 위치를 인식하는 방법으로서, 종래에는 작성된 지도에 기록된 좌표를 이용하여 목적지의 위치를 인식하는 방법, 이동로봇이 위치한 공간의 천장이나 벽 등에 설치된 주행 유도기를 통해 이동로봇이 자신의 현재 위치를 인식함으로써 목적지의 위치를 인식하는 방법, 또는 목적지 영상을 통해 목적지의 위치를 인식하는 방법 등이 이용되었다.

<6> 이 중, 목적지의 영상을 통해 목적지의 위치를 인식하는 방법이 많이 이용되고 있는데, 이러한 목적지의 영상을 통해 목적지의 위치를 인식하는 방법의 경우, 종래에는 이동로봇이 위치하고 있는 공간의 조명 밝기를 고려하지 않고 영상의 동일여부를 판단하였으므로, 동일한 영상이라 하더라도 양 영상이 촬영된 시점의 조도가 다른 경우 이동로봇은 이를 다른 영상이라 판단할 수 있게 된다는 문제점이 있었다.

발명의 내용

해결 하고자하는 과제

<7> 본 발명은 상술한 문제점을 해결하기 위한 것으로서, 식별지의 인식을 통해 이동로봇의 이동경로에 관한 지도를 작성할 수 있는 이동로봇의 주행 제어 방법 및 이를 이용한 이동로봇을 제공하는 것을 기술적 과제로 한다.

<8> 또한, 본 발명은 조도를 고려하여 특정 객체의 영상을 인식함으로써 목적지의 위치를 판단하거나 장애물을 판별할 수 있는 이동로봇의 주행 제어 방법 및 이를 이용한 이동로봇을 제공하는 것을 다른 기술적 과제로 한다.

과제 해결수단

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<9> 상술한 목적을 달성하기 위한 본 발명의 일 측면에 따른 이동로봇의 주행 제어 방법은 영상 센서를 이용하여 이동로봇이 위치한 환경에 배치된 식별지들을 인식하는 단계 상기 인식된 식별지들을 이용하여 상기 이동로봇의 이동경로 및 하나 이상의 목표점을 결정하는 단계 및 상기 이동경로 및 상기 하나 이상의 목표점을 이용하여 지도를 작성하는 단계를 포함한다.

<10> 이때, 상기 이동로봇의 이동경로 및 상기 하나 이상의 목표점은 상기 인식된 식별지의 색상 및 모양 중 적어도 하나에 따라 결정되며, 상기 이동경로는 상기 인식된 식별지의 색상 및 모양 중 적어도 하나에 따라 전역 이동경로 및 지역 이동경로로 구분되고, 상기 목표점은 상기 인식된 식별지의 색상 및 모양 중 적어도 하나에 따라 전역 목표점 및 지역 목표점으로 구분된다.

<11> 한편, 상기 이동로봇의 주행 제어 방법은, 상기 목표점 확인을 위해 각 조도별로 촬영된 목표점 확인영상을 수집하여 상기 각 목표점과 매칭시켜 저장하는 단계를 더 포함하는 하고, 상기 목표점 확인영상 저장단계 이후에, 상기 목표점에 대한 이동명령이 수신되면, 상기 작성된 지도를 참조하여 상기 목표점으로 이동하는 단계 상기 목표점에서의 조도를 감지한 후 상기 목표점에서 영상을 촬영하는 단계 및 상기 목표점에서의 촬영영상과 상기 목표점에 매칭되어 있는 상기 감지된 조도에서의 목표점 확인영상을 비교하여 상기 이동로봇의 위치를 판단하는 단계를 더 포함할 수 있다.

<12> 일 실시예에 있어서, 상기 이동로봇의 위치 판단 단계는, 상기 목표점에서의 촬영영상 및 상기 목표점 확인영상을 전처리하는 단계를 더 포함함으로써, 상기 전처리된 목표점에서의 촬영영상과 상기 전처리된 목표점 확인영상의 차이가 기준치 이하인 경우 상기 목표점에서의 촬영영상과 상기 목표점 확인영상을 비교하는 할 수 있는데, 이때, 상기 전처리는 MCT(Modified Census Transform)를 이용하여 수행된다.

<13> 또한, 상기 이동로봇의 위치 확인 단계는, 상기 목표점에서의 촬영영상 및 상기 목표점 확인영상으로부터 특징점을 추출하고, 추출된 상기 목표점에서의 촬영영상의 특징점과 상기 목표점 확인영상의 특징점을 매칭함으로써 상기 목표점 확인영상과 목표점 촬영영상을 비교하는데, 이때, 상기 각 영상의 특징점은 SIFT(Scale Invariant Feature Transform)을 이용하여 추출된다.

<14> 이후, 상기 이동로봇의 위치 확인 단계에서 상기 목표점에서의 촬영 영상과 상기 목표점 확인영상에 차이가 있는 경우, 상기 목표점에서의 촬영영상이 상기 목표점 확인영상과 동일해지도록 상기 이동로봇의 위치를 보정하는 단계를 더 포함할 수 있다.

<15> 한편, 상기 이동로봇의 주행 제어 방법은, 장애물 확인을 위해 각 조도별로 촬영된 장애물 확인영상을 수집하여 저장하는 단계 상기 작성된 지도를 따라 이동 중에 장애물이 감지되면, 상기 장애물 감지 위치에서의 조도를 감지한 후 상기 장애물 감지 위치에서 영상을 촬영하는 단계 및 상기 장애물 감지 위치에서의 촬영상과 상기 감지된 조도에 매칭되어 있는 상기 장애물 확인영상을 비교하여 상기 장애물을 판별하는 단계를 더 포함할 수 있으며, 상기 장애물이 판별되면 판별된 장애물에 따라 장애물 회피 경로를 설정하는 단계 및 상기 설정된 회피 경로에 따라 이동하여 상기 장애물을 회피하는 단계를 더 포함할 수 있다.

<16> 상술한 목적을 달성하기 위한 이동로봇의 주행 제어 방법은, 영상센서를 통해 촬영된 확인영상을 각 조도별로 수집하는 단계 이동로봇의 이동 중 특정 위치에서 상기 영상센서를 통해 하나 이상의 촬영영상이 수신되면, 상기 특정위치에서 감지되는 조도와 매칭되어 있는 상기 확인영상을 추출하는 단계 상기 특정위치에서 수신된 상기 하나 이상의 촬영영상 및 상기 추출된 확인영상을 전처리하는 단계 상기 하나 이상의 촬영영상 중 상기 전처리된 촬영영상과 상기 전처리된 확인영상의 차이가 기준치 이하인 촬영영상을 결정하는 단계 및 상기 결정된 촬영영상과 상기 추출된 확인영상의 동일여부를 판단하는 단계를 포함한다.

<17> 상술한 목적을 달성하기 위한 본 발명의 또 다른 측면에 따른 이동로봇은 이동로봇이 위치한 환경에 배치된 식별지들을 인식하거나, 이동로봇의 이동 중 영상을 촬영하는 영상 센서 상기 영상 센서에 의해 인식된 식별지들을 이용하여 상기 이동로봇의 이동경로 및 하나 이상의 목표점을 결정하거나, 이동로봇의 위치를 판단하는 위치 결정부 상기 위치 결정부에 의해 결정된 상기 이동경로 및 상기 하나 이상의 목표점을 이용하여 지도를 작성하는 지도 작성부 상기 지도 작성부에 의해 작성된 지도가 저장되는 메모리 상기 이동로봇을 이동시키는 구동부 및 상기 위치 결정부에 의해 결정된 이동경로 또는 상기 지도 작성부에 의해 작성된 지도에 따라 상기 이동로봇이 이동하도록 상기 구동부를 제어하는 주행 제어부를 포함한다.

효 과

<18> 상술한 바와 같이 본 발명에 따르면, 식별지의 인식을 통해 이동로봇의 이동경로에 관한 지도를 이동로봇이 스

스로 작성함으로써 보다 정확한 지도의 작성은 물론, 지도 작성에 소요되는 시간을 줄일 수 있다는 효과가 있다.

<19> 또한, 본 발명은 지도 작성시 이동로봇의 이동경로를 전역 이동경로 및 지역 이동경로로 구분함으로써 이동로봇이 위치한 환경의 구조가 변경될 때마다 작성된 지도 전체를 변경할 필요 없이 변경된 영역에서의 이동경로만을 다시 결정하여 지도를 수정할 수 있어, 이동로봇의 지도를 효율적으로 작성할 수 있다는 효과가 있다.

<20> 또한, 본 발명은 목적지의 위치를 판단하거나 장애물을 판별함에 있어서, 이동로봇이 위치한 환경의 조도를 고려함으로써 목적지의 위치를 정확하게 판단하거나 장애물을 보다 정확하게 판별할 수 있다는 효과가 있다.

발명의 실시를 위한 구체적인 내용

<21> 이하 첨부된 도면을 참조하여 본 발명의 실시예에 대해 상세히 설명한다.

<22> 도 1은 본 발명의 일 실시예에 따른 이동로봇의 개략적인 블록도이다. 도시된 바와 같이, 이동로봇(100)은 구동부(110), 영상센서(120), 제어부(130), 조도감지센서(140), 메모리(150), 장애물 감지부(160)를 포함한다.

<23> 구동부(110)는 이동로봇(100)의 좌륜(미도시)을 구동시키는 좌륜모터(112) 및 이동로봇(100)의 우륜(미도시)을 구동시키는 우륜모터(114)를 포함하는 것으로서, 후술할 주행 제어부(139)의 제어에 따라 좌륜모터(112) 및 우륜모터(114)를 독립적으로 역방향 또는 정방향으로 구동시킴으로써 이동로봇(100)이 직직 또는 회전하드록 한다.

<24> 또한, 구동부(110)는 좌륜모터(112) 및 우륜모터(114)의 회전수를 산출하여 후술할 위치 결정부(132)로 전달함으로써 위치 확인부(132)가 이동로봇(100)의 실제 이동거리를 산출함으로써 이동로봇의 현재 위치를 판단할 수 있도록 한다.

<25> 영상센서(120)는 이동로봇이 위치한 환경에 대한 지도 작성을 위해 이동로봇이 위치한 환경, 예컨대, 이동로봇이 주행하게 될 공간의 바닥, 벽, 천장 등과 같은 곳에 배치된 식별지들을 인식한다.

<26> 즉, 본 발명은, 이동로봇의 지도를 작성하기 위해, 이동로봇이 위치하는 환경에 미리 식별지를 배치하여 두고, 이동로봇의 영상센서(120)를 통해 인식된 식별지를 따라 이동로봇이 이동하도록 함으로써 이동로봇이 스스로 지도를 작성할 수 있도록 하는 것이다.

<27> 한편, 영상센서(120)는 이동로봇이 주행함에 있어서, 후술할 위치 결정부(132)에 의해 결정된 소정 목표점에 도달했는지를 확인하기 위한 목표점 확인영상을 미리 촬영한 후 각 목표점의 위치와 매칭시켜 영상 저장영역(152)에 저장한다. 이때, 목표점 확인영상은 하나의 목표점에 하나 이상의 목표점 확인영상이 매칭될 수 있다.

<28> 일 실시예에 있어서, 이동로봇이 위치한 환경의 조도가 변경되는 것을 고려하여, 영상센서(120)는 목표점 확인영상들을 이동로봇이 위치한 환경의 조도를 변경시켜가면서 각 조도별로 촬영하고, 촬영된 목표점 확인 영상들을 각 조도별로 저장할 수 있다.

<29> 또한, 영상센서(120)는 이동로봇의 주행 중 출현 가능한 장애물들을 미리 촬영한 후 이를 영상 저장영역(152)에 저장한다. 이때, 출현 가능한 장애물은 사람이나 동물등과 같이 움직이는 장애물일 수도 있고, 가구나 물건 등과 같이 고정된 장애물일 수도 있다.

<30> 장애물 확인영상을 촬영함에 있어서도, 영상센서(120)는 이동로봇이 위치한 환경의 조도가 변경되는 것을 고려하여, 장애물 확인영상들을 이동로봇이 위치한 환경의 조도를 변경시켜가면서 각 조도별로 촬영하고, 촬영된 장애물 확인 영상을 각 조도별로 저장할 수 있다.

<31> 또한, 영상센서(120)는 이동로봇이 이동을 개시한 이후, 소정 시간 단위로 영상을 촬영하고, 촬영된 영상을 후술할 영상 처리부(136)로 전달함으로써 이동로봇이 목표점에 도달했는지 여부나, 장애물이 감지 또는 감지된 장애물의 종류가 무엇인지를 판별할 수 있게 해 준다. 이하에서는 설명의 편의를 위해 특정 목표점에서 영상센서(120)에 의해 촬영된 영상을 목표점 촬영영상이라 한다.

<32> 조도감지 센서(125)는 이동로봇이 위치한 환경의 조도를 감지하는 것으로서, 이러한 조도감지 센서(125)는 이동로봇이 위치한 환경의 조도가 변경되는 경우 현재 위치에서의 조도를 정확하게 감지함으로써 영상센서(120)에 의해 촬영되는 영상들을 보다 정확하게 인식하기 위한 것이다.

<33> 제어부(130)는 이동로봇(100)에 포함된 각 구성요소들을 제어함으로써 이동로봇(100)의 전반적인 동작을 제어하는 것으로서, 위치 결정부(132), 지도 작성부(134), 주행 제어부(136), 영상 처리부(136), 및 장애물 판별부

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(139)를 포함한다.

<34> 위치 결정부(132)는 지도 작성을 위해 영상센서(120)에 의해 인식된 식별지들을 이용하여 이동로봇의 이동경로 또는 하나 이상의 목표점을 결정하거나, 상술한 구동부(110)로부터 전달되는 정보를 이용하여 이동로봇의 실제 이동거리를 산출함으로써 이동로봇의 현재 위치를 판단한다.

<35> 여기서, 목표점이란 이동로봇이 도달해야 하는 지점을 의미하는 것으로서, 예컨대, 이동로봇이 위치 안내용 로봇인 경우, 안내 대상이 되는 객체가 존재하는 위치들이 목표점으로 설정될 수 있다.

<36> 일 실시예에 있어서, 위치 결정부(132)는 지도 작성에 이용될 이동로봇의 이동경로 또는 하나 이상의 목표점을 영상센서(120)에 의해 인식된 식별지의 색상 및 모양 중 적어도 하나를 이용하여 결정할 수 있다.

<37> 또한, 위치 결정부(132)는 영상센서(120)에 의해 인식된 식별지의 색상 또는 모양에 따라 이동로봇의 이동경로를 전역 이동경로(Global Path)와 지역 이동경로(Local Path)로 구분하고, 식별지의 색상 또는 모양에 따라 목표점을 전역 목표점(Global Target)과 지역 목표점(Local Target)으로 구분할 수 있다.

<38> 여기서, 전역 이동경로는 거실이나 홀과 같이 그 구조가 자주 변경되지 않는 영역에서의 이동경로를 의미하고, 지역 이동경로는 방과 같이 그 구조가 자주 변경될 수 있는 영역에서의 이동경로를 의미한다.

<39> 이렇게 위치 결정부(132)는 이동경로를 전역 이동경로와 지역 이동경로를 구분함으로써 이동로봇이 위치한 환경의 구조가 변경될 때마다 작성된 지도 전체를 변경할 필요 없이 변경된 영역에서의 이동경로만을 다시 결정하여 지도를 수정할 수 있어, 이동로봇의 지도를 효율적으로 작성할 수 있게 된다.

<40> 한편, 전역 목표점이란 전역 경로상에서 이동로봇이 도달해야 하는 목표점을 의미하는 것이고, 지역 목표점이란 지역 경로상에서 이동로봇이 도달해야 하는 목표점을 의미한다.

<41> 위치 결정부(132)가 영상센서(120)에 의해 인식된 식별지의 색상 또는 모양을 이용하여 전역 및 지역 이동경로와 전역 및 지역 목표점을 결정하는 방법을 도 2를 참조하여 구체적으로 설명한다.

<42> 도 2는 본 발명의 일 실시예에 따른 위치 결정부가(132)가 이동경로 및 목표점을 설정하는 방법을 보여주는 도면이다. 도 2에서, 이동로봇의 이동경로 및 목표점은 식별지의 색상에 따라 결정되며, 결정된 이동경로를 전역 및 지역 이동경로의 구분하는 것과 결정된 목표점을 전역 및 지역 목표점으로 구분하는 것은 식별지의 모양을 통해 수행되는 것으로 가정한다.

<43> 도 2에 도시된 바와 같이, 시작점인 제1 위치에 있는 이동로봇(100)에 전원을 인가하거나, 지도 작성 명령이 수신되면 이동로봇(100)은 주행을 시작하고, 주행 중 이동로봇의 영상센서(120)는 제1 위치에 배치된 제1 식별지(200)를 인식하게 된다. 위치 결정부(132)는 인식된 제1 식별지(200)의 색상이 직진을 나타내는 색상이므로 이동로봇(100)이 직진하도록 이동경로를 설정한다. 이때, 위치 결정부(132)는 이동르봇(100)이 제1 위치로부터 실제 이동한 거리를 이용하여 제1 식별지(200)의 위치를 기록한다.

<44> 이후, 영상센서(120)를 통해 제2 식별지(210)가 인식되면, 위치 결정부(132)는 인식된 식별지(210)의 색상이 좌회전을 나타내는 색상이므로 이동로봇(100)이 좌회전하도록 이동경로를 설정하고, 제2 식별지(210)의 위치를 기록한다.

<45> 이후, 영상센서(120)를 통해 제3 식별지(220)가 인식되면, 위치 결정부(132)는 인식된 식별지(220)의 색상이 제1 목표점 및 좌회전을 나타내는 색상이므로, 제3 식별지(220)가 배치된 위치를 제1 목표점으로 결정함으로써 제1 목표점의 위치를 기록한 후 이동로봇이 좌회전하도록 이동경로를 설정한다.

<46> 이후, 영상센서(120)를 통해 제4 식별지(230)가 인식되면, 위치 결정부(132)는 인식된 식별지의 색상이 우회전을 나타내는 색상이므로 이동로봇(100)이 우회전하도록 이동경로를 설정하고, 제4 식별지(230)의 위치를 기록한다.

<47> 이후, 영상센서(120)를 통해 제5 식별지(240)가 인식되면, 위치 결정부(132)는 인식된 식별지의 색상이 제2 목표점 및 180도 회전을 나타내는 색상이므로, 제5 식별지(240)가 배치된 위치를 제2 목표점으로 결정함으로써 제2 목표점의 위치를 기록한 후 이동로봇이 180도 회전하도록 이동경로를 설정한다.

<48> 이러한 과정을 통해 위치 결정부(132)는 시작점인 제1 위치로부터 제2 목표점까지의 이동경로 및 제1 목표점과 제2 목표점의 위치를 결정하게 된다.

<49> 한편, 위치 결정부(132)는 제1 내지 제3 식별지(200 내지 220)의 모양을 이용하여 제1 식별지(200)부터 제3 식

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별지(220)까지의 거리를 전역 이동경로(250)로 설정하고, 제3 식별지(220)가 배치된 위치인 제1 목표점을 전역 목표점으로 설정한다. 또한, 제4 및 제5 식별지(230, 240)의 모양을 이용하여 제3 식별지(220)부터 제5 식별지(240)가지의 거리를 지역 이동경로(260)로 설정하고, 제5 식별지가 배치된 위치인 제2 목표점을 지역 목표점으로 결정한다.

<50> 위치 결정부(132)는 이동로봇이 위치한 환경 전체에 대해 상술한 과정을 반복하여 수행함으로써 이동로봇의 모든 이동경로 및 목표점을 설정한다.

<51> 한편, 위치 결정부(132)는 엔코드와 같은 회전 감지 센서(미도시)를 이용하여 좌륜 모터(132) 및 우륜 모터(134)의 회전수를 검출함으로써 이동로봇의 실제 이동거리를 산출하고, 산출된 이동로봇의 실제 이동거리를 이용하여 현재 이동로봇의 위치를 판단한다.

<52> 또한, 위치 결정부(132)는 후술할 영상 처리부(138)에 의한 영상의 비교결과 특정 목표점 촬영영상이 해당 목표점에 매칭된 목표점 확인영상에 차이가 있는 경우, 이동로봇이 해당 목표점에 정확하게 위치하고 있지 않은 것으로 판단하여, 해당 목표점에서 감지된 조도, 목표점 촬영영상, 및 현재 이동로봇의 위치에서 목표점 촬영영상에 포함된 객체까지의 거리 정보를 이용하여 이동로봇의 위치를 보정하기 위한 보정경로를 생성하여 주행 제어부(136)로 전달한다. 이때, 목표점 촬영영상에 포함된 객체와 현재 이동로봇이 위치 사이의 거리는 목표점 촬영영상을 이용하여 산출할 수 있다.

<53> 예컨대, 목표점 촬영영상과 목표점 확인영상을 비교한 결과, 목표점 촬영영상에 포함된 객체의 위치가 목표점 확인영상에 포함된 객체에 비해 좌측으로 치우쳐 있는 것으로 판단되는 경우, 이동로봇이 목표점으로부터 우측으로 치우쳐 있다는 것을 의미하므로, 위치 결정(132)는 목표점 촬영영상에 포함된 객체의 위치가 목표점 확인영상에 포함된 객체의 위치와 동일해 지도록 이동로봇의 보정경로를 생성한다.

<54> 또한, 목표점 촬영영상에 포함된 객체의 크기가 목표점 확인영상에 포함된 객체에 비해 작은 경우 이때, 이동로봇이 정확한 목표점에 아직 도달하지 않은 것을 의미하므로, 위치 결정부(132)는 목표점 촬영영상에 포함된 객체의 위치가 목표점 확인영상에 포함된 객체의 크기가 동일해 지도록 이동로봇의 보정경로를 생성한다.

<55> 지도 작성부(134)는 위치 결정부(132)에 의해 설정된 이동경로, 각 목표점의 위치, 각 식별지들의 위치, 및 각 식별지들 사이의 거리를 이용하여 이동로봇이 주행해야 할 지도를 작성하고, 작성된 지도를 메모리(150)의 지도 저장영역(154)에 저장한다.

<56> 지도 작성부(134)는 지도를 작성함에 있어서, 각 목표점의 좌표에 영상센서(120)에 의해 미리 촬영된 목표점 확인영상을 매칭시켜 저장한다. 이때, 지도 작성부(134)는 각 목표점에 상응하는 목표점 확인영상의 식별자와 각 목표점 좌표를 매칭시키는 방법으로 목표점과 목표점 확인 영상을 매칭시킬 수 있다.

<57> 주행 제어부(136)는 지도 작성 시에는 위치 결정부(132)에 의해 결정된 이동경로를 따라 이동로봇이 이동하도록 구동부(110)를 제어한다. 또한, 주행 제어부(136)는 지도가 작성된 후에는 이동로봇의 위치 보정을 위해 위치 결정부(132)에 의해 생성된 보정경로를 따라 이동로봇이 이동하거나, 외부로부터 특정 목표점으로의 이동명령이 수신되면 작성된 지도에 따라 이동로봇이 특정 목표점으로 이동하도록 구동부(110)를 제어한다. 또한, 주행 제어부(136)는 후술할 장애물 판별부(139)에 의해 생성된 장애물 회피 경로를 따라 이동로봇이 장애물을 회피하여 이동하도록 한다.

<58> 영상 처리부(138)는 주행 제어부(136)의 제어에 따라 이동로봇이 특정 목표점에 도달한 후, 영상센서(120)로부터 수신되는 목표점 촬영영상을 해당 목표점 좌표에 매칭되어 있는 목표점 확인영상과 비교한다.

<59> 이때, 해당 목표점 좌표에 매칭되어 있는 목표점 확인영상은 각 조도별로 저장되어 있기 때문에, 영상 처리부(138)는 해당 목표점 좌표에 매칭되어 있는 목표점 확인영상 중 조도감지 센서(125)에 의해 감지된 조도에 매칭되어 있는 목표점 확인영상을 목표점 촬영영상과 비교한다.

<60> 구체적으로, 영상 처리부(138)는 특정 목표점에서 영상센서(120)로부터 목표점 촬영영상이 수신되면, 영상 저장영역(152)으로부터 해당 목표점에 상응하는 목표점 확인영상들 중 감지된 조도에 매칭된 목표점 확인영상을 추출하여 양 영상의 동일여부를 비교하는 것이다.

<61> 일 실시예에 있어서, 영상센서(120)는 소정 시간 주기 단위로 영상을 촬영하기 때문에, 특정 목표점 근처에서 촬영된 모든 목표점 촬영영상을 영상 저장영역(152)으로부터 추출된 목표점 확인영상과 비교하는 것은 이동로봇의 부하를 증가시킬 수 있으므로, 영상 처리부(138)는 전처리 과정을 거쳐 일정 조건을 만족하는 목표점 촬영영

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상들만을 영상 저장영역(152)에 저장된 목표점 확인영상과 비교할 수 있다.

<62> 이때, 영상 처리부(138)는 MCT(Modified Census Transform)기법을 이용하여 영상을 전처리 할 수 있다. MCT란 조도변화에 강인하도록 고안된 영상 처리 기법으로서, 픽셀의 밝기값 단위의 영상을 중심픽셀을 기준으로 중심픽셀의 주변 픽셀들의 밝기값을 이용하여 이진화 하는 방법이다.

<63> 구체적으로, 특정 픽셀 x에서의 주변 픽셀들의 집합을 $\underline{N}(x)$라 할 때, $\underline{N}(x)$에 포함된 각 픽셀들의 밝기값들의 평균값인 $\overline{I(x)}$를 산출하고, 각 픽셀의 밝기값 $I(y)$와 평균값 $\overline{I(x)}$를 비교하여 $\bar{I}(x) < I(y)$면, 즉 각 픽셀의 밝기값이 평균값보다 크면 해당 픽셀의 밝기값을 1로 변환하고, $\bar{I}(x) \geq I(y)$면, 즉, 각 픽셀의 밝기값이 평균값 이하이면 해당 픽셀의 밝기값을 0으로 변환한다. 이를 수식으로 표현하면 다음의 수학식 1과 같다.

수학식 1

<64> $$\Gamma(\mathbf{x}) = \otimes_{\mathbf{y} \in N'(\mathbf{x})} C(\bar{I}(\mathbf{x}), I(\mathbf{y}))$$

<65> 여기서, $\otimes$는 연결 연산자를 의미하고, C는 비교함수로써 수학식 2와 같이 정의된다

수학식 2

<66> $$C(\bar{I}(\mathbf{x}), I(\mathbf{y})) = \begin{cases} 1 \text{ if } \bar{I}(\mathbf{x}) < I(\mathbf{y}), \\ 0 \text{ otherwise,} \end{cases}$$

<67> 이러한 MCT를 도 3을 참조하여 구체적으로 설명한다. 도 3a와 같이 주변 픽셀들의 밝기값이 주어졌을 때, 주변 픽셀들의 밝기값의 평균값 $\overline{I(x)}$는 2.8이 되고, 밝기값이 평균값보다 큰 픽셀은 그 밝기값을 1로 변환하고, 밝기값이 평균값보다 작은 픽셀은 0으로 변환함으로써 주변 픽셀의 밝기값을 도 3b에 도시된 바와 같이 이진화한다.

<68> 영상 처리부(138)는 특정 목표점에서의 목표점 촬영영상 및 목표점 확인영상에 각각 MCT기법을 적용함으로써 목표점 촬영영상의 MCT값 $\Gamma_I(\infty)$와 목표점 확인영상의 MCT값 $\Gamma_R(\infty)$를 생성한다. 이때, 각 MCT값의 이진수들의 집합을 a라고 할 때 a에 포함된 1의 개수의 합을 $\xi(a)$로 정의하면 양 영상의 차이를 다음의 수학식 3과 같이 정의할 수 있다.

수학식 3

<69> $$\sum_{x \in \Sigma} \xi(\Gamma_I(x) \ \ xor \ \ \Gamma_R(x))$$

<70> 이때, 영상 처리부(138)는 수학식 3의 결과, 즉 각 MCT값의 이진수들의 집합 a에 포함된 1의 개수의 합의 차이가 기준치보다 작을 경우, 목표점 촬영영상이 목표점 확인영상과 비교 가능한 영상인 것으로 판단한다. 영상 처리부(138)는 이러한 MCT를 이용하여 전처리를 수행함으로써 목표점 근처에서 촬영된 모든 목표점 촬영영상 중 일부 영상만을 목표점 확인영상과 비교할 수 있게 된다.

<71> 일 실시예에 있어서, 영상 처리부(138)는 목표점 촬영영상이나 목표점 확인영상에 전경과 배경이 모두 포함되어 있는 경우, 배경 부분에 대해서만 MCT를 실행함으로써 정확도를 높일 수 있다.

<72> 한편, 영상 처리부(138)는 전처리가 완료되면, 목표점 촬영영상이 목표점 확인영상과 동일한지 여부를 판단하게 된다. 일 실시예에 있어서, 영상 처리부(138)는 각 영상으로부터 특징점들을 추출한 후 특징점을 매칭함으로써 양 영상의 동일여부를 판단할 수 있다. 이때, 영상 처리부(138)는 각 영상의 특징점을 추출하기 위해 영상의

크기 및 회전 변화에 강인한 영상처리 알고리즘인 SIFT(Scale-Invariant Feature Transform)기법을 이용할 수 있다.

<73> 이러한 SIFT 기법을 이용하여 특징점을 추출하는 방법을 도 4a 내지 도 4d를 참조하여 간략하게 설명한다. 먼저, 도 4a에 도시된 바와 같은 영상의 스케일을 변환하여 N개의 옥텟(Octave)을 형성하고, 각 옥텟의 영상에 가우시안 필터(Gaussian Filter)를 적용함으로써 블러 영상(Blurr Image)을 생성한다. 이러한 블러 영상을 수학식으로 표현하면 다음의 수학식 4와 같다.

수학식 4

<74>
$$L(x,y,\sigma) = G(x,y,\sigma) \times I(x,y)$$

<75> 여기서, $L(x,y,\sigma)$는 블러 영상을 의미하고, $I(x,y)$는 입력영상을 의미하며, $G(x,y,\sigma)$는 블러 영상의 생성에 이용된 가우시안 함수를 의미하는 것으로서 수학식 5와 같이 정의된다.

수학식 5

<76>
$$G(x,y,\sigma) = \frac{1}{2\pi\sigma^2} e^{-(x^2+y^2)/2\sigma^2}$$

<77> 이때, 도 4b에 도시된 바와 같이 각 옥텟의 영상에 가우시안 필터를 적용함에 있어서, 시그마값을 일정하게 증가시켜 각 옥텟마다 복수개의 블러 영상을 생성한다. 이후, 도 4c에 도시된 바와 같이, 각 옥텟 별로 인접한 영상끼리의 차(DOG: Difference of Gaussian)를 산출한다. 이를 수학식으로 표현하면 다음의 수학식 6과 같다.

수학식 6

<78>
$$D(x,y,\sigma) = L(x,y,k\sigma) - L(x,y,\sigma)$$

<79> 여기서, $D(x,y,\sigma)$는 DOG를 의미하고, $L(x,y,k\sigma)$와 $L(x,y,\sigma)$는 특정 스케일에서의 블러 영상들을 의미한다.

<80> 이후, 각 옥텟에서 산출된 DOG 영상 중에서 기준영상을 결정한 후 기준영상에서 소정 단위 구역, 예컨대, 3 by 3 픽셀 매트릭스(Matrix) 내에서 최대 픽셀값(Maxima) 및/또는 최소 픽셀값(Minima)을 결정한다. 이후, 결정된 최대 픽셀값 및/또는 최소 픽셀값을 DOG 기준 영상의 전후 영상에서 각각 산출된 최대 픽셀값 및/또는 최소 픽셀값과 비교하여 그 중 가장 큰 픽셀값과 가장 작은 픽셀값을 선택하고, 선택된 픽셀을 특징점(Keypoint) 후보군으로 결정한다.

<81> 이후, 모든 옥텟에 포함된 DOG에 대해서도 동일한 과정을 반복하여 각 옥텟 별로 특징점 후보군을 결정한 후, 특징점 후보군 중 그 출현 빈도가 기준치 이하인 특징점 및 에지(Edge)인 특징점을 특징점 후보군에서 제외시킴으로써 특징점을 결정한다.

<82> 여기서, 특징점이 에지인지 여부를 판단하기 위해 수학식 7에 정의된 Hessian Matrix를 사용한다.

수학식 7

<83>
$$H = \begin{bmatrix} D_{xx} & D_{xy} \\ D_{xy} & D_{yy} \end{bmatrix}$$

<84> 이를 구체적으로 살펴보면, Hessian Matrix에서 α를 가장 큰 값의 Eigenvalue라고 하고 β를 두 번째로 큰

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Eigenvalue라고 하는 경우 다음의 수학식 8과 수학식 9을 만족하므로, $\alpha = r\beta$ 일 때, 수학식 8 및 수학식 9를 이용하여 수학식10과 같은 결과를 산출할 수 있다.

수학식 8

$$Tr(H) = \alpha + \beta$$

<85>

수학식 9

$$Det(H) = \alpha\beta$$

<86>

수학식 10

$$\frac{Tr(H)^2}{Det(H)} = \frac{(\alpha+\beta)^2}{\alpha\beta} = \frac{(r\beta+\beta)^2}{r\beta^2} = \frac{(r+1)^2}{r}$$

<87>

<88> 수학식 8에서 Tr(H)는Hessian 행렬의 Trace행렬을 의미하고, 수학식 9에서 Det(H)는 Hessian 행렬의 Determine 행렬을 의미한다.

<89> 한편, 수학식 10에서, r 가 일정할 때, $\frac{Tr(H)^2}{Det(H)}$ 이 $\frac{(r+1)^2}{r}$ 보다 큰 경우 해당 특징점은 에지가 된다.

<90> 상술한 과정을 통해도 4a에 도시된 영상으로부터 결정된 특징점들이 도 4d에 도시되어 있다.

<91> 이후, 결정된 특징점을 이용하여 해당 영상의 특징점들에 대한 기술자(Descriptor)를 생성한다. 특징점 기술자는 각 특징점의 크기값(Magnitude) 및 방향성(Orientation)을 산출한 후, 방향성 별로 크기값을 합산함으로써 생성된다. 여기서, 각 특징점의 크기값과 방향성은 각각 수학식 11 및 12를 이용하여 산출된다.

수학식 11

$$m(x,y) = \sqrt{(L(x+1,y)-L(x-1,y))^2 + (L(x,y+1)-L(x,y-1))^2}$$

<92>

수학식 12

$$\theta(x,y) = \tan^{-1}((L(x,y+1)-L(x,y-1)) / (L(x+1,y)-L(x-1,y)))$$

<93>

<94> 영상 처리부(138)는 상술한 SIFT 기법을 이용하여 양 영상의 특징점들을 추출하고, 양 영상의 특징점 기술자들을 비교함으로써 기술자들의 차이가 가장 작은 특징점들을 동일한 특징점인 것으로 판단하여 매칭하는 방법으로 양 영상을 비교한다.

<95> 이러한 영상 처리부(138)에 의한 양 영상의 비교결과 양 영상에 차이가 있는 것으로 판단되는 경우, 현재 이동로봇이 목표점에 정확히 위치하고 있지 않은 것이므로 위치 결정부(132)를 통해 보정 경로를 생성하게 한다.

<96> 한편, 영상 처리부(138)는 이동로봇이 이동하는 도중 후술할 장애물 감지부(160)에 의해 장애물이 감지되면, 장애물이 감지된 위치에서의 조도에 매칭되어 있는 장애물 확인영상들과 장애물 감지 위치에서 영상센서(120)로부터 수신되는 장애물 촬영영상을 비교하여 장애물 확인영상들 중 장애물 촬영영상과 동일한 장애물 확인영상을 추출한다.

<97> 구체적으로, 영상 처리부(138)는 장애물이 감지된 위치에서 영상센서(120)로부터 장애물 촬영영상이 수신되면,

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상술한 영상 처리 기법(전처리 기법 및 특징점 추출 기법)을 이용하여 영상 저장영역(152)에 저장되어 있는 장애물 확인영상들을 검색하여, 수신된 장애물 촬영영상과 동일한 장애물 확인 영상을 추출한다.

<98> 다시 도 1을 참조하면, 장애물 판별부(139)는 후술할 장애물 감지부(160)에 의해 장애물이 감지되면, 영상 처리부(138)에 의해 추출된 장애물 확인영상을 이용하여 감지된 장애물이 어떠한 것인지 판별한다. 이후, 장애물 판별부(139)는 판별된 장애물의 종류나 크기, 장애물의 이동성 여부 등을 종합적으로 고려하여 장애물의 회피를 위한 장애물 회피 경로를 생성하고, 생성된 장애물 회피 경로를 주행 제어부(136)로 전송함으로써 이동로봇이 장애물을 회피할 수 있도록 한다.

<99> 메모리(150)는 영상센서(120)를 통해 획득된 목표점 확인영상들 및 장애물 확인 영상들이 저장되는 영상 저장영역(152)과 지도 작성부(134)에 의해작성된 지도가 저장되는 지도 저장영역(154)을 포함한다.

<100> 일 실시예에 있어서, 영상 저장영역(120)에는 각 목표점 확인영상들 및 장애물 확인영상들이 조도별로 저장되어 있으며, 각 목표점 확인영상들은 해당 목표점의 좌표와 매칭되어 저장되어 있다. 이러한 메모리(150)는 EEPROM 또는 플래쉬 메모리 등으로 구현될 수 있다.

<101> 장애물 감지부(160)는 이동로봇의 이동경로 상에 존재하는 장애물을 감지하는 것으로서, 외부로 신호를 송출하고 반사된 신호를 수신할 수 있는 센서쌍으로 구현되는 원/근거리 센서부(162)나 장애물과의 충돌을 통해 장애물을 감지하는 범퍼(164) 중 적어도 하나를 포함한다. 이때, 원/근거리 센서부(162)는 원거리 센서부와 근거리 센서부가 별개로 구성될 수 있으며, 원/근거리 센서부(162) 및 범퍼는 이동로봇의 전면, 후면, 및 측면 중 적어도 한 면에 장착될 수 있다.

<102> 이 외에도, 이동로봇(100)은 제어부(140)의 상태를 외부로 표시하기 위한 표시부(170)나 이동로봇이 담당하게 될 고유의 기능을 구현하기 위한 다양한 모듈들을 더 포함할 수 있다.

<103> 이하에서는 상술한 이동로봇이 이동경로에 대한 지도를 작성하는 과정을 도 5를 참조하여 구체적으로 설명한다.

<104> 먼저, 이동로봇의 영상센서(120)를 통해 이동로봇이 위치한 환경에 배치되어 있는 각 식별지들을 인식한다(제100단계). 이때, 식별지들은 이동로봇이 위치하는 환경의 바닥, 벽, 또는 천장 등에 배치될 수 있다. 이후, 인식된 식별지들의 색상 및 모양 중 적어도 하나에 따라 이등로봇이 이동해야 할 이동경로 및/또는 하나 이상의 목표점을 결정한다(제110단계). 일 실시예에 있어서, 이동로봇의 이동경로는 인식되는 식별지의 색상 또는 모양에 따라 전역 이동경로와 지역 이동경로로 구분되며, 이동로봇의 목표점은 인식되는 식별지의 색상 또는 모양에 따라 전역 목표점과 지역 목표점으로 구분될 수 있다.

<105> 다음으로, 결정된 이동경로 및 목표점을 이용하여 이동로봇이 위치한 환경에서의 지도를 작성하여 지도 저장영역에 저장한다(제120단계).

<106> 다음으로, 도 6을 참조하여 본 발명의 일 실시예에 따른 이동로봇의 주행 제어 방법을 설명한다.

<107> 먼저, 사전단계로써, 이동로봇이 위치한 환경에서의 목표점 확인을 위한 목표점 확인영상과 장애물 확인 영상을 촬영하여 영상 저장영역에 저장한다(제200단계). 이때, 이동로봇이 위치한 환경의 조도가 변경되더라도 이등로봇이 영상을 보다 정확하게 인식하도록 하기 위해 목표점 확인영상과 장애물 확인영상은 이동로봇이 위치한 환경에서의 조도를 변경시켜가면서 촬영한 후, 촬영된 영상은 각 조도별로 저장한다.

<108> 여기서, 목표점 확인영상은 각 목표점에 존재하는 특정 객체를 촬영한 영상을 의미하고, 장애물 확인영상은 이동로봇이 위치한 환경에서 출현 가능한 장애물을 촬영한 영상을 의미하고, 목표점 확인영상은 지도상의 각 목표점과 매칭되어 저장하는 것이 바람직하다.

<109> 다음으로, 특정 목표점에 대한 이동명령이 수신되면(제210단계), 작성된 지도에 따라 특정 목표점으로 주행을 시작한다(제220단계). 목표점으로 이동 중 장애물이 감지되는지 여부를 판단하여(제230단계), 장애물이 감지되는 경우 장애물이 감지된 위치에서의 조도를 감지하고(제240단계), 장애물이 감지된 위치에서 촬영된 영상(이하, '장애물 촬영영상'이라 함)을 제240단계에서 인식된 조도에 매칭되어 있는 장애물 확인영상과 비교함으로써 장애물 촬영영상과 동일한 장애물 확인영상이 존재하는지 판단한다(제250단계).

<110> 이때, 장애물 촬영영상과 장애물 확인영상을 비교함에 이어서, MCT 기법을 이용한 전처리 과정을 통해 비교대상되는 장애물 촬영영상의 개수를 감소시킬 수 있다.

<111> 일 실시예에 있어서, 장애물 촬영영상과 장애물 확인영상의 비교는 각 영상으로부터 추출된 특징점의 대칭여부를 통해 수행될 수 있는데, 이러한 특징점 추출은 SIFT 기법을 이용하여 수행될 수 있다. SIFT 기법을 이용하

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여 양 영상의 특징점을 매칭하는 방법을 도 7을 참조하여 구체적으로 설명한다.

<112> 먼저, 비교 대상이 되는 양 영상의 스케일을 변환하여 각 영상별로 N개의 옥텟(Octave)을 형성하고(제400단계), 각 옥텟의 영상에 가우시안 필터(Gaussian Filter)를 적용하여 각 영상에 블러(Blurr처리)를 수행함으로써 블러 영상(Blurr Image)을 생성한다(제410단계). 이때, 각 옥텟의 영상에 가우시안 필터를 적용함에 있어서, 시그마 값을 일정하게 증가시킴으로써 각 옥텟마다 복수개의 영상을 생성한다.

<113> 이후, 각 옥텟에 포함된 영상들 중 인접한 영상들간의 차(DOG: Difference of Gaussian)를 산출하고(제420단계), 각 옥텟 별로 최대 픽셀값(Maxima) 및/또는 최소 픽셀값(Minima)을 결정한다(제430단계). 다음으로, 결정된 최대 픽셀값 및/또는 최소 픽셀값을 DOG 기준 영상의 전후 영상에서 각각 산출된 최대 픽셀값 및/또는 최소 픽셀값과 비교하여 그 중 가장 큰 픽셀값과 가장 작은 픽셀값을 선택하고, 선택된 픽셀을 특징점(Keypoint) 후보군으로 결정한다(제440단계).

<114> 다음으로, 특징점 후보군들 중 그 출현개수가 기준치 이하이거나, 에지 특징점들을 제외함으로써 특징점을 결정한 후(제450단계), 각 특징점들에 대한 기술자(Descriptor)를 생성한다(제460단계). 마지막으로, 양 영상의 특징점 기술자들을 이용하여 양 영상의 특징점을 매칭시킨다(제470단계).

<115> 다시 도 6을 참조하면, 제250단계에서의 판단결과, 장애물이 감지된 위치에서 촬영된 영상과 동일한 장애물 확인영상이 존재하는 경우 해당 장애물 확인영상을 이용하여 감지된 장애물을 판별하고(제260단계), 판별된 장애물에 따라 장애물 회피 경로를 생성함으로써 생성된 장애물 회피경로를 이용하여 장애물을 회피한다(제270단계). 한편, 제250단계에서, 장애물 촬영영상과 동일한 장애물 확인영상이 존재하지 않는 경우 해당 장애물 촬영영상을 새로운 장애물 확인영상으로 영상 저장영역에 저장한다(제275단계).

<116> 장애물을 회피한 후, 또는 제230단계에서 장애물이 감지되지 않은 경우, 목표점에 도달했는지 여부를 판단하여(제280단계), 도달하지 않은 경우 작성된 지도에 따라 목표점으로의 주행을 계속한다(제220단계).

<117> 한편, 제280단계에서 목표점에 도달한 것으로 판단되는 경우 해당 위치에서의 조도를 인식하고(제290단계), 해당 위치에서 획득되는 목표점 촬영영상을 해당 목표점에 매칭되어 있는 목표점 확인영상 중 제290단계에서 인식된 조도에서의 목표점 확인영상과 비교하여 목표점 확인영상과 목표점 촬영영상이 차이가 있는지를 판단한다(제300단계). 이때, 목표점 확인영상과 목표점 촬영영상을 비교 과정은 상술한 장애물 확인영상과 장애물 촬영영상의 비교과정과 동일하므로 상세한 설명은 생략하기로 한다.

<118> 비교결과 목표점 확인영상과 목표점 촬영영상에 차이가 있는 경우, 예컨대, 목표점 촬영영상에 포함된 객체의 위치나 크기가 목표점 확인영상에 포함된 객체의 위치나 크기와 다른 경우, 이동로봇이 목표점에 정확하게 위치하고 있지 않은 것으로 판단하여, 목표점 촬영영상에 포함된 객체의 위치나 크기가 목표점 확인영상에 포함된 객체의 위치나 크기와 동일해 지도록 이동로봇의 보정 경로를 생성함으로써 생성된 보정 경로를 이용하여 이동로봇의 위치를 보정한다(제320단계).

<119> 상술한 실시예에 있어서는, 이동로봇이 최종 목표점에서만 그 위치의 정확성을 판단하는 것으로 기재하였지만, 변형된 실시예에 있어서는 최종 목표점으로 이동하는 과정 중에 존재하는 다른 목표점들의 위치에서 이동로봇의 위치를 확인함으로써 이동로봇이 지도에서 정해진 경로에 따라 정확하게 이동하고 있는지 여부를 판단할 수 있다.

<120> 예컨대, 도 2와 같은 예에서, 지역 목표점인 제2 목표점(240)으로의 이동명령이 수신된 경우, 제2 목표점(240)으로 이동하기 위해 이동로봇은 전역 이동경로 상에 존재하는 전역 목표점인 제1 목표점(220)을 경유하여 하므로, 제1 목표점(220) 상에서 수시된 제1 목표점 확인영상과 제1 목표점에 매칭되어 있는 제1 목표점 확인영상을 비교함으로써 이동로봇이 제1 목표점에 정확하게 위치하고 있는지 여부를 판단할 수 있을 것이다.

<121> 상술한 이동 로봇의 주행 제어 방법은 다양한 컴퓨터 수단을 이용하여 수행될 수 있는 프로그램 형태로도 구현될 수 있는데, 이때 이동 로봇의 주행 제어 방법을 수행하기 위한 프로그램은 하드 디스크, CD-ROM, DVD, 롬(ROM), 램, 또는 플래시 메모리와 같은 컴퓨터로 판독할 수 있는 기록 매체에 저장된다.

<122> 본 발명이 속하는 기술분야의 당업자는 본 발명이 그 기술적 사상이나 필수적 특징을 변경하지 않고서 다른 구체적인 형태로 실시될 수 있다는 것을 이해할 수 있을 것이다.

<123> 예컨대, 상술한 실시예에 있어서는, 이동로봇이 이동경로를 따라 직진하고 있는지 여부를 판단하기 위해 시작점인 제1 위치와 현재 위치인 제2 위치에서 산출된 각 센서별 신호 도달거리를 이용하였지만, 변형된 실시예에 있어서는, 시작점이 아니라 이동로봇의 현재 위치 및 이동로봇의 직전의 위치에서 산출된 각 센서별 신호 도달거

리를 이용할 수도 있을 것이다.

<124> 그러므로, 이상에서 기술한 실시예들은 모든 면에서 예시적인 것이며 한정적인 것이 아닌 것으로 이해해야만 한다. 본 발명의 범위는 상기 상세한 설명보다는 후술하는 특허청구범위에 의하여 나타내어지며, 특허청구범위의 의미 및 범위 그리고 그 등가 개념으로부터 도출되는 모든 변경 또는 변형된 형태가 본 발명의 범위에 포함되는 것으로 해석되어야 한다.

도면의 간단한 설명

<125> 도 1은 본 발명의 일 실시예에 따른 이동 로봇의 개략적인 블럭도.

<126> 도 2는 식별지 인식에 따라 이동경로 및 목표점을 결정하는 방법을 보여주는 도면.

<127> 도 3a 및 3b는 MCT 기법을 이용하여 픽셀의 밝기값을 이진화한 일예를 보여주는 도면.

<128> 도 4a 내지 4d는 SIFT 기법에 따라 특징점을 추출하는 과정을 보여주는 도면.

<129> 도 5는 본 발명의 일 실시예에 따라 지도를 작성하는 방법을 보여주는 플로우차트.

<130> 도 6은 본 발명의 일 실시예에 따라 이동로봇의 주행을 제어하는 방법을 보여주는 도면.

<131> 도 7은SIFT 기법을 이용하여 특징점을 추출하는 방법을 보여주는 플로우차트.

<132> <도면의 주요 부분에 대한 부호의 설명>

<133> 100: 이동로봇 110: 구동부

<134> 120: 영상센서 125: 조도감지 센서

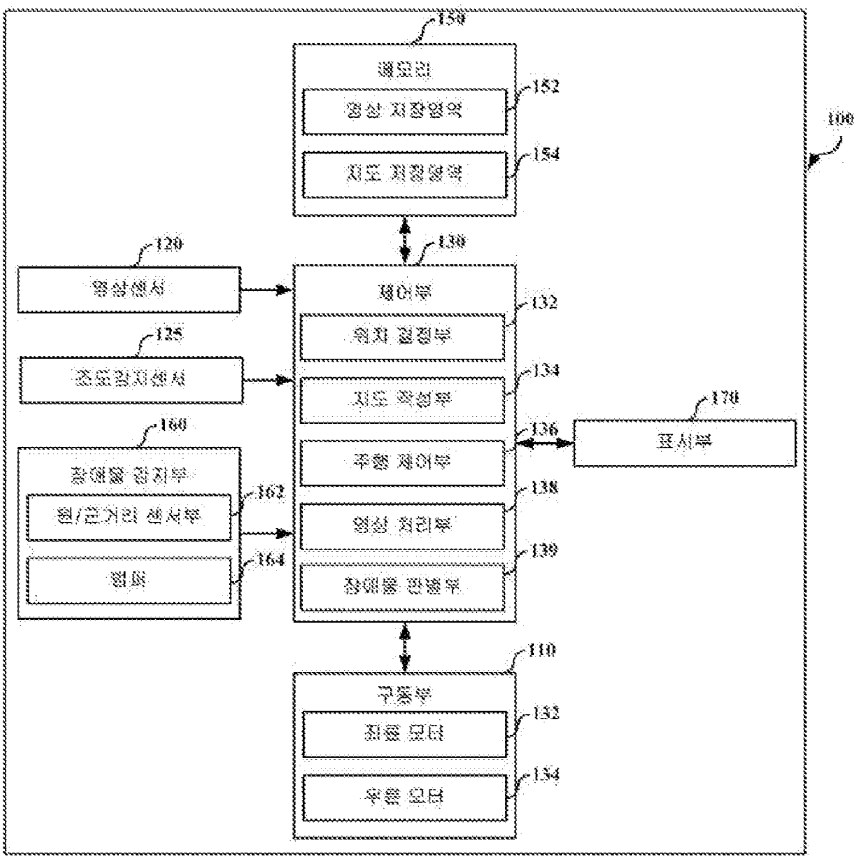
<135> 130: 제어부 150: 메모리

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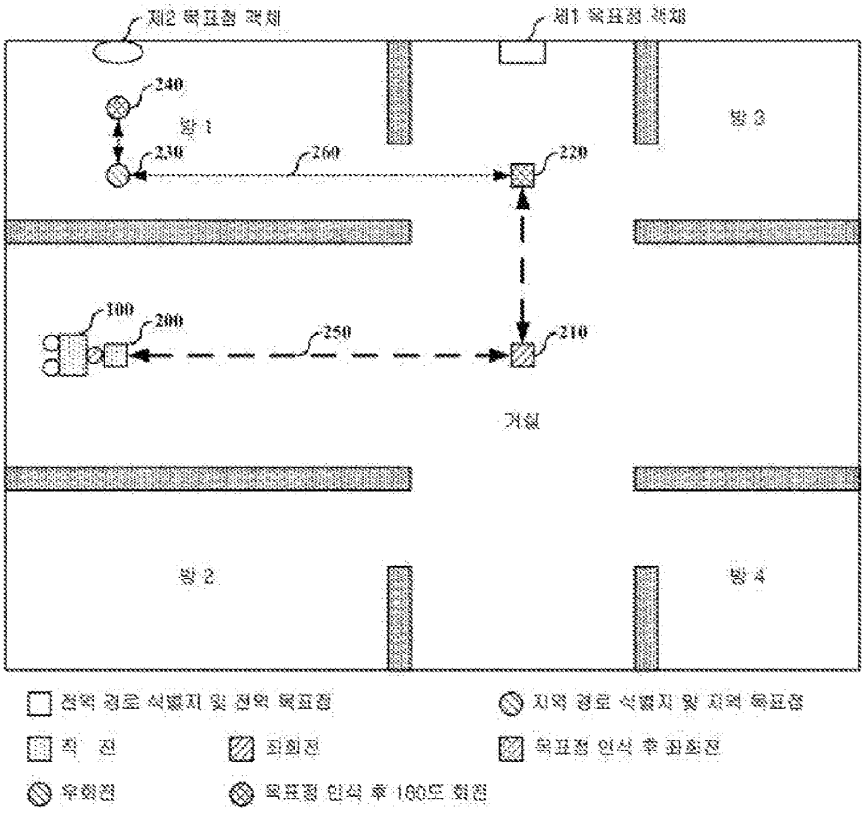
도면

도면1



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도면2



도면3a

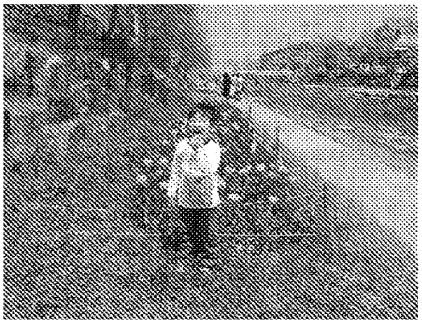
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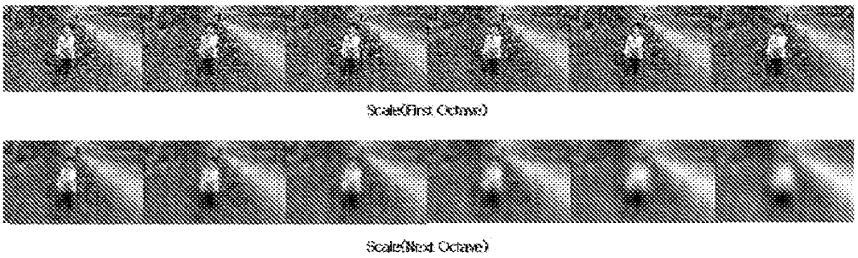
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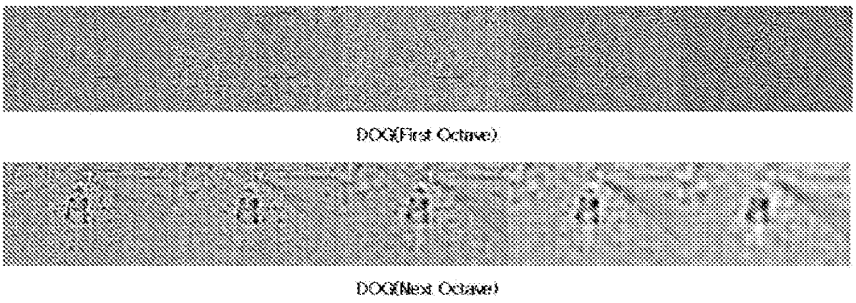
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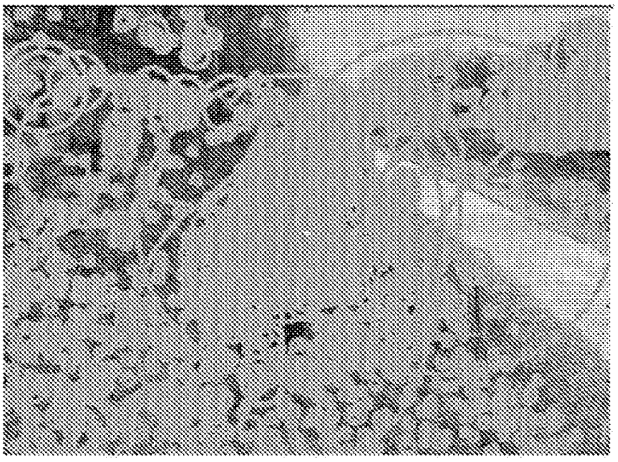


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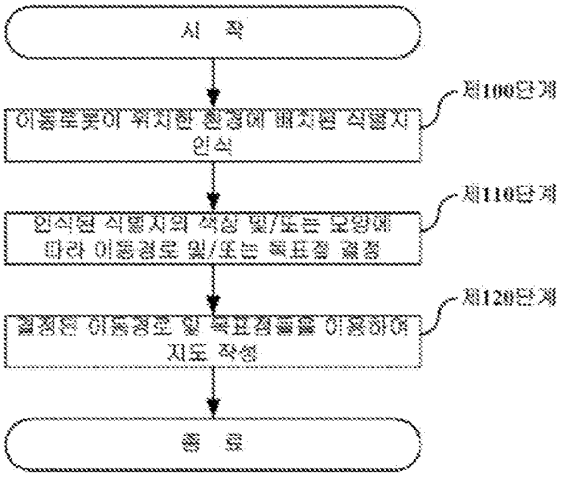


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도면4d

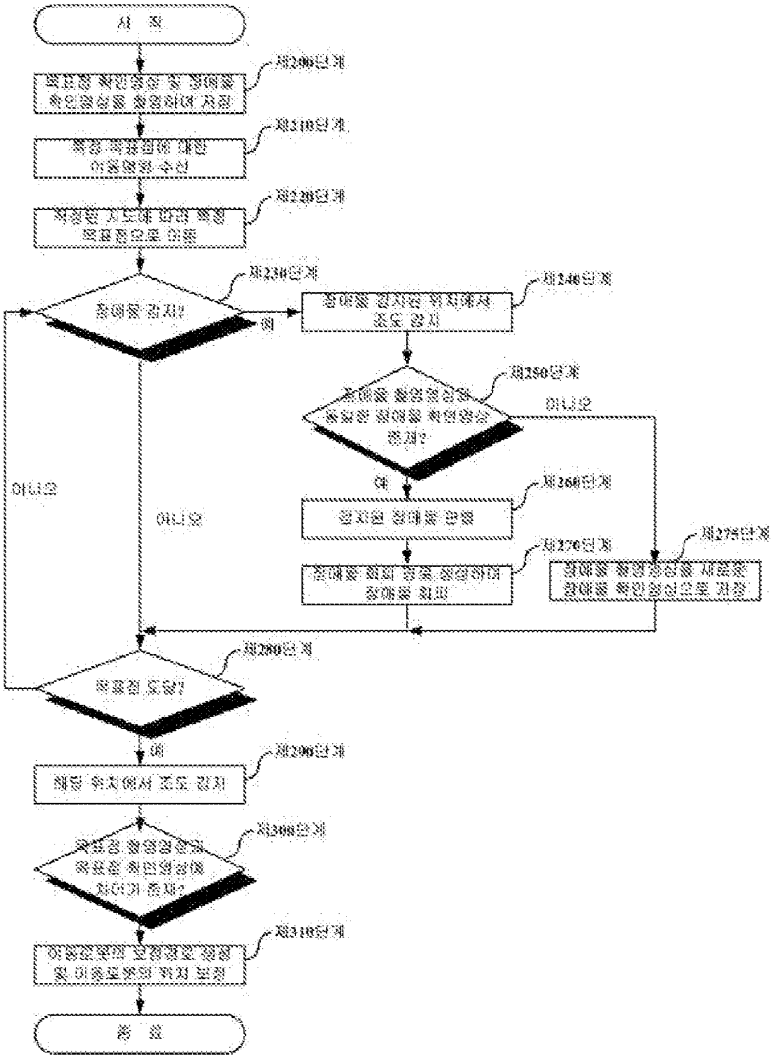


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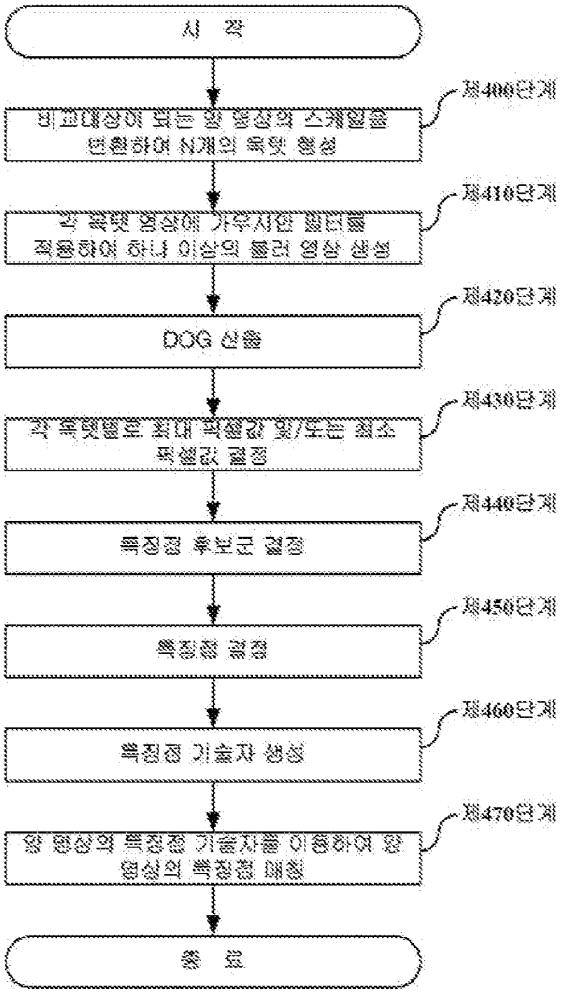
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도면6



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도면7



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Espacenet

CN114794993A Cleaning machine control method and device, cleaning machine, control equipment and storage medium

Applicants: SHANXI JIA SHI DA ROBOT TECH CO LTD

Inventors: LIANG XUELIANG,HAO ZHENYU,ZHANG YUJIE,ZHAO XIAOCHUN,WANG BAOLIANG,HAN WEIQING

Classifications:

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CPC **A47L11/24 (CN); A47L11/283 (CN); A47L11/4008 (CN); A47L11/4038 (CN); G06T11/206 (CN); G06V20/10 (CN)**; A47L2201/00 (CN); A47L2201/06 (CN);

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Cleaning machine control method and device, cleaning machine, control equipment and storage medium

Abstract

The invention relates to the technical field of cleaning robots, and discloses a control method and device of a cleaning machine, the cleaning machine, control equipment and a storage medium, and the method comprises the steps that area information of an operation area where the cleaning machine is located is obtained, and the area information comprises an area range; establishing a cleaning map according to the area information and the current position of the cleaning machine in the operation area; and controlling the cleaning machine to clean the operation area according to the cleaning map. The cleaning efficiency of the cleaning machine on the operation area is improved.

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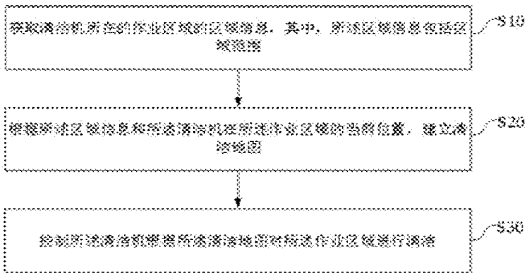
权利要求书2页 说明书12页 附图6页

(54)发明名称

清洁机的控制方法、装置、清洁机、控制设备及存储介质

(57)摘要

本申请涉及清洁机器人技术领域，公开了一种清洁机的控制方法、装置、清洁机、控制设备及存储介质，包括：获取清洁机所在的作业区域的区域信息，其中，所述区域信息包括区域范围；根据所述区域信息和所述清洁机在所述作业区域的当前位置，建立清洁地图；控制所述清洁机根据所述清洁地图对所述作业区域进行清洁。本申请旨在提高清洁机对作业区域进行清洁的效率。



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1.一种清洁机的控制方法，其特征在于，包括：

获取清洁机所在的作业区域的区域信息，其中，所述区域信息包括区域范围和污渍信息，所述污渍信息至少包括污渍位置；

根据所述区域信息和所述清洁机在所述作业区域的当前位置，建立清洁地图；

控制所述清洁机根据所述清洁地图对所述作业区域进行清洁。

2.根据权利要求1所述的清洁机的控制方法，其特征在于，所述控制所述清洁机根据所述清洁地图对所述作业区域进行清洁的步骤包括：

根据所述清洁地图确定清洁路线；

控制所述清洁机沿着所述清洁路线对所述作业区域进行清洁。

3.根据权利要求1所述的清洁机的控制方法，其特征在于，所述控制所述清洁机根据所述清洁地图对所述作业区域进行清洁的步骤包括：

将所述清洁地图发送到控制设备上，以供所述控制设备基于所述清洁地图生成清洁指令；

接收到所述控制设备发送的清洁指令时，控制所述清洁机根据所述清洁指令对所述作业区域进行清洁。

4.根据权利要求3所述的清洁机的控制方法，其特征在于，所述控制所述清洁机根据所述清洁指令对所述作业区域进行清洁的步骤包括：

检测到所述清洁指令为第一清洁指令时，识别所述第一清洁指令在所述清洁地图上规划的清洁路线；

控制所述清洁机沿着所述清洁路线对所述作业区域进行清洁。

5.根据权利要求3所述的清洁机的控制方法，其特征在于，所述控制所述清洁机根据所述清洁指令对所述作业区域进行清洁的步骤包括：

检测到所述清洁指令为第二清洁指令时，确定所述第二清洁指令在所述清洁地图上定位的目标污渍位置；

控制所述清洁机前往所述目标污渍位置以预设模式进行清洁，直至清除所述目标污渍位置上的污渍。

6.根据权利要求3所述的清洁机的控制方法，其特征在于，所述控制所述清洁机根据所述清洁指令对所述作业区域进行清洁的步骤包括：

检测到所述清洁指令为第三清洁指令时，根据所述作业区域内所有的污渍位置规划清洁路线；

控制所述清洁机沿所述清洁路线行进，并对所述清洁路线上所有的污渍位置进行清洁。

7.根据权利要求1-6中任一项所述的清洁机的控制方法，其特征在于，所述获取清洁机所在的作业区域的区域信息的步骤包括：

在所述清洁机对所述作业区域进行全域清洁的过程中，获取所述作业区域的区域信息。

8.根据权利要求1所述的清洁机的控制方法，其特征在于，所述清洁机包括主体，以及至少一个行走转盘，所述至少一个行走转盘可转动地安装于所述主体朝向待清洁面的一侧，所述至少一个行走转盘转动和/或倾斜以带动所述主体相对待清洁面移动。

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9.根据权利要求8所述的清洁机的控制方法，其特征在于，所述清洁机还包括清洁转盘，所述清洁转盘可转动地设置于所述主体朝向待清洁面的一侧。

10.一种清洁机的控制方法，其特征在于，包括：

控制设备接收清洁机发送的清洁地图，显示所述清洁地图，其中，所述清洁地图基于所述清洁机所在的作业区域的区域信息及所述清洁机在所述作业区域的当前位置建立；所述区域信息包括区域范围；

检测到基于所述清洁地图生成的清洁指令时，将所述清洁指令发送至所述清洁机，以使所述清洁机根据所述清洁指令对所述作业区域进行清洁。

11.根据权利要求10所述的清洁机的控制方法，其特征在于，所述清洁指令包括第一清洁指令、第二清洁指令和第三清洁指令中的任一个；

其中，所述控制设备检测到第一清洁指令生成时，将所述第一清洁指令发送至所述清洁机；

所述清洁机接收到所述第一清洁指令时，识别所述第一清洁指令在所述清洁地图上规划的清洁路线，并沿着所述清洁路线对所述作业区域进行清洁；或

所述控制设备检测到第二清洁指令生成时，将所述第二清洁指令发送至所述清洁机；

所述清洁机接收到所述第二清洁指令时，以预设模式对目标污渍位置进行清洁，直至清除所述目标污渍位置上的污渍；或

所述控制设备检测到第三清洁指令生成时，将所述第三清洁指令发送至所述清洁机；

所述清洁机接收到所述第三清洁指令时，根据所述作业区域内所有的污渍位置规划清洁路线，并沿所述清洁路线行进，以对所述清洁路线上所有的污渍位置进行清洁。

12.一种清洁机的控制装置，其特征在于，包括：

获取模块，用于获取清洁机所在的作业区域的区域信息，其中，所述区域信息包括区域范围和污渍信息，所述污渍信息至少包括污渍位置；

建图模块，用于根据所述区域信息和所述清洁机在所述作业区域的当前位置，建立清洁地图；

控制模块，用于控制所述清洁机根据所述清洁地图对所述作业区域进行清洁。

13.一种清洁机，其特征在于，所述清洁机包括存储器、处理器及存储在所述存储器上并可在所述处理器上运行的清洁机的控制程序，所述清洁机的控制程序被所述处理器执行时实现如权利要求1至9中任一项所述的清洁机的控制方法的步骤。

14.一种控制设备，其特征在于，所述控制设备包括存储器、处理器及存储在所述存储器上并可在所述处理器上运行的清洁机的控制程序，所述清洁机的控制程序被所述处理器执行时实现如权利要求10或11所述的清洁机的控制方法的步骤。

15.一种计算机可读存储介质，其特征在于，所述计算机可读存储介质上存储有清洁机的控制程序，所述清洁机的控制程序被处理器执行时实现如权利要求1至11中任一项所述的清洁机的控制方法的步骤。

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清洁机的控制方法、装置、清洁机、控制设备及存储介质

技术领域

[0001] 本申请涉及清洁机器人技术领域，尤其涉及一种清洁机的控制方法、清洁机的控制装置、清洁机、控制设备以及计算机可读存储介质。

背景技术

[0002] 随着科学技术的发展与人民生活水平的提高，人们对于改善居住环境和提高生活质量的要求越来越高，智能、高效的家用清洁机(或称清洁机器人)越来越受到用户青睐，使人们可以从繁琐的家务活动中解脱出来。

[0003] 目前，在清洁机对作业区域进行清洁的过程中，若只是一边探索作业区域一边进行清洁，就有可能会对已清洁的地方进行反复清洁，这样不仅清洁效率低下，而且还造成了一定的清洁资源的浪费。

发明内容

[0004] 本申请提供一种清洁机的控制方法、清洁机的控制装置、清洁机、控制设备以及计算机可读存储介质，旨在提高清洁机对作业区域进行清洁的效率。

[0005] 为实现上述目的，提供一种清洁机的控制方法，包括以下步骤：

获取清洁机所在的作业区域的区域信息，其中，所述区域信息包括区域范围；

根据所述区域信息和所述清洁机在所述作业区域的当前位置，建立清洁地图；

控制所述清洁机根据所述清洁地图对所述作业区域进行清洁。

[0006] 可选的，所述控制所述清洁机根据所述清洁地图对所述作业区域进行清洁的步骤包括：

根据所述清洁地图确定清洁路线；

控制所述清洁机沿着所述清洁路线对所述作业区域进行清洁。

[0007] 可选的，所述控制所述清洁机根据所述清洁地图对所述作业区域进行清洁的步骤包括：

将所述清洁地图发送到控制设备上，以供所述控制设备基于所述清洁地图生成清洁指令；

接收到所述控制设备发送的清洁指令时，控制所述清洁机根据所述清洁指令对所述作业区域进行清洁。

[0008] 可选的，所述控制所述清洁机根据所述清洁指令对所述作业区域进行清洁的步骤包括：

检测到所述清洁指令为第一清洁指令时，识别所述第一清洁指令在所述清洁地图上规划的清洁路线；

控制所述清洁机沿着所述清洁路线对所述作业区域进行清洁。

[0009] 可选的，所述控制所述清洁机根据所述清洁指令对所述作业区域进行清洁的步骤包括：

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检测到所述清洁指令为第二清洁指令时，确定所述第二清洁指令在所述清洁地图上定位的目标污渍位置；

控制所述清洁机前往所述目标污渍位置以预设模式进行清洁，直至清除所述目标污渍位置上的污渍。

[0010] 可选的，所述控制清洁机根据所述清洁指令对所述作业区域进行清洁的步骤包括：

检测到所述清洁指令为第三清洁指令时，根据所述作业区域内所有的污渍位置规划清洁路线；

控制所述清洁机沿所述清洁路线行进，并对所述清洁路线上所有的污渍位置进行清洁。

[0011] 可选的，所述获取清洁机所在的作业区域的区域信息的步骤包括：

在所述清洁机对所述作业区域进行全域清洁的过程中，获取所述作业区域的区域信息。

[0012] 可选的，所述清洁机包括主体，以及至少一个行走转盘，所述至少一个行走转盘可转动地安装于所述主体朝向待清洁面的一侧，所述至少一个行走转盘转动和/或倾斜以带动所述主体相对待清洁面移动。

[0013] 可选的，所述清洁机还包括清洁转盘，所述清洁转盘可转动地设置于所述主体朝向待清洁面的一侧。

[0014] 为实现上述目的，还提供一种清洁机的控制方法，包括：

控制设备接收清洁机发送的清洁地图，显示所述清洁地图，其中，所述清洁地图基于所述清洁机所在的作业区域的区域信息及所述清洁机在所述作业区域的当前位置建立；所述区域信息包括区域范围；

检测到基于所述清洁地图生成的清洁指令时，将所述清洁指令发送至所述清洁机，以使所述清洁机根据所述清洁指令对所述作业区域进行清洁。

[0015] 可选的，所述清洁指令包括第一清洁指令、第二清洁指令和第三清洁指令中的任一个；

其中，所述控制设备检测到第一清洁指令生成时，将所述第一清洁指令发送至所述清洁机；

所述清洁机接收到所述第一清洁指令时，识别所述第一清洁指令在所述清洁地图上规划的清洁路线，并沿着所述清洁路线对所述作业区域进行清洁；或

所述控制设备检测到第二清洁指令生成时，将所述第二清洁指令发送至所述清洁机；

所述清洁机接收到所述第二清洁指令时，以预设模式对目标污渍位置进行清洁，直至清除所述目标污渍位置上的污渍；或

所述控制设备检测到第三清洁指令生成时，将所述第三清洁指令发送至所述清洁机；

所述清洁机接收到所述第三清洁指令时，根据所述作业区域内所有的污渍位置规划清洁路线，并沿所述清洁路线行进，以对所述清洁路线上所有的污渍位置进行清洁。

[0016] 为实现上述目的，还提供一种清洁机的控制装置，包括：

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获取模块，用于获取清洁机所在的作业区域的区域信息，其中，所述区域信息包括区域范围；

建图模块，用于根据所述区域信息和所述清洁机在所述作业区域的当前位置，建立清洁地图；

控制模块，用于控制所述清洁机根据所述清洁地图对所述作业区域进行清洁。

[0017] 为实现上述目的，还提供一种清洁机，所述清洁机包括：存储器、处理器及存储在所述存储器上并可在所述处理器上运行的清洁机的控制程序，所述清洁机的控制程序被所述处理器执行时实现如上述清洁机的控制方法的步骤。

[0018] 为实现上述目的，还提供一种控制设备，所述控制设备包括：存储器、处理器及存储在所述存储器上并可在所述处理器上运行的清洁机的控制程序，所述清洁机的控制程序被所述处理器执行时实现如上述清洁机的控制方法的步骤。

[0019] 为实现上述目的，还提供一种计算机可读存储介质，所述计算机可读存储介质上存储有清洁机的控制程序，所述清洁机的控制程序被处理器执行时实现如上述清洁机的控制方法的步骤。

[0020] 本申请提供的清洁机的控制方法、清洁机的控制装置、清洁机、控制设备以及计算机可读存储介质，利用清洁机基于作业区域的污渍分布情况建立清洁地图，并基于清洁地图对作业区域进行清洁，提高了清洁机清除作业区域内的污渍的效率。

附图说明

[0021] 图1为一实施例中清洁机的控制方法步骤示意图；

图2为一实施例中清洁机的控制方法的清洁地图示例图；

图3为另一实施例中清洁机的控制方法步骤示意图；

图4为一实施例中清洁机的控制方法的用户触发清洁地图示例图；

图5为又一实施例中清洁机的控制方法步骤示意图；

图6为一实施例的清洁机的结构示例图；

图7为另一实施例的清洁机的结构示例图；

图8为一实施例的清洁机的控制装置的内部结构示意框图；

图9为一实施例的清洁机的内部结构示意框图；

图10为一实施例的控制设备的内部结构示意框图。

[0022] 目的的实现、功能特点及优点将结合实施例，参照附图做进一步说明。

具体实施方式

[0023] 下面详细描述本申请的实施例，所述实施例的示例在附图中示出，其中自始至终相同或类似的标号表示相同或类似的元件或具有相同或类似功能的元件。下面通过参考附图描述的实施例是示例性的，旨在用于解释本申请，而不能理解为对本申请的限制，基于本申请中的实施例，本领域普通技术人员在没有作出创造性劳动前提下所获得的所有其他实施例，都属于本申请保护的范围。

[0024] 参照图1，在一实施例中，所述清洁机的控制方法包括：

步骤S10、获取清洁机所在的作业区域的区域信息，其中，所述区域信息包括区域

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范围；

步骤S20、根据所述区域信息和所述清洁机在所述作业区域的当前位置，建立清洁地图；

步骤S30、控制所述清洁机根据所述清洁地图对所述作业区域进行清洁。

[0025] 本实施例中，实施例终端可以是清洁机，也可以是控制清洁机器的控制设备、控制装置等。

[0026] 其中，所述清洁机可以是擦窗机、擦地机、擦墙机、擦屋子顶部的擦顶机等，清洁机的作业区域可以是窗户、地板、瓷砖墙、房顶等表面光滑或者不光滑的区域。即清洁机可以为需要吸附在待清洁面上的清洁机，或者为不需要吸附在待清洁面上的清洁机。以下以清洁机为擦窗机为例进行说明。

[0027] 如步骤S10所述，清洁机所在的作业区域可以指的是清洁机负责清洁的具有一定区域范围的区域，如当清洁机用于擦地时，则其作业区域可以是一处室内空间中的地板。如当清洁机用于擦窗时，则作业区域可以是窗户玻璃。

[0028] 可选的，当清洁机处在作业区域中时，终端(控制设备或清洁机)可以是通过向清洁机发送相应的控制指令，以控制清洁机巡视整个作业区域来获取作业区域内的区域信息。其中，所述区域信息至少包括区域范围，还可包括污渍信息。污渍信息可以包括污渍位置。当然，清洁机也可以自身巡视整个作业区域来获取作业区域内的区域信息。

[0029] 可选的，清洁机设置有测距传感器，并可通过测距传感器测量作业区域的尺寸，从而得到区域范围。

[0030] 可选的，清洁机设置有污渍识别传感器，并可通过污渍识别传感器获取作业区域内的污渍信息。其中，所述污渍信息至少包括污渍位置，如当控制清洁机在巡视作业区域的过程中检测到污渍时，则记录该污渍在作业区域中的位置；或者，也可以是利用清洁机携带的摄像头(如深度摄像头)拍摄其作业区域内的图片，并利用图片分析技术识别图中的污渍，并根据污渍在图中的成像区域分析污渍在作业区域内的真实位置。

[0031] 可选的，所述污渍信息还可包括污渍成分，在终端(控制设备或清洁机)控制清洁机或者清洁机自身通过污渍识别传感器在识别污渍的同时，还可以通过污渍识别传感器同步识别得到相应污渍的成分(污渍成分可以是动物粪便、泥灰、汁液等)。

[0032] 可选的，所述污渍信息还可包括污渍三维信息，清洁机通过污渍识别传感器在识别污渍的同时，还可以应用图像识别技术来获得相应污渍的三维图形信息。

[0033] 如步骤S20所述，终端(控制设备或清洁机)可以是以作业区域所在平面构建平面直角坐标系或三维坐标系，并根据检测到的区域范围，以等比例的方式在坐标系中构建与实际的作业区域相对应的地图，进而得到基础的清洁地图。

[0034] 可选的，清洁机还根据在作业区域检测到的污渍信息，将各污渍在现实中的作业区域中的位置(即污渍位置)，映射显示到清洁地图中的作业区域范围内的相应位置。这样在清洁地图中就可以显示出每个污渍的相应位置。

[0035] 可选的，清洁机还会将本机当前在作业区域中的位置(即当前位置)，同步显示到清洁地图中。其中，清洁机可以是定时或实时在清洁地图中更新其当前在作业区域中的位置。

[0036] 可选的，参照图2，当清洁地图显示有作业区域的地图、图上有每个污渍的位置、清

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洁机在图上的当前位置时，则清洁地图构建完成。

[0037] 如步骤S30所述，在清洁地图构建完成后，终端(控制设备或清洁机)可以是根据所述清洁地图确定清洁路线，控制所述清洁机沿着所述清洁路线对所述作业区域进行清洁(或者清洁机自身主动沿着所述清洁路线对所述作业区域进行清洁)。

[0038] 可选的，终端(控制设备或者清洁机)根据清洁地图上所有的污渍位置规划清洁路线时，可以是根据各个污渍位置与清洁机当前位置的远近关系规划清洁路线(如以离清洁机越近则优先清洁为原则，这样离清洁机最近的污渍位置就可以作为清洁路线上的第一个清洁点，而下一个清洁点即为处第一个清洁点外离清洁机最近的污渍位置，以此类推)，并使规划的清洁路线可以覆盖所有污渍位置。

[0039] 可选的，在根据所有污渍位置生成清洁路线后，则控制清洁机或者清洁机自身从当前位置沿清洁路线行进，并在行进的过程中执行相应的清洁任务，以对所述清洁路线上所有的污渍位置进行清洁。其中，在清洁机沿清洁路线行进的过程中，可以是在抵达清洁路线上的每个污渍位置之后，则针对相应的污渍位置进行定点清洁(如反复擦拭该污渍位置数遍)，直至相应污渍位置上的污渍被清洁干净。

[0040] 或者，终端(控制设备或清洁机)也可以先检测清洁地图上所有的污渍的数量是否大于预设阈值。若污渍数量小于预设阈值，则根据所述清洁地图确定清洁路线，并清洁机沿着所述清洁路线对所述作业区域进行清洁；若污渍数量大于或等于预设阈值，则清洁机直接对全作业区域进行清洁。其中，所述预设阈值用于衡量污渍数量的多少，具体可根据实际情况需要设置，本实施例对此不作限定。

[0041] 这样，利用清洁机基于作业区域的污渍分布情况建立清洁地图，并基于清洁地图对作业区域进行清洁，提高了清洁机对作业区域进行清洁的效率，尤其是提高了清洁机清除作业区域内的污渍的效率。

[0042] 在一实施例中，参照图3，在上述实施例的基础上，所述控制所述清洁机根据所述清洁地图对所述作业区域进行清洁的步骤包括：

步骤S40、将所述清洁地图发送到控制设备上，以供所述控制设备基于所述清洁地图生成清洁指令；

步骤S41、接收到所述控制设备发送的清洁指令时，控制所述清洁机根据所述清洁指令对所述作业区域进行清洁。

[0043] 本实施例中，在清洁地图构建完成后，清洁机还会将清洁地图发送至与其关联的控制设备上(如遥控器、移动智能终端等)，以供控制设备显示清洁地图。其中，控制设备上可以预置有与清洁地图相适配的APP应用，在控制设备接收到清洁机发送的清洁地图后，可以通过打开相应的APP应用，从而将清洁地图显示在显示界面中。这样，用户通过查看控制设备上的清洁地图，就可以了解到清洁机作业区域内的污渍分布情况，并可通过控制设备远程遥控清洁机针对具体污渍分布情况执行相应的清洁任务。

[0044] 可选的，清洁机在将清洁地图发送至控制设备后，还可以实时或定时更新清洁地图中的污渍位置和清洁机的最新位置(即当前位置)，并将更新信息反馈至控制设备，以使控制设备可以同步更新清洁地图。

[0045] 可选的，为了方便用户了解到详细的污渍信息，从而控制清洁机执行更精细的清洁操作，生成的清洁图像还可以显示各污渍位置对应的污渍成分。

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[0046] 可选的，若生成的清洁地图是三维地图，则还可以根据各污渍位置对应的污渍三维信息，在清洁地图上显示各污渍的三维图形，以便于用户更为直观地了解到

这样，利用清洁机基于作业区域的污渍分布情况建立清洁地图，并将清洁地图发送至相关控制设备，这样用户无需亲临清洁机作业区域就可以通过控制设备远程了解到清洁机作业区域的污渍分布情况，以便于用户基于清洁地图遥控清洁机针对具体的脏污场景执行一些精细化的清洁操作，提升了清洁机使用的便利性。

[0047] 可选的，用户通过控制设备显示的清洁地图了解到清洁机作业区域内的污渍分布情况后，可以通过控制设备向清洁机发出相应的清洁指令，以控制清洁机针对具体的污渍分布情况进行清洁。

[0048] 可选的，为了方便用户控制，可以在地图应用中显示常规控制按键，用户可以利用常规控制按键直接通过控制设备向清洁机发出一些常规的控制指令，以控制清洁机执行相应的清洁任务；用户也可以是通过触发控制设备显示的清洁地图，从而生成相应的清洁指令，然后再通过控制设备向清洁机发送清洁指令，在清洁机接收到控制设备发送的清洁指令后，则执行清洁指令。

[0049] 可选的，针对清洁机的常规控制指令可以是对清洁机的开关机控制、移动方向控制(如控制清洁机往上、下、左、右方向移动)、运行模式控制(如定点清洁模式、自动清洁模式、深度清洁模式等)。其中，处于远程的用户通过清洁地图观察到清洁机与各污渍之间的相对位置后，可以是通过手动控制清洁机移动至污渍位置，然后选择定点清洁模式，这时清洁机就会在相应污渍位置上进行来回(如上下来回或左右来回)往复擦拭；或者当用户观察到窗户肮脏程度比较高(如污渍位置的数量较多)，则可以通过控制设备控制清洁机进入自动清洁模式，这时清洁机就会按照默认路径(如“Z”字形、“N”字形或“弓”字形)行进，且边行进边清洁，直至完成对整个作业区域的清洁；或者用户也可以控制清洁机进入深度清洁模式，这样清洁机就会对整个作业区域自动进行清洁多遍(如反复清洁两遍)。

[0050] 可选的，用户通过控制设备显示的清洁地图了解到清洁机作业区域内的污渍分布情况后，也可以是通过触发清洁地图中显示的污渍位置，以此来生成相应的清洁指令，这样当用户通过控制设备向清洁机发出相应的清洁指令时，清洁机就可以基于用户之前所触发的污渍位置进行清洁，这样就可以方便用户基于清洁地图遥控清洁机针对具体的脏污场景执行一些精细化的清洁操作，提升了清洁机使用的便利性。

[0051] 此外，为了方便用户控制清洁机停止或开始运行，用户也可以是通过触碰清洁地图中显示的清洁机图标(该图标同时也代表了清洁机的当前位置)，以此控制清洁机停止或开始运行。如当清洁机在运行时，用户触发一下清洁机图标，就可以控制清洁机停机；在清洁机停机时，用户触发一下清洁机图片，则可以控制清洁机上电启动。

[0052] 在一实施例中，在上述实施例基础上，所述控制所述清洁机根据所述清洁指令对所述作业区域进行清洁的步骤包括：

检测到所述清洁指令为第一清洁指令时，识别所述第一清洁指令在所述清洁地图上规划的清洁路线；

控制所述清洁机沿着所述清洁路线对所述作业区域进行清洁。

[0053] 本实施例中，基于清洁地图生成的清洁指令可以包括第一清洁指令。

[0054] 可选的，参照图4，用户通过控制设备上的APP应用所显示的清洁地图了解到清洁

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机作业区域内的污渍分布情况后，可以基于清洁地图触发其中多个污渍位置(或是利用APP应用中配置的常规控制按键触发)，当控制设备检测到基于所述清洁地图触发了多个污渍位置时，则根据所述多个污渍位置之间的连线在所述清洁地图上规划相应的清洁路线，并生成所述第一清洁指令。

[0055] 其中，用户触发多个污渍位置的方式，可以是通过进行多点位置的连线，从而触发多个污渍位置；也可以是在一定时长内连续点击多个污渍位置，从而触发多个污渍位置；也可以是选中一片地图区域(如在地图上画一个圈)，从而触发位于该地图区域内的多个污渍位置。

[0056] 其中，控制设备规划清洁路线的方式，可以是根据用户触发多个污渍位置的先后顺序，对多个污渍位置进行连线，并结合清洁机的当前位置，从而生成以供清洁机行进的清洁路线；或者，控制设备也可以是根据各个污渍位置与清洁机当前位置的远近关系规划清洁路线(如以离清洁机越近则优先清洁为原则，这样离清洁机最近的污渍位置就可以作为清洁路线上的第一个清洁点，而下一个清洁点即为处第一个清洁点外离清洁机最近的污渍位置，以此类推)。

[0057] 可选的，控制设备在生成第一清洁指令后，则将第一清洁指令发送至清洁机，以控制清洁机执行第一清洁指令对应的清洁任务。当清洁机接收到控制设备发送的清洁指令，并在检测到该清洁指令为第一清洁指令后，则识别所述第一清洁指令在所述清洁地图上规划的清洁路线，并在识别得到清洁路线后，则从当前位置沿清洁路线沿着所述清洁路线对所述作业区域进行清洁。

[0058] 其中，清洁机执行清洁任务的方式，可以是在沿清洁路线行进的过程中，一边行进一边进行清洁，这样当清洁机走完清洁路线之后，也就能覆盖清洁到清洁路线上的所有污渍位置。或者，在清洁机沿清洁路线行进的过程中，也可以只在抵达清洁路线上的每个污渍位置之后，再针对相应的污渍位置进行定点清洁(如反复擦拭该污渍位置数遍)。

[0059] 这样，可以方便用户在清洁地图上绘制清洁机的运行轨迹，使得清洁机按照该路径运行并对用户想要清洁多个污渍点进行清洁，从而方便用户通过控制设备控制清洁机执行一些精细化的清洁操作。

[0060] 在一实施例中，在上述实施例基础上，所述控制所述清洁机根据所述清洁指令对所述作业区域进行清洁的步骤包括：

检测到所述清洁指令为第二清洁指令时，确定所述第二清洁指令在所述清洁地图上定位的目标污渍位置；

控制所述清洁机前往所述目标污渍位置以预设模式进行清洁，直至清除所述目标污渍位置上的污渍。

[0061] 本实施例中，基于清洁地图生成的清洁指令可以包括第二清洁指令。

[0062] 可选的，用户通过控制设备上的APP应用所显示的清洁地图了解到清洁机作业区域内的污渍分布情况后，可以基于清洁地图触发其中任一个污渍位置(记为目标污渍位置)，当控制设备检测到用户基于所述清洁地图触发了任一目标污渍位置时，则根据所述目标污渍位置生成所述第二清洁指令，并将所述第二清洁指令发送至清洁机，以控制清洁机执行第二清洁指令对应的清洁任务。例如，当用户用手指在控制设备显示的清洁地图上针对某个污渍位置做出擦拭动作，则控制设备会确定该污渍位置即为用户当前想要清洁的目

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标污渍位置。

[0063] 可选的，当清洁机接收到控制设备发送的清洁指令，并在检测到该清洁指令为第二清洁指令后，则确定第二清洁指令在所述清洁地图上定位的目标污渍位置。然后清洁机会从当前位置运行至目标污渍位置，并在抵达目标污渍位置后，以预设模式对目标污渍位置进行清洁，直至清除所述目标污渍位置上的污渍。

[0064] 其中，清洁机在前往目标污渍位置时，可以根据当前位置与目标污渍位置之间的连线，确定运行的最佳路径(如以两点间最短距离的连线作为最佳路径)，并沿最佳路径前往目标污渍位置，从而提高清洁机运行的效率。

[0065] 可选的，所述预设模式可以是定点清洁模式(如针对目标污渍位置进行反复擦拭)，也可以是用户私人定制的一些清洁模式(如针对目标污渍位置进行深度清洁，以对目标污渍位置清洁多遍)。

[0066] 这样，可以方便用户远程控制清洁机对清洁机作业区域进行定点清洁。

[0067] 在一实施例中，在上述实施例基础上，所述控制清洁机根据所述清洁指令对所述作业区域进行清洁的步骤包括：

检测到所述清洁指令为第三清洁指令时，根据所述作业区域内所有的污渍位置规划清洁路线；

控制所述清洁机沿所述清洁路线行进，并对所述清洁路线上所有的污渍位置进行清洁。

[0068] 本实施例中，基于清洁地图生成的清洁指令可以包括第三清洁指令。

[0069] 可选的，在控制设备上用于显示清洁地图的APP应用中，提供有全域清洁选项(如通过全选按键或自动清洁按键来表示)。用户通过控制设备上的APP应用所显示的清洁地图了解到清洁机作业区域内的污渍分布情况后，认为有必要对所有污渍位置进行清洁时，可以通过触发全域清洁选项，来通过控制设备控制清洁机对所有污渍位置进行清洁。

[0070] 可选的，当控制设备检测到用户基于所述清洁地图触发了全域清洁选项时，生成所述第三清洁指令，并将所述第三清洁指令发送至清洁机，以控制清洁机执行第三清洁指令对应的清洁任务。当清洁机接收到控制设备发送的清洁指令，并在检测到该清洁指令为第三清洁指令后，则根据所述作业区域内所有的污渍位置规划清洁路线。其中，清洁机规划清洁路线的方式，可以是根据各个污渍位置与清洁机当前位置的远近关系规划清洁路线(如以离清洁机越近则优先清洁为原则，这样离清洁机最近的污渍位置就可以作为清洁路线上的第一个清洁点，而下一个清洁点即为处第一个清洁点外离清洁机最近的污渍位置，以此类推)，并使规划的清洁路线可以覆盖所有污渍位置。

[0071] 可选的，在清洁机根据所有污渍位置生成清洁路线后，则从当前位置沿清洁路线行进，并在行进的过程中执行相应的清洁任务，以对所述清洁路线上所有的污渍位置进行清洁。其中，在清洁机沿清洁路线行进的过程中，可以是在抵达清洁路线上的每个污渍位置之后，则针对相应的污渍位置进行定点清洁(如反复擦拭该污渍位置数遍)，直至相应污渍位置上的污渍被清洁干净。

[0072] 这样，即方便用户通过控制设备远程控制清洁机对所有污渍位置进行清洁，同时清洁机通过规划清洁路线，还可以提高对所有污渍位置进行清洁的效率，即清洁机只需针对清洁路线进行清洁即可，无需对全作业区域进行清洁亦可以实现清洁所有的污渍点。

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[0073] 在一实施例中，参照图5，在上述实施例基础上，所述获取清洁机所在的作业区域的区域信息的步骤包括：

步骤S11、在所述清洁机对所述作业区域进行全域清洁的过程中，获取所述作业区域的区域信息。

[0074] 本实施例中，终端可以控制清洁机在其所在的作业区域中，先按照默认路径（如“Z”字形、“N”字形或“弓”字形）行进，且边行进边清洁，以对整个作业区域进行全域清洁，以清除掉作业区域内容易清洁的污渍。同时，清洁机还会在全域清洁的过程中获取所述作业区域的区域信息，包括区域范围和顽固污渍的污渍信息。

[0075] 应当理解的是，所谓顽固污渍即为清洁机清洁一遍过后未能清洁掉的污渍。

[0076] 可选的，清洁机在对作业区域清洁一遍后，根据得到区域信息和所述清洁机在所述作业区域的当前位置，建立清洁地图，以在清洁地图中显示顽固污渍的位置和相关信息。

[0077] 这样当清洁机将生成的清洁地图发送至控制设备上进行显示时，就可以方便用户通过控制设备了解到清洁机作业区域内的顽固污渍，并根据实际的污渍情况，针对这些污渍控制清洁机作出相应精细化的清洁操作，以使清洁机可以清除掉作业区域内的顽固污渍。而对于那些容易清洁的污渍，在清洁机一边清洁一边获取区域信息的过程就已经清除掉了，也就节省掉了用户通过控制设备远程遥控清洁机清除这些易清除污渍的操作。

[0078] 在一实施例中，参照图6或图7，所述清洁机包括主体100和移动机构200，所述移动机构200可包括至少一个行走转盘210，所述至少一个行走转盘210可转动地安装于所述主体朝向待清洁面的一侧，所述至少一个行走转盘210转动和/或倾斜以带动所述主体相对待清洁面移动。

[0079] 可选的，所述清洁机还包括清洁转盘300，所述清洁转盘300可转动地设置于所述主体100朝向待清洁面的一侧。

[0080] 可选的，所述清洁机还包括负压装置（图中未标示），所述主体100和清洁转盘300与待清洁面之间形成所述负压腔室，所述负压装置与所述主体100连接，负压装置工作以使得所述负压腔室内产生负压。

[0081] 可选的，负压装置位于主体100的内部或者主体100的外部。在负压装置位于主体100的外部时，可通过管道连接负压装置与主体100。负压装置工作时，使得主体100、清洁转盘300与待清洁面之间形成的密闭空间产生负压。在负压状态下，清洁机紧紧吸附在待清洁面上，可产生移动机构200移动所需的摩擦力，进而可使得清洁机通过移动机构200在竖直或倾斜的待清洁面的清洁场景下，实现稳定移动。

[0082] 可选的，参照图6，移动机构200包括至少两个行走转盘210，至少两个行走转盘210可转动地安装于主体100朝向待清洁面的一侧，至少两个行走转盘210转动以带动主体100相对待清洁面移动。行走转盘210接触于待清洁面，并在转动时通过与待接触面的摩擦力作用以带动主体100移动。

[0083] 可选的，每个行走转盘210上和待清洁面的接触部位套设或粘设有摩擦系数大的材料，可以是硅胶、橡胶等。移动机构200中，各行走转盘210分别采用独立动力源驱动。

[0084] 可选的，移动机构200包括两个行走转盘210，分别为第一行走转盘和第二行走转盘，并对应通过两个动力源驱动；第一行走转盘沿第一方向转动，第二行走转盘沿第二方向转动，第一方向与第二方向相反。具体地，第一方向包括顺时针方向或逆时针方向，第二方

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向包括顺时针方向或逆时针方向。并且，当主体100需要转向时，可以是两个行走转盘210的转动速度不一样，如其中的一个转动较快，另一个转动速度较慢，如此可带动主体100转动。当然，在清洁机需要在与基准面呈不同夹角的待清洁面之间移动时，还可以通过改变行走转盘210相对于不同待清洁面的倾斜角度，以使行走转盘210可以带动主体100从当前所在的待清洁面，切换至另一个待清洁面。

[0085] 在一些实施例中，清洁机在作业区域内移动时，可以一边移动、一边对作业区域内的待清洁面进行清洁。参照图6，清洁转盘300包括转动部和清洁部(图中未示出)，清洁部设于转动部朝向待清洁面的一侧表面，驱动件与转动部传动连接。

[0086] 清洁机工作时，驱动件驱动转动部转动，清洁部随转动部转动以对待清洁面进行清洁。具体地，驱动件与转动部之间可设置传动结构，传动结构的动力输入端与驱动件连接，传动结构的动力输出端与转动部连接，驱动件通过所设的传动结构以形成与转动部的传动连接。可选的，转动部选用同步带，清洁部选用清洁布、一次性清洁布或清洁海绵等，粘设或套设于同步带上。

[0087] 作为清洁转盘300安装的可选实施方式，主体100朝向待清洁面的一侧表面设置若干个支撑轮，若干个支撑轮呈周向布局，转动部套设于多个支撑轮上以实现安装。进一步地，若干个支撑轮的至少一个设计为主动支撑轮，其它的设计为被动支撑轮。驱动件通过驱动主动支撑轮转动，以使得转动部转动。当然，此可选实施方式仅为示例性的，并非限制性的，还可选用其它。

[0088] 在一些实施例中，参照图7，清洁机包括至少两个清洁转盘300和至少两个行走转盘210，所述清洁转盘300与所述行走转盘210的数量相等，即一个清洁转盘300对应一个行走转盘210。在主体100上，设置有驱动件(图中未标示)。驱动件用于分别驱动行走转盘210和清洁转盘300，在驱动件的驱动下，行走转盘210和清洁转盘300以不同速度转动，且每个清洁转盘300与对应的行走转盘210的转动方向可同向、可反向。对于一个行走转盘210和清洁转盘300，驱动件可以是包括一个动力源，通过一个动力源为行走转盘210和清洁转盘300同时提供动力；或者，驱动件也可以是包括两个动力源，通过两个动力源分别为行走转盘210和清洁转盘300提供动力。对应不同的驱动布局形式，可设置对应的传动结构，以分别实现对行走转盘210和清洁转盘300的传动。

[0089] 可选的，清洁机在工作时，通过驱动件分别驱动行走转盘210和清洁转盘300转动，至少两个行走转盘210转动以带动主体100在待清洁面上移动，清洁转盘300转动以清洁待清洁面。

[0090] 此外，还提出一种清洁机的控制方法，包括：

控制设备接收清洁机发送的清洁地图，显示所述清洁地图，其中，所述清洁地图基于所述清洁机所在的作业区域的区域信息及所述清洁机在所述作业区域的当前位置建立；所述区域信息包括区域范围；

检测到基于所述清洁地图生成的清洁指令时，将所述清洁指令发送至所述清洁机，以使所述清洁机根据所述清洁指令对所述作业区域进行清洁。

[0091] 可选的，所述清洁指令包括第一清洁指令、第二清洁指令和第三清洁指令中的任一个；

其中，所述控制设备检测到第一清洁指令生成时，将所述第一清洁指令发送至所

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述清洁机；

所述清洁机接收到所述第一清洁指令时，识别所述第一清洁指令在所述清洁地图上规划的清洁路线，并沿着所述清洁路线对所述作业区域进行清洁；或

所述控制设备检测到第二清洁指令生成时，将所述第二清洁指令发送至所述清洁机；

所述清洁机接收到所述第二清洁指令时，以预设模式对目标污渍位置进行清洁，直至清除所述目标污渍位置上的污渍；或

所述控制设备检测到第三清洁指令生成时，将所述第三清洁指令发送至所述清洁机；

所述清洁机接收到所述第三清洁指令时，根据所述作业区域内所有的污渍位置规划清洁路线，并沿所述清洁路线行进，以对所述清洁路线上所有的污渍位置进行清洁。

[0092] 参照图8，实施例中还提供一种清洁机的控制装置Z10，包括：

获取模块Z11，用于获取清洁机所在的作业区域的区域信息，其中，所述区域信息包括区域范围和污渍信息，所述污渍信息至少包括污渍位置；

建图模块Z12，用于根据所述区域信息和所述清洁机在所述作业区域的当前位置，建立清洁地图；

控制模块Z13，用于控制所述清洁机根据所述清洁地图对所述作业区域进行清洁。

[0093] 参照图9，实施例中还提供一种清洁机，该清洁机内部结构可以如图9所示。该清洁机包括通过系统总线连接的处理器、存储器和通信接口。其中，该处理器用于提供计算和控制能力。该清洁机的存储器包括非易失性存储介质、内存储器。该非易失性存储介质存储有操作系统、计算机程序和数据库。该内存储器为非易失性存储介质中的操作系统和计算机程序的运行提供环境。该清洁机的数据库用于存储清洁机的控制程序，还可用于存储设备运行中收到的所有数据，包括地图信息、污渍信息、行走距离、行走时间、行走角度等数据。该清洁机的通信接口用于与外部的终端进行通信连接，包括数据与指令的交互。该清洁机的输入装置用于接收外部设备输入的信号。该计算机程序被处理器执行时以实现一种如以上实施例所述的清洁机的控制方法。

[0094] 本领域技术人员可以理解，图9中示出的结构，仅仅是与方案相关的部分结构的框图，并不构成对方案所应用于其上的控制设备的限定。

[0095] 参照图10，实施例中还提供一种控制设备，该控制设备内部结构可以如图10所示。该控制设备包括通过系统总线连接的处理器、存储器和通信接口。其中，该处理器用于提供计算和控制能力。该控制设备的存储器包括非易失性存储介质、内存储器。该非易失性存储介质存储有操作系统、计算机程序和数据库。该内存储器为非易失性存储介质中的操作系统和计算机程序的运行提供环境。该控制设备的数据库用于存储清洁机的控制程序，还可用于存储设备运行中收到的所有数据，包括地图信息、污渍信息、行走距离、行走时间、行走角度等数据。该控制设备的通信接口用于与外部的终端进行通信连接，包括数据与指令的交互。该控制设备的输入装置用于接收外部设备输入的信号。该计算机程序被处理器执行时以实现一种如以上实施例所述的清洁机的控制方法。

[0096] 本领域技术人员可以理解，图10中示出的结构，仅仅是与方案相关的部分结构的框图，并不构成对方案所应用于其上的控制设备的限定。

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[0097] 此外，还提出一种计算机可读存储介质，所述计算机可读存储介质包括清洁机的控制程序，所述清洁机的控制程序被处理器执行时实现如以上实施例所述的清洁机的控制方法的步骤。可以理解的是，本实施例中的计算机可读存储介质可以是易失性可读存储介质，也可以为非易失性可读存储介质。

[0098] 综上所述，为实施例中提供的清洁机的控制方法、清洁机的控制装置、清洁机、控制设备和计算机可读存储介质，利用清洁机基于作业区域的污渍分布情况建立清洁地图，并基于清洁地图对作业区域进行清洁，提高了清洁机清除作业区域内的污渍的效率，并通过将清洁地图发送至相关控制设备，这样用户无需亲临清洁机作业区域就可以通过控制设备远程了解到清洁机作业区域的脏污分布情况，以便于用户基于清洁地图遥控清洁机针对具体的脏污场景执行一些精细化的清洁操作，提升了清洁机使用的便利性。

[0099] 本领域普通技术人员可以理解实现上述实施例方法中的全部或部分流程，是可以通过计算机程序来指令相关的硬件来完成，所述的计算机程序可存储于一非易失性计算机可读取存储介质中，该计算机程序在执行时，可包括如上述各方法的实施例的流程。其中，所提供的和实施例中所使用的对存储器、存储、数据库或其它介质的任何引用，均可包括非易失性和/或易失性存储器。非易失性存储器可以包括只读存储器(ROM)、可编程ROM(PROM)、电可编程ROM(EPROM)、电可擦除可编程ROM(EEPROM)或闪存。易失性存储器可包括随机存取存储器(RAM)或者外部高速缓冲存储器。作为说明而非局限，RAM通过多种形式可得，诸如静态RAM(SRAM)、动态RAM(DRAM)、同步DRAM(SDRAM)、双速据率SDRAM(SSRSDRAM)、增强型SDRAM(ESDRAM)、同步链路(Synchlink)DRAM(SLDRAM)、存储器总线(Rambus)直接RAM(RDRAM)、直接存储器总线动态RAM(DRDRAM)、以及存储器总线动态RAM(RDRAM)等。

[0100] 需要说明的是，在本文中，术语“包括”、“包含”或者其任何其它变体意在涵盖非排他性的包含，从而使得包括一系列要素的过程、装置、物品或者方法不仅包括那些要素，而且还包括没有明确列出的其它要素，或者是还包括为这种过程、装置、物品或者方法所固有的要素。在没有更多限制的情况下，由语句“包括一个……”限定的要素，并不排除在包括该要素的过程、装置、物品或者方法中还存在另外的相同要素。

[0101] 以上所述仅为的优选实施例，并非因此限制的专利范围，凡是利用说明书及附图内容所作的等效结构或等效流程变换，或直接或间接运用在其它相关的技术领域，均同理包括在的专利保护范围内。

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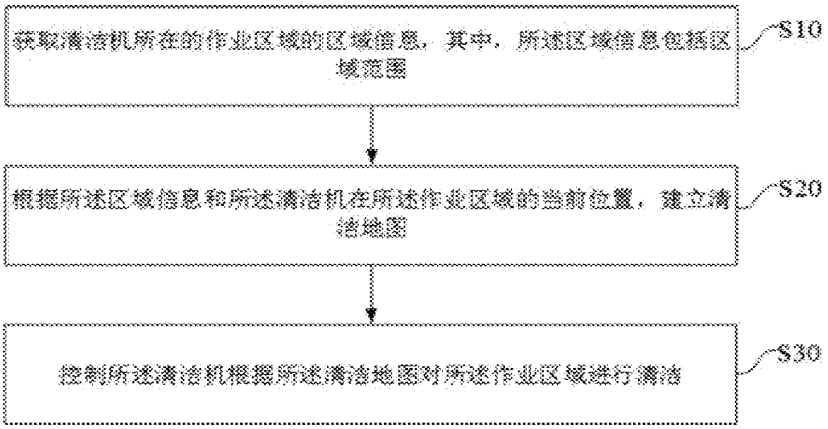


图1

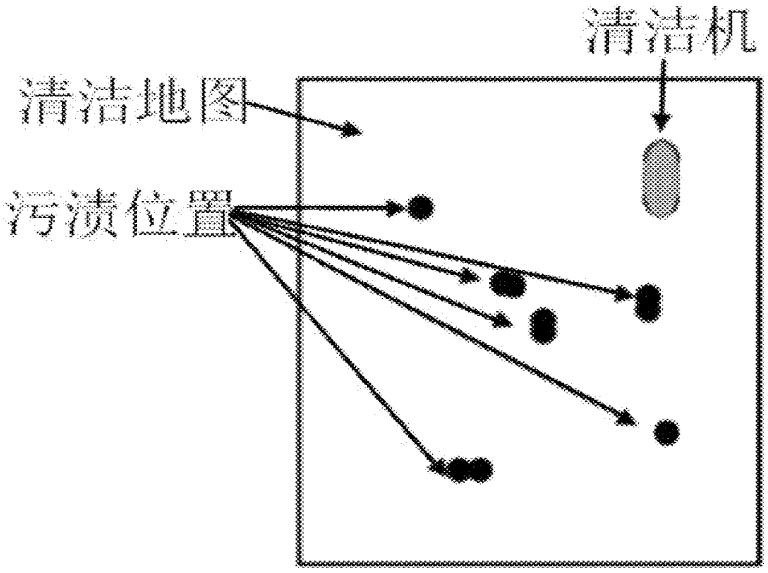


图2

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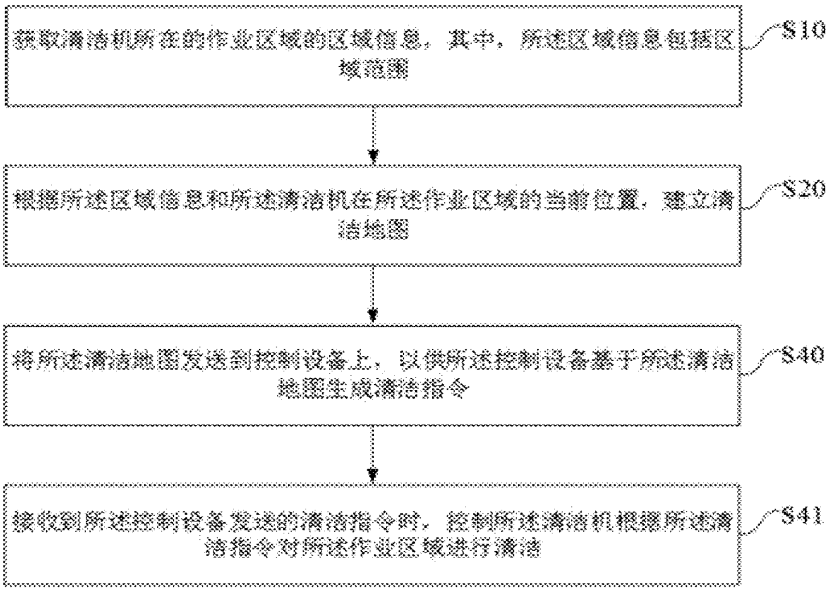


图3

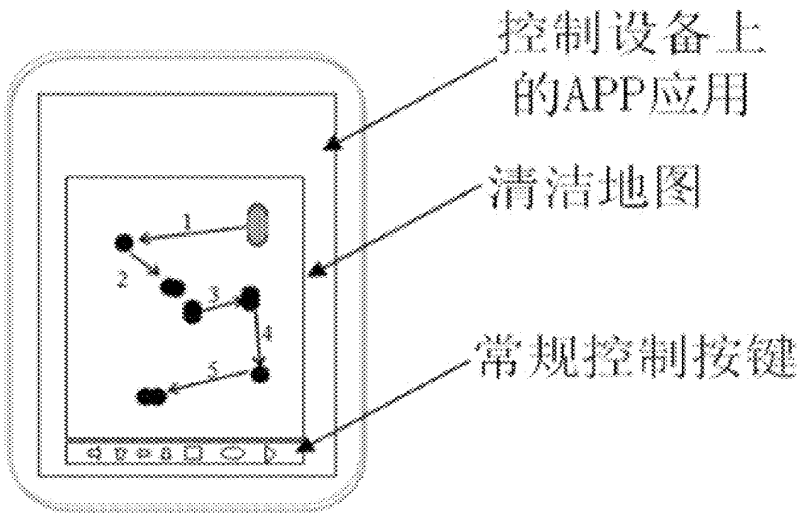


图4

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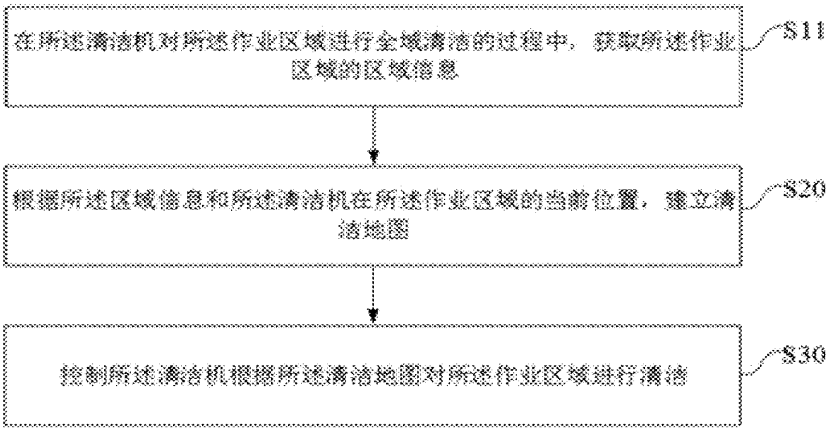


图5

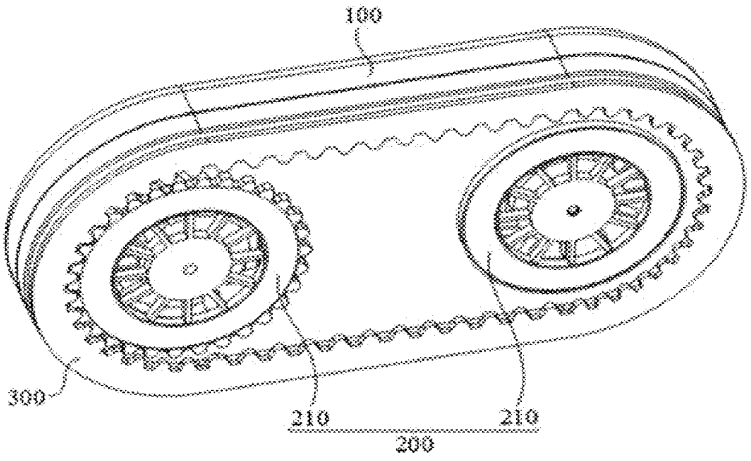


图6

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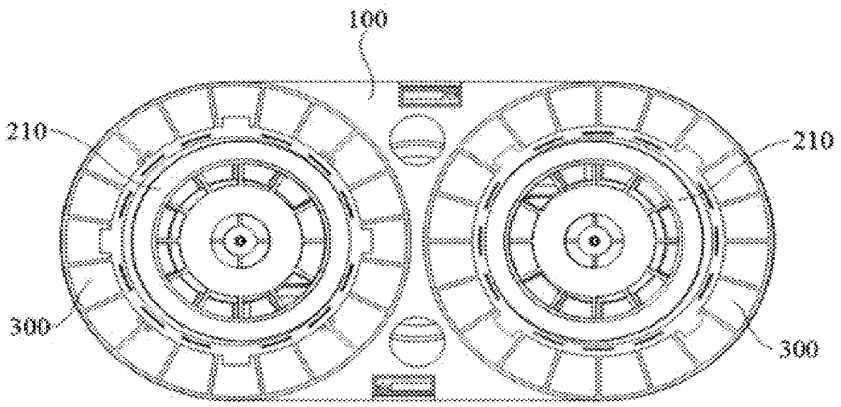


图7

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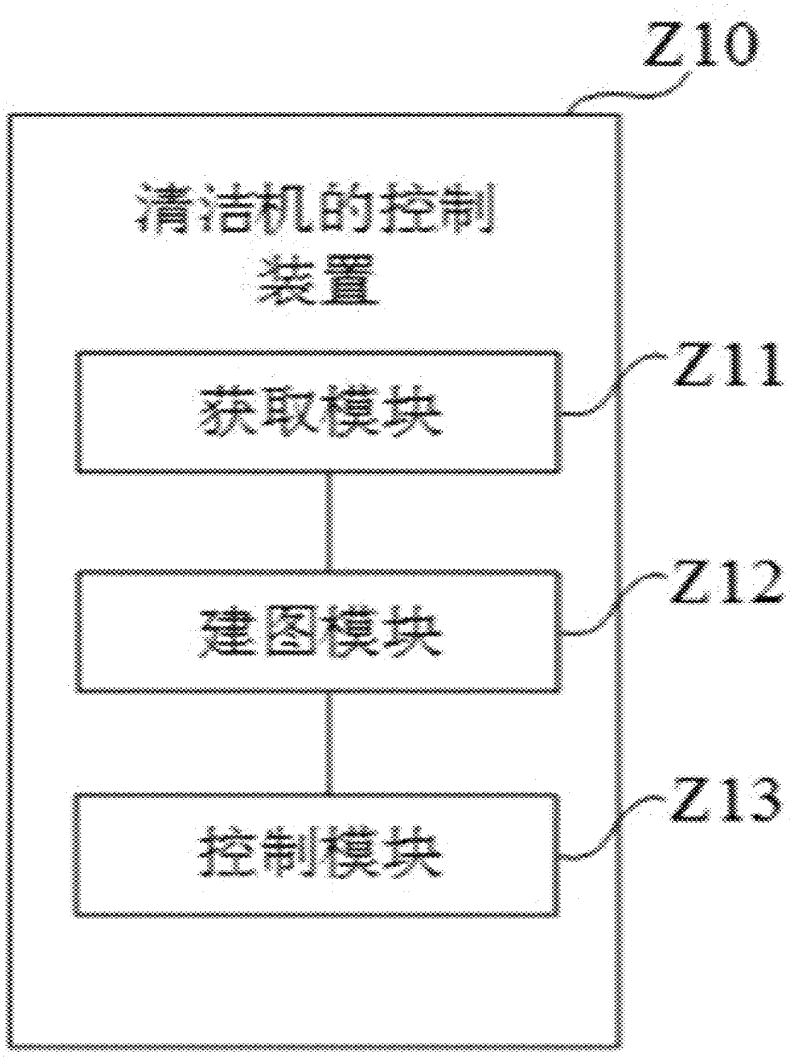


图8

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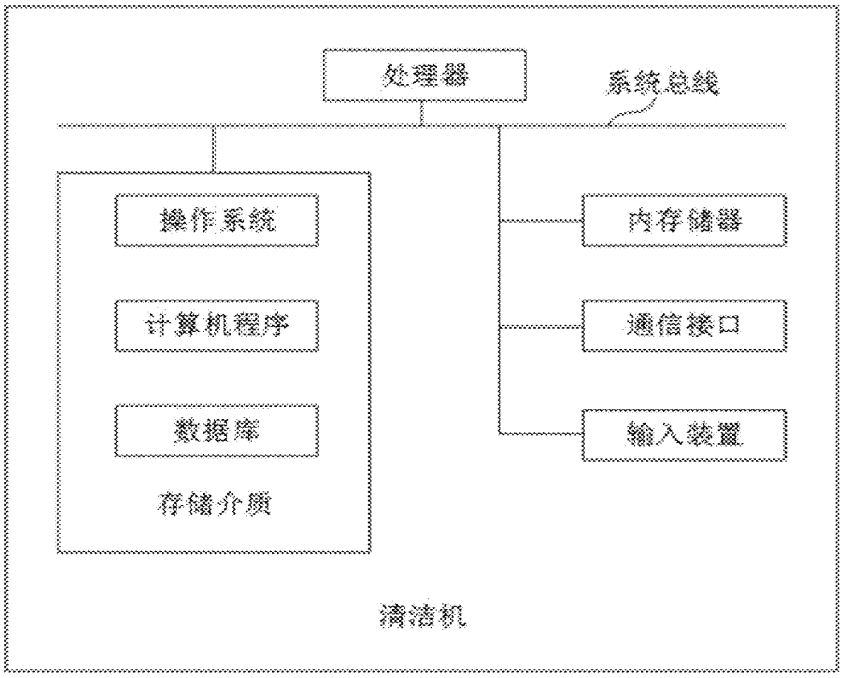


图9

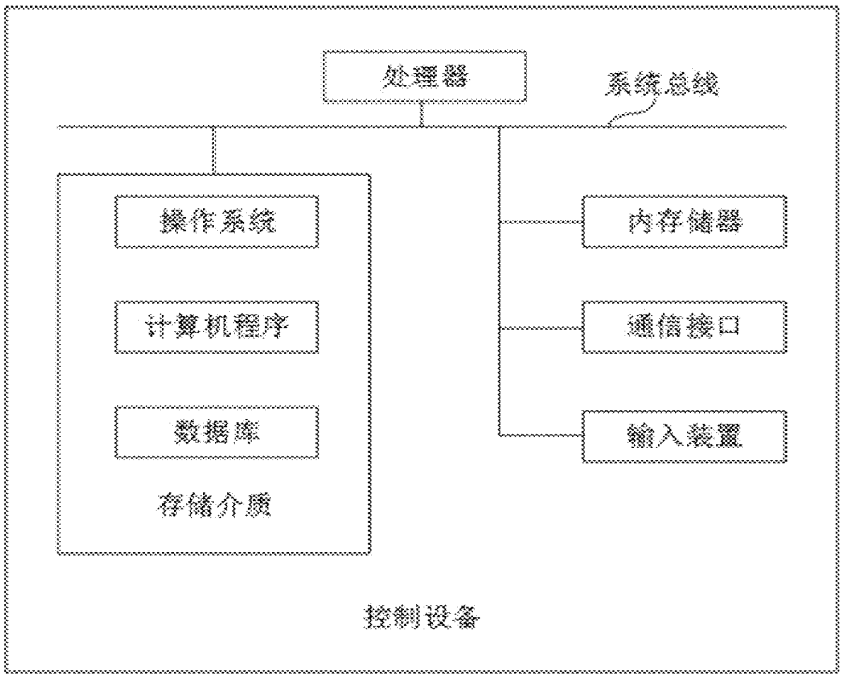


图10

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Espacenet

CN116197932A Control method and system of pool cleaning robot and robot control equipment

Applicants: TIANJIN WANGYUAN INTELLIGENT TECH CO LTD

Inventors: MA TINGYUAN,LI CHENG

Classifications:
IPC ***B25J13/00; E04H4/16;***

CPC **B25J13/00 (CN); E04H4/16 (CN); E04H4/1654 (CN);** Y02P90/02 (EP);

Priorities: CN202310203430A 2023-03-06

Application: CN202310203430A·2023-03-06

Publication: CN116197932A·2023-06-02

Published as: CN116197932A

Control method and system of pool cleaning robot and robot control equipment

Abstract

The invention discloses a control method, device and system of a pool cleaning robot and robot control equipment, and belongs to the technical field of robots. According to the technical scheme provided by the embodiment of the invention, the robot control interface is displayed when the pool cleaning robot in the pool is controlled. And in response to the operation on the robot control interface, determining control information when the pool cleaning robot is controlled. The control information is sent to the pool cleaning robot, and therefore control over the pool cleaning robot is completed. The pool cleaning robot can be conveniently and quickly controlled through the robot control interface, and the efficiency of controlling the pool cleaning robot is improved.

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B25J 13/00(2006.01)
E04H 4/16(2006.01)

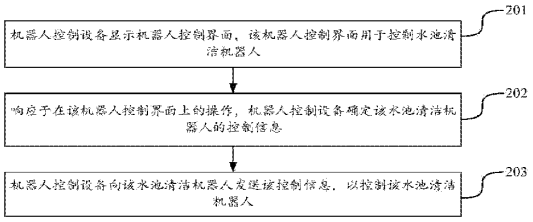
权利要求书2页 说明书16页 附图4页

(54)发明名称

水池清洁机器人的控制方法、系统以及机器人控制设备

(57)摘要

本申请公开了一种水池清洁机器人的控制方法、装置、系统以及机器人控制设备，属于机器人技术领域。通过本申请实施例提供的技术方案，在控制水池内的水池清洁机器人时，显示机器人控制界面。响应于在该机器人控制界面上的操作，确定对该水池清洁机器人进行控制时的控制信息。将该控制信息发送给水池清洁机器人，从而完成对该水池清洁机器人的控制。通过该机器人控制界面就能够方便快捷地实现对水池清洁机器人的控制，提高了控制水池清洁机器人的效率。



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1.一种水池清洁机器人的控制方法，其特征在于，所述方法包括：

显示机器人控制界面，所述机器人控制界面用于控制水池清洁机器人；

响应于在所述机器人控制界面上的操作，确定所述水池清洁机器人的控制信息；

向所述水池清洁机器人发送所述控制信息，以控制所述水池清洁机器人。

2.根据权利要求1所述的方法，其特征在于，所述响应于在所述机器人控制界面上的操作，确定所述水池清洁机器人的控制信息包括下述任一项：

响应于在所述机器人控制界面上的滑动操作，确定所述水池清洁机器人的控制信息，所述控制信息用于控制所述水池清洁机器人按照所述滑动操作指示的方式进行移动；

响应于在所述机器人控制界面上的手势操作，确定所述水池清洁机器人的控制信息，所述控制信息用于控制所述水池清洁机器人按照所述手势操作指示的方式进行移动和/或执行所述手势操作指示的动作。

3.根据权利要求2所述的方法，其特征在于，所述响应于在所述机器人控制界面上的滑动操作，确定所述水池清洁机器人的控制信息包括：

响应于在所述机器人控制界面上的滑动操作，确定所述滑动操作的滑动方向和滑动距离；

基于所述滑动方向和所述滑动距离，确定所述控制信息，所述控制信息用于控制所述水池清洁机器人按照所述滑动方向指示的方向和所述滑动距离指示的距离进行移动。

4.根据权利要求3所述的方法，其特征在于，所述机器人控制界面上显示有所述水池清洁机器人的图标，所述响应于在所述机器人控制界面上的滑动操作，确定所述滑动操作的滑动方向和滑动距离包括：

响应于在所述机器人控制界面上对所述图标的拖动操作，确定所述拖动操作结束时所述图标的最终位置；

基于所述图标的最终位置和所述图标的起始位置，确定所述滑动方向和所述滑动距离。

5.根据权利要求3所述的方法，其特征在于，所述基于所述滑动方向和所述滑动距离，确定所述控制信息包括：

基于所述滑动方向，确定所述水池清洁机器人的移动方向；

基于所述滑动距离，确定所述水池清洁机器人的移动距离；

基于所述移动方向和所述移动距离，确定所述控制信息。

6.根据权利要求2所述的方法，其特征在于，所述响应于在所述机器人控制界面上的手势操作，确定所述水池清洁机器人的控制信息包括：

响应于在所述机器人控制界面上的手势操作，确定所述手势操作对应的第一动作和/或第一位置；

基于所述第一动作和/或所述第一位置，确定所述控制信息。

7.根据权利要求1所述的方法，其特征在于，所述机器人控制界面上显示有所述水池清洁机器人在水池的池壁上的起始位置和起始动作中的至少一项，所述向所述水池清洁机器人发送所述控制信息，以控制所述水池清洁机器人之后，所述方法还包括：

在所述机器人控制界面上显示所述水池清洁机器人的当前位置和当前动作中的至少一项，所述当前位置和所述当前动作是基于所述控制信息控制所述水池清洁机器人后的位

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置和动作。

8.根据权利要求7所述的方法，其特征在于，所述在所述机器人控制界面上显示所述水池清洁机器人的当前位置和当前动作中的至少一项包括：

获取所述水池清洁机器人的位置信息和动作执行信息中的至少一项；

基于所述位置信息和所述动作执行信息中的至少一项，在所述机器人控制界面上显示所述水池清洁机器人的当前位置和当前动作中的至少一项。

9.一种水池清洁机器人的控制装置，其特征在于，所述装置包括：

界面显示模块，用于显示机器人控制界面，所述机器人控制界面用于控制水池清洁机器人；

控制信息确定模块，用于响应于在所述机器人控制界面上的操作，确定所述水池清洁机器人的控制信息；

发送模块，用于向所述水池清洁机器人发送所述控制信息，以控制所述水池清洁机器人。

10.一种机器人控制设备，其特征在于，所述机器人控制设备包括一个或多个处理器和一个或多个存储器，所述一个或多个存储器中存储有至少一条计算机程序，所述计算机程序由所述一个或多个处理器加载并执行以实现如权利要求1至权利要求8任一项所述的水池清洁机器人的控制方法。

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水池清洁机器人的控制方法、系统以及机器人控制设备

技术领域

[0001] 本申请涉及机器人技术领域，特别涉及一种水池清洁机器人的控制方法、装置、系统以及机器人控制设备。

背景技术

[0002] 随着计算机技术的发展，机器人技术也随之快速发展，比如，用户使用扫地机器人来进行房屋地面的清洁，使用擦窗机器人来进行房屋窗户的清洁，使用水池清洁机器人来进行水池的清洁等。

[0003] 使用水池清洁机器人对水池的池壁进行清洁的过程中，有时需要人工控制水池清洁机器人，如何提高人工控制水池清洁机器人时的效率是研究的热点。

发明内容

[0004] 本申请实施例提供了一种水池清洁机器人的控制方法、装置、系统以及机器人控制设备，可以提高人工控制水池清洁机器人时的效率，技术方案如下：

[0005] 一方面，提供了一种水池清洁机器人的控制方法，所述方法包括：

[0006] 显示机器人控制界面，所述机器人控制界面用于控制水池清洁机器人；

[0007] 响应于在所述机器人控制界面上的操作，确定所述水池清洁机器人的控制信息；

[0008] 向所述水池清洁机器人发送所述控制信息，以控制所述水池清洁机器人。

[0009] 在一种可能的实施方式中，所述响应于在所述机器人控制界面上的操作，确定所述水池清洁机器人的控制信息包括下述任一项：

[0010] 响应于在所述机器人控制界面上的滑动操作，确定所述水池清洁机器人的控制信息，所述控制信息用于控制所述水池清洁机器人按照所述滑动操作指示的方式进行移动；

[0011] 响应于在所述机器人控制界面上的手势操作，确定所述水池清洁机器人的控制信息，所述控制信息用于控制所述水池清洁机器人按照所述手势操作指示的方式进行移动和/或执行所述手势操作指示的动作。

[0012] 在一种可能的实施方式中，所述响应于在所述机器人控制界面上的滑动操作，确定所述水池清洁机器人的控制信息包括：

[0013] 响应于在所述机器人控制界面上的滑动操作，确定所述滑动操作的滑动方向和滑动距离；

[0014] 基于所述滑动方向和所述滑动距离，确定所述控制信息，所述控制信息用于控制所述水池清洁机器人按照所述滑动方向指示的方向和所述滑动距离指示的距离进行移动。

[0015] 在一种可能的实施方式中，所述机器人控制界面上显示有所述水池清洁机器人的图标，所述响应于在所述机器人控制界面上的滑动操作，确定所述滑动操作的滑动方向和滑动距离包括：

[0016] 响应于在所述机器人控制界面上对所述图标的拖动操作，确定所述拖动操作结束时所述图标的最终位置；

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[0017] 基于所述图标的最终位置和所述图标的起始位置，确定所述滑动方向和所述滑动距离。

[0018] 在一种可能的实施方式中，所述基于所述滑动方向和所述滑动距离，确定所述控制信息包括：

[0019] 基于所述滑动方向，确定所述水池清洁机器人的移动方向；

[0020] 基于所述滑动距离，确定所述水池清洁机器人的移动距离；

[0021] 基于所述移动方向和所述移动距离，确定所述控制信息。

[0022] 在一种可能的实施方式中，所述响应于在所述机器人控制界面上的手势操作，确定所述水池清洁机器人的控制信息包括：

[0023] 响应于在所述机器人控制界面上的手势操作，确定所述手势操作对应的第一动作和/或第一位置；

[0024] 基于所述第一动作和/或所述第一位置，确定所述控制信息。

[0025] 在一种可能的实施方式中，所述机器人控制界面上显示有所述水池清洁机器人在所述池壁上的起始位置和起始动作中的至少一项，所述向所述水池清洁机器人发送所述控制信息，以控制所述水池清洁机器人之后，所述方法还包括：

[0026] 在所述机器人控制界面上显示所述水池清洁机器人的当前位置和当前动作中的至少一项，所述当前位置和所述当前动作是基于所述控制信息控制所述水池清洁机器人后的位置和动作。

[0027] 在一种可能的实施方式中，所述在所述机器人控制界面上显示所述水池清洁机器人的当前位置和当前动作中的至少一项包括：

[0028] 获取所述水池清洁机器人的位置信息和动作执行信息中的至少一项；

[0029] 基于所述位置信息和所述动作执行信息中的至少一项，在所述机器人控制界面上显示所述水池清洁机器人的当前位置和当前动作中的至少一项。

[0030] 在一种可能的实施方式中，所述获取所述水池清洁机器人的位置信息和动作执行信息中的至少一项包括下述任一项：

[0031] 获取所述水池清洁机器人返回的所述位置信息和所述动作执行信息中的至少一项；

[0032] 获取所述水池清洁机器人的基站返回的所述位置信息和所述动作执行信息中的至少一项。

[0033] 在一种可能的实施方式中，所述向所述水池清洁机器人发送所述控制信息包括下述任一项：

[0034] 向所述水池清洁机器人的通信单元发送所述控制信息；

[0035] 向所述水池清洁机器人的基站发送所述控制信息，以使所述基站向所述水池清洁机器人转发所述控制信息。

[0036] 一方面，提供了一种水池清洁机器人的控制系统，所述系统包括：机器人控制设备以及水池清洁机器人；

[0037] 所述机器人控制设备用于显示机器人控制界面，所述机器人控制界面用于控制水池清洁机器人；

[0038] 所述机器人控制设备还用于响应于在所述机器人控制界面上的操作，确定所述水

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池清洁机器人的控制信息；

[0039] 所述机器人控制设备还用于向所述水池清洁机器人发送所述控制信息；

[0040] 所述水池清洁机器人用于接收所述控制信息；

[0041] 所述水池清洁机器人还用于响应于所述控制信息，执行所述控制信息对应的控制动作。

[0042] 一方面，提供了一种水池清洁机器人的控制装置，所述装置包括：

[0043] 界面显示模块，用于显示机器人控制界面，所述机器人控制界面用于控制水池清洁机器人；

[0044] 控制信息确定模块，用于响应于在所述机器人控制界面上的操作，确定所述水池清洁机器人的控制信息；

[0045] 发送模块，用于向所述水池清洁机器人发送所述控制信息，以控制所述水池清洁机器人。

[0046] 在一种可能的实施方式中，所述控制信息确定模块，用于执行下述任一项：

[0047] 响应于在所述机器人控制界面上的滑动操作，确定所述水池清洁机器人的控制信息，所述控制信息用于控制所述水池清洁机器人按照所述滑动操作指示的方式进行移动；

[0048] 响应于在所述机器人控制界面上的手势操作，确定所述水池清洁机器人的控制信息，所述控制信息用于控制所述水池清洁机器人按照所述手势操作指示的方式进行移动和/或执行所述手势操作指示的动作。

[0049] 在一种可能的实施方式中，所述控制信息确定模块，用于响应于在所述机器人控制界面上的滑动操作，确定所述滑动操作的滑动方向和滑动距离；基于所述滑动方向和所述滑动距离，确定所述控制信息，所述控制信息用于控制所述水池清洁机器人按照所述滑动方向指示的方向和所述滑动距离指示的距离进行移动。

[0050] 在一种可能的实施方式中，所述机器人控制界面上显示有所述水池清洁机器人的图标，所述控制信息确定模块，用于响应于在所述机器人控制界面上对所述图标的拖动操作，确定所述拖动操作结束时所述图标的最终位置；基于所述图标的最终位置和所述图标的起始位置，确定所述滑动方向和所述滑动距离。

[0051] 在一种可能的实施方式中，所述控制信息确定模块，用于基于所述滑动方向，确定所述水池清洁机器人的移动方向；基于所述滑动距离，确定所述水池清洁机器人的移动距离；基于所述移动方向和所述移动距离，确定所述控制信息。

[0052] 在一种可能的实施方式中，所述控制信息确定模块，用于响应于在所述机器人控制界面上的手势操作，确定所述手势操作对应的第一动作和/或第一位置；基于所述第一动作和/或所述第一位置，确定所述控制信息。

[0053] 在一种可能的实施方式中，所述机器人控制界面上显示有所述水池清洁机器人在所述池壁上的起始位置和起始动作中的至少一项，所述界面显示模块还用于在所述机器人控制界面上显示所述水池清洁机器人的当前位置和当前动作中的至少一项，所述当前位置和所述当前动作是基于所述控制信息控制所述水池清洁机器人后的位置和动作。

[0054] 在一种可能的实施方式中，所述界面显示模块还用于获取所述水池清洁机器人的位置信息和动作执行信息中的至少一项；基于所述位置信息和所述动作执行信息中的至少一项，在所述机器人控制界面上显示所述水池清洁机器人的当前位置和当前动作中的至少

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一项。

[0055] 在一种可能的实施方式中，所述界面显示模块还用于执行下述任一项：

[0056] 获取所述水池清洁机器人返回的所述位置信息和所述动作执行信息中的至少一项；

[0057] 获取所述水池清洁机器人的基站返回的所述位置信息和所述动作执行信息中的至少一项。

[0058] 在一种可能的实施方式中，所述发送模块，用于执行下述任一项：

[0059] 向所述水池清洁机器人的通信单元发送所述控制信息；

[0060] 向所述水池清洁机器人的基站发送所述控制信息，以使所述基站向所述水池清洁机器人转发所述控制信息。

[0061] 一方面，提供了一种机器人控制设备，所述机器人控制设备包括一个或多个处理器和一个或多个存储器，所述一个或多个存储器中存储有至少一条计算机程序，所述计算机程序由所述一个或多个处理器加载并执行以实现所述水池清洁机器人的控制方法。

[0062] 一方面，提供了一种计算机可读存储介质，所述计算机可读存储介质中存储有至少一条计算机程序，所述计算机程序由处理器加载并执行以实现所述水池清洁机器人的控制方法。

[0063] 一方面，提供了一种计算机程序产品或计算机程序，该计算机程序产品或计算机程序包括程序代码，该程序代码存储在计算机可读存储介质中，机器人控制器的处理器从计算机可读存储介质读取该程序代码，处理器执行该程序代码，使得该机器人控制器执行上述水池清洁机器人的控制方法。

[0064] 通过本申请实施例提供的技术方案，在控制水池内的水池清洁机器人时，显示机器人控制界面。响应于在该机器人控制界面上的操作，确定对该水池清洁机器人进行控制时的控制信息。将该控制信息发送给水池清洁机器人，从而完成对该水池清洁机器人的控制。通过该机器人控制界面就能够方便快捷地实现对水池清洁机器人的控制，提高了控制水池清洁机器人的效率。

附图说明

[0065] 为了更清楚地说明本申请实施例中的技术方案，下面将对实施例描述中所需要使用的附图作简单的介绍，显而易见地，下面描述中的附图仅仅是本申请的一些实施例，对于本领域普通技术人员来讲，在不付出创造性劳动的前提下，还可以根据这些附图获得其他的附图。

[0066] 图1是本申请实施例提供的一种水池池壁上的水池清洁机器人的示意图；

[0067] 图2是本申请实施例提供的一种水池清洁机器人的控制方法的流程图；

[0068] 图3是本申请实施例提供的一种水池清洁机器人的控制方法的流程图；

[0069] 图4是本申请实施例提供的一种界面示意图；

[0070] 图5是本申请实施例提供的一种水池清洁机器人的控制系统的示意图；

[0071] 图6是本申请实施例提供的一种水池清洁机器人的控制装置的结构示意图；

[0072] 图7是本申请实施例提供的一种机器人控制设备的结构示意图。

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具体实施方式

[0073] 为使本申请的目的、技术方案和优点更加清楚，下面将结合附图对本申请实施方式作进一步的详细描述。

[0074] 本申请中术语“第一”“第二”等字样用于对作用和功能基本相同的相同项或相似项进行区分，应理解，“第一”、“第二”、“第n”之间不具有逻辑或时序上的依赖关系，也不对数量和执行顺序进行限定。

[0075] 路径规划：路径规划是运动规划的主要研究内容之一。运动规划由路径规划和轨迹规划组成，连接起点位置和终点位置的序列点或曲线称之为路径，构成路径的策略称之为路径规划。在本申请实施例中，对水池清洁机器人进行的路径规划也即是对水池清洁机器人的清洁路径进行规划。

[0076] 水池清洁机器人：用于清洁水池的机器人，其中，清洁水池包括清洁水池的底部以及清洁水池的池壁。

[0077] 本申请实施例提供的技术方案能够应用在控制水池清洁机器人清洁水池的池壁的场景下，参见图1，水池清洁机器人100具有爬壁功能，能够附着在水池的池壁101上。该水池清洁机器人100人能够在机器人控制器的控制下在该水池的池壁101上进行移动。比如，该水池清洁机器人100能够在该水池的池壁101上沿池壁向上移动，也能够在该水池的池壁101上沿池壁向下移动，还能够在该水池的池壁101上沿池壁向左或者向右移动，还能够在该水池的池壁101上进行旋转等，本申请实施例对于该水池清洁机器人在该池壁101上的运动方式不作限定。水池清洁机器人100除了能够在水池的池壁101上运动之外，也能够在水池的池底上进行运动，从而实现对水池池底的清洁。

[0078] 下面对本申请实施例提供的技术方案进行说明，图2是本申请实施例提供的一种水池清洁机器人的控制方法的流程图，参见图2，以执行主体为机器人控制设备为例，方法包括下述步骤。

[0079] 201、机器人控制设备显示机器人控制界面，该机器人控制界面用于控制水池清洁机器人。

[0080] 其中，机器人控制设备是人工控制时用户使用的设备，该机器人控制设备具有处理器、存储器和通信单元，具有信息处理、信息存储以及信息发送的功能。该机器人控制界面是提供水池清洁机器人控制功能的交互界面，该机器人控制界面可以是机器人控制应用的应用界面。控制该水池清洁机器人是指控制该水池清洁机器人进行移动以及执行清洁动作。该水池清洁机器人既可以位于水池的池壁上，也可以位于水池的池底上。在该水池清洁机器人吸附在水池的池壁上的情况下，该水池清洁机器人能够在该水池的池壁上进行移动以及执行清洁动作，控制该水池清洁机器人包括控制该水池清洁机器人在池壁上进行移动以及执行清洁动作。在该水池清洁机器人位于水池的池底上的情况下，该水池清洁机器人能够在该水池的池底上进行移动以及执行清洁动作，控制该水池清洁机器人包括控制该水池清洁机器人在池底上进行移动以及执行清洁动作。

[0081] 202、响应于在该机器人控制界面上的操作，机器人控制设备确定该水池清洁机器人的控制信息。

[0082] 其中，在该机器人控制界面上的操作包括滑动操作以及手势操作，特别的，在本申请实施例中，滑动操作包括拖动操作。在该机器人控制界面上执行不同的操作能够生成不

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同的控制信息，不同的控制信息能够对水池清洁机器人产生不同的控制结果，比如，控制该水池清洁机器人移动至指定位置或者控制该水池清洁机器人进行指定清洁动作。

[0083] 203、机器人控制设备向该水池清洁机器人发送该控制信息，以控制该水池清洁机器人。

[0084] 其中，该水池清洁机器人的底部配置有行走单元，通过驱动该行走单元能够控制该水池清洁机器人在该水池的池壁上进行移动。该水池清洁机器人的机器人控制器能够基于该控制信息来驱动该行走单元，从而实现该水池清洁机器人的移动，该机器人控制器内置于该水池清洁机器人，用于控制该水池清洁机器人的不同组件。

[0085] 在一些实施例中，该水池清洁机器人配置有清洁单元，通过该清洁单元能够实现对该水池的池壁进行清洁。在一些实施例中，该清洁单元包括滚刷，通过滚刷的转动能够实现对池壁的清洁。或者，在该清洁单元不包括滚刷的情况下，水池清洁机通过内部驱动装置和过滤装置，将池水过滤后排出来实现对池壁的清洁。当然，该清洁单元也可以同时包括滚刷和喷水口，本申请实施例对此不作限定。该水池清洁机器人的机器人控制器能够基于该控制信息来控制该清洁单元，从而控制该水池清洁机器人执行不同的清洁动作。

[0086] 另外，该水池清洁机器人的清洁功能在移动过程中既可以启动也可以不启动，该水池清洁机器人的清洁功能在移动过程中启动是指，该水池清洁机器人能够在移动的过程中启动清洁功能，从而实现对该池壁上经过的位置进行清洁。

[0087] 通过本申请实施例提供的技术方案，在控制水池内的水池清洁机器人时，显示机器人控制界面。响应于在该机器人控制界面上的操作，确定对该水池清洁机器人进行控制时的控制信息。将该控制信息发送给水池清洁机器人，从而完成对该水池清洁机器人的控制。通过该机器人控制界面就能够方便快捷地实现对水池清洁机器人的控制，提高了控制水池清洁机器人的效率。

[0088] 需要说明的是，上述步骤201-203是对本申请实施例提供的技术方案的简单介绍，下面将结合一些例子，对本申请实施例提供的技术方案进行较为详细的说明，参见图3，方法包括下述步骤。

[0089] 301、机器人控制设备显示机器人控制界面，该机器人控制界面用于控制水池清洁机器人。

[0090] 其中，机器人控制设备是人工控制时用户使用的设备，该机器人控制设备具有处理器、存储器和通信单元，具有信息处理、信息存储以及信息发送的功能。在一些实施例中，该水池清洁机器人用于清洁泳池，此时该水池清洁机器人也被称为泳池清洁机器人。该机器人控制设备与该水池清洁机器人配对，能够通过无线通信的方式控制该水池清洁机器人，从而实现更加灵活的人工控制。该机器人控制界面是提供水池清洁机器人控制功能的交互界面，该机器人控制界面可以是机器人控制应用的应用界面。控制该水池清洁机器人是指控制该水池清洁机器人进行移动以及执行清洁动作。该水池清洁机器人既可以位于水池的池壁上，也可以位于水池的池底上。在该水池清洁机器人吸附在水池的池壁上的情况下，该水池清洁机器人能够在该水池的池壁上进行移动以及执行清洁动作，控制该水池清洁机器人包括控制该水池清洁机器人以及执行清洁动作。在该水池清洁机器人位于水池的池底上的情况下，该水池清洁机器人能够在该水池的池底上进行移动以及执行清洁动作，控制该水池清洁机器人包括控制该水池清洁机器人在池底上进行移动以及执行清洁动作。

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[0091] 在一种可能的实施方式中，响应于对该水池清洁机器人的选择操作，机器人控制设备显示该水池清洁机器人的机器人控制界面。

[0092] 其中，对该水池清洁机器人的选择操作用于从多个候选水池清洁机器人中选择进行人工控制的该水池清洁机器人。

[0093] 在这种实施方式下，在需要对该水池清洁机器人进行人工控制时，通过对该水池清洁机器人执行选择操作就能够显示该水池清洁机器人的机器人控制界面，通过该机器人控制界面能够实现对该水池清洁机器人的控制，提高了对该水池清洁机器人进行控制的效率。

[0094] 举例来说，机器人控制设备显示机器人选择界面，该机器人选择界面上显示有多个候选水池机器人。响应于在该机器人选择界面上的选择操作，机器人控制设备显示被选中的该水池清洁机器人的机器人控制界面。其中，该多个候选水池机器人均是与该机器人控制设备绑定的水池机器人，也就是说该机器人控制设备能够控制该多个候选水池机器人。比如，参见图4，机器人控制设备显示机器人选择界面401，该机器人选择界面401上显示有多个候选水池机器人A-E。响应于在该机器人选择界面401上对水池清洁机器人B的选择操作，机器人控制设备显示该水池清洁机器人B的机器人控制界面402。

[0095] 在一些实施例中，该机器人控制界面包括机器人状态展示区域以及操作控制区域，其中，该机器人状态展示区域用于展示该水池清洁机器人的状态，比如展示该水池清洁机器人的信号强度、电量、工作情况以及清洁耗材剩余情况等。该操作控制区域用于采集对该水池清洁机器人的控制操作，在一些实施例中，后续步骤302中在该机器人控制界面上的操作可以是指在该操作控制区域中执行的操作。

[0096] 在一些实施例中，该机器人状态展示区域还用于展示该水池清洁机器人在该池壁上的位置，也即是以该池壁为全局地图，展示该水池清洁机器人在该全局地图中的位置，这样有助于了解该水池清洁机器人的位置，从而实现更加高效的清洁。

[0097] 在一种可能的实施方式中，该机器人控制设备为该水池清洁机器人的专用控制设备，在该机器人控制设备启动的情况下，机器人控制器显示该机器人控制界面。

[0098] 其中，该机器人控制界面的形式参见上一种实施方式的相关描述，在此不再赘述。

[0099] 在这种实施方式下，直接启动该机器人控制设备就能够显示该机器人控制界面，控制该水池清洁机器人的效率较高。

[0100] 举例来说，响应于对该机器人控制设备的启动指令，该机器人控制设备启动并与该水池清洁机器人进行配对。在该机器人控制设备与该水池清洁机器人配对成功的情况下，该机器人控制设备启动完成，显示该机器人控制界面，该机器人控制设备与该水池清洁机器人保持通信连接。

[0101] 302、响应于在该机器人控制界面上的操作，机器人控制设备确定该水池清洁机器人的控制信息。

[0102] 其中，在该机器人控制界面上的操作包括滑动操作以及手势操作，特别的，在本申请实施例中，滑动操作包括拖动操作。在该机器人控制界面上执行不同的操作能够生成不同的控制信息，不同的控制信息能够对水池清洁机器人产生不同的控制结果，比如，控制该水池清洁机器人移动至指定位置或者控制该水池清洁机器人进行指定清洁动作。

[0103] 在一种可能的实施方式中，响应于在该机器人控制界面上的滑动操作，机器人控

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制设备确定该水池清洁机器人的控制信息，该控制信息用于控制该水池清洁机器人按照该滑动操作指示的方式进行移动。

[0104] 其中，按照该滑动操作指示的方式进行移动包括按照该滑动操作指示的方向进行移动以及按照该滑动操作指示的距离进行移动。这种实施方式下该控制信息包括运动信息，运动信息包括移动方向和移动距离。

[0105] 在这种实施方式下，通过在该机器人控制界面上执行滑动操作就能够快捷地控制该水池清洁机器人进行移动，控制该水池清洁机器人的效率较高。相较于点击操作，滑动操作为用户提供的更加灵活的控制方式。用户在机器人控制界面上执行不同方向和/或距离的滑动操作，既能够实现在小范围内对水池清洁机器人的精准控制，也能够实现在大范围内对水池清洁机器人的快速控制，这是点击操作无法实现的。

[0106] 举例来说，响应于在该机器人控制界面上的滑动操作，机器人控制设备确定该滑动操作的滑动方向和滑动距离。机器人控制设备基于该滑动方向和该滑动距离，确定该控制信息，该控制信息用于控制该水池清洁机器人按照该滑动方向指示的方向和该滑动距离指示的距离进行移动。

[0107] 其中，该滑动操作的滑动方向是指该机器人控制界面上该滑动操作的起始位置指向结束位置的方向，该滑动操作的滑动距离是指该机器人控制界面上该滑动操作的起始位置指向结束位置之间的距离。该滑动方向用于指示该水池清洁机器人在池壁上的移动方向，该滑动距离用于指示该水池清洁机器人在池壁上的移动距离，该滑动距离与该移动距离正相关。

[0108] 为了对上述举例中描述的方式进行更加清楚的说明，下面将分为两个部分对上述举例提供的实施方式进行说明。

[0109] 第一部分、响应于在该机器人控制界面上的滑动操作，机器人控制设备确定该滑动操作的滑动方向和滑动距离。

[0110] 在一种可能的实施方式中，该机器人控制界面上显示有该水池清洁机器人的图标，响应于在该机器人控制界面上对该图标的拖动操作，机器人控制设备确定该拖动操作结束时该图标的最终位置。机器人控制设备基于该图标的最终位置和该图标的起始位置，确定该滑动方向和该滑动距离。

[0111] 其中，该水池清洁机器人的图标用于表示该水池清洁机器人，拖动该图标能够更加直观地展示滑动方向和滑动距离，从而提高滑动操作的准确性。

[0112] 举例来说，该机器人控制界面上显示有该水池清洁机器人的图标，响应于在该机器人控制界面上对该图标的拖动操作，机器人控制设备确定该拖动操作结束时该图标的最终位置。机器人控制设备基于该图标在该机器人控制界面上的最终坐标和起始坐标，确定该滑动方向和该滑动距离。

[0113] 在一些实施例中，该机器人控制界面上显示有该池壁对应的全局地图，该水池清洁机器人的图标显示在该全局地图上，从而反映该水池清洁机器人在该池壁上的位置。在该全局地图上拖动该图标能够更加直观地展现该水池清洁机器人将要移动至的位置。其中，该全局地图是通过该水池清洁机器人构建的，该水池清洁机器人在工作过程中能够根据实际情况调整该全局地图。

[0114] 第二部分、机器人控制设备基于该滑动方向和该滑动距离，确定该控制信息。

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[0115] 在一种可能的实施方式中，机器人控制设备基于该滑动方向，确定该水池清洁机器人的移动方向。机器人控制设备基于该滑动距离，确定该水池清洁机器人的移动距离。机器人控制设备基于该移动方向和该移动距离，确定该控制信息。

[0116] 在这种实施方式下，通过滑动距离和滑动方向就能够确定移动距离和移动方向，从而确定控制信息，控制信息的确定效率较高。

[0117] 举例来说，机器人控制设备将该滑动方向确定为该水池清洁机器人的移动方向，比如，该滑动方向为水平向右，那么该移动方向也即是水平向右。机器人控制设备将该滑动距离与预设系数相乘，得到该水池清洁机器人的移动距离，该预设技术由技术人员根据实际情况进行设置或调整，本申请实施例对此不作限定。机器人控制设备基于该移动方向和该移动距离，确定该控制信息。

[0118] 在介绍完通过滑动操作来确定控制信息之后，下面将介绍通过手势操作来确定控制信息的方法。

[0119] 在一种可能的实施方式中，响应于在该机器人控制界面上的手势操作，机器人控制设备确定该水池清洁机器人的控制信息，该控制信息用于控制该水池清洁机器人按照该手势操作指示的方式进行移动和/或执行该手势操作指示的动作。

[0120] 其中，手势操作包括在该机器人控制界面上执行的特定操作，比如多指滑动、画圈以及连续点击等。在这种实施方式下，控制信息包括运动信息和/或动作信息，运动信息包括移动方向和移动距离，或者，运动信息包括目标坐标。动作信息包括动作标识，动作表示与该水池清洁机器人能够执行的动作对应。

[0121] 在这种实施方式下，通过在该机器人控制界面上执行手势操作就能够快捷地控制该水池清洁机器人进行移动，控制该水池清洁机器人的效率较高。相较于点击操作，由于手势操作可以由用户配置，手势操作为用户提供的更加灵活的控制方式。另外，点击操作需要机器人控制界面中存在可以被点击的控件，在控制方式较多的情况下，机器人控制界面中存在的大量控件会干扰用户查看界面，也存在误点击而带来的错误控制。利用手势操作控制水池清洁机器人时，无需在机器人控制界面上设置控件，机器人控制界面可以显示更多的有用信息，从而提高人机交互的效率。

[0122] 举例来说，响应于在该机器人控制界面上的手势操作，机器人控制设备确定该手势操作对应的第一动作和/或第一位置。机器人控制设备基于该第一动作和/或该第一位置，确定该控制信息。

[0123] 其中，该第一动作为该水池清洁机器人执行的动作，比如为强力清洁、多次清洁以及旋转清洁等。该第一位置为预设位置，比如为水池的水位线上、池壁的中心、水池的中心、充电基站以及水位线上的特定位置等。第一动作和第一位置由技术人员根据实际情况进行设置或者调整，本申请实施例对此不作限定。

[0124] 比如，响应于在该机器人控制界面上的手势操作，机器人控制设备确定该手势操作是否为预设的手势操作。在该手势操作为预设的手势操作的情况下，机器人控制设备获取该手势操作对应的配置信息，该配置信息携带该手势操作对应的第一动作和/或第一位置。机器人控制设备基于该第一动作和/或该第一位置，确定该控制信息。在该手势操作不为预设的手势操作的情况下，机器人控制设备不对该手势操作进行响应。在一些实施例中，该控制信息中以第一动作标识的形式来表示该第一动作，以第一坐标的方式来表示该第一

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位置，该第一坐标也即是该水池清洁机器人将要移动至的坐标。

[0125] 在介绍完通过手势操作来确定控制信息之后，下面将介绍通过对控件的点击操作来确定控制信息的方法。

[0126] 在一种可能的实施方式中，响应于在该机器人控制界面上对目标功能控件的点击操作，机器人控制设备确定该水池清洁机器人的控制信息，该控制信息用于控制该水池清洁机器人按照该目标功能控件指示的方式进行移动或执行该目标功能控件指示的动作。

[0127] 其中，该目标功能控件对应的功能由技术人员根据实际情况进行设置或者调整，本申请实施例对此不作限定。在这种实施方式下，控制信息包括运动信息和/或动作信息，运动信息包括移动方向和移动距离，或者，运动信息包括目标坐标。动作信息包括动作标识，动作表示与该水池清洁机器人能够执行的动作对应。

[0128] 举例来说，响应于在该机器人控制界面上对该目标功能控件的点击操作，机器人控制设备确定该目标功能控件对应的第二动作和/或第二位置。机器人控制设备基于该第二动作和/或该第二位置，确定该控制信息。

[0129] 其中，该第二动作为该水池清洁机器人执行的动作，比如为强力清洁、多次清洁以及旋转清洁等。该第二位置为预设位置，比如为水池的水位线上、池壁的中心、水池的中心、充电基站以及水位线上的特定位置等。第二动作和第二位置由技术人员根据实际情况进行设置或者调整，本申请实施例对此不作限定。在一些实施例中，该控制信息中以第二动作标识的形式来表示该第二动作，以第二坐标的方式来表示该第二位置，该第二坐标也即是该水池清洁机器人将要移动至的坐标。

[0130] 需要说明的是，机器人控制设备能够采用上述任一种方式来确定该控制信息，本申请实施例对此不作限定。

[0131] 303、机器人控制设备向该水池清洁机器人发送该控制信息。

[0132] 其中，该水池清洁机器人的底部配置有行走单元，通过驱动该行走单元能够控制该水池清洁机器人在该水池的池壁上进行移动。该水池清洁机器人的机器人控制器能够基于该控制信息来驱动该行走单元，从而实现该水池清洁机器人的移动，该机器人控制器内置于该水池清洁机器人，用于控制该水池清洁机器人的不同组件。在一些实施例中，该水池清洁机器人还包括驱动单元，该驱动单元与该机器人控制器和该行走单元相连，该驱动单元由该机器人控制进行控制，该驱动单元能够为行走单元提供动力，以使得该水池清洁机器人能够通过行走单元在水池的池壁上进行移动和旋转。在一些实施例中，该行走单元为万向轮。在该水池清洁机器人移动的过程中，该水池清洁机器人始终位于该水池的池壁上。

[0133] 在一些实施例中，该水池清洁机器人由外接电源供电，这样可以保证该水池清洁机器人在清洁水池这种面积较大的场景时能够完成任务。或者，该水池清洁机器人由内置电池供电，从而摆脱连接线的限制，能够在更大的范围内执行清洁任务。或者，该水池清洁机器人通过太阳能电池板进行供电，从而降低使用该水池清洁机器人进行清洁时的能源成本，本申请实施例对于该水池清洁机器人的供电方式不作限定。在一些实施例中，该水池清洁机器人还包括陀螺仪，通过该陀螺仪能够确定自身的方向。

[0134] 在一些实施例中，该水池清洁机器人的底部还配置有清洁单元，通过该清洁单元能够实现对该水池的池壁进行清洁。在一些实施例中，该清洁单元包括滚刷，通过滚刷的转动能够实现对池壁的清洁。或者，在该清洁单元不包括滚刷的情况下，水池清洁机通过内部

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驱动装置和过滤装置，将池水过滤后排出来实现对池壁的清洁。当然，该清洁单元也可以同时包括滚刷和喷水口，本申请实施例对此不作限定。该水池清洁机器人的机器人控制器能够基于该控制信息来控制该清洁单元，从而控制该水池清洁机器人执行不同的清洁动作。

[0135] 另外，该水池清洁机器人的清洁功能在移动过程中既可以启动也可以不启动，该水池清洁机器人的清洁功能在移动过程中启动是指，该水池清洁机器人能够在移动的过程中启动清洁功能，从而实现对该池壁上经过的位置进行清洁。

[0136] 在一种可能的实施方式中，机器人控制设备向该水池清洁机器人的通信单元发送该控制信息。

[0137] 其中，向该通信单元发送该控制信息也即是通过远程通信的方式来向该水池清洁机器人发送控制信息，控制信息的发送更加灵活高效。

[0138] 在一种可能的实施方式中，机器人控制设备向该水池清洁机器人的基站发送该控制信息，以使该基站向该水池清洁机器人转发该控制信息。

[0139] 其中，该基站可以为该水池清洁机器人的充电基站，也可以为集成有充电功能的综合基站，本申请实施例对此不作限定。

[0140] 304、水池清洁机器人接收该控制信息。

[0141] 在一种可能的实施方式中，水池清洁机器人的机器人控制器通过通信单元接收该控制信息。

[0142] 其中，该机器人控制器内置于该水池清洁机器人，用于控制该水池清洁机器人的不同组件。

[0143] 305、响应于该控制信息，水池清洁机器人执行该控制信息对应的控制动作。

[0144] 其中，该控制信息对应的控制动作也即是通过在机器人控制界面上的操作确定的控制动作，包括移动控制动作和动作控制动作。

[0145] 在一种可能的实施方式中，响应于该控制信息，水池清洁机器人的机器人控制器从该控制信息中获取运动信息和/或动作信息。机器人控制器基于该运动信息和/或该动作信息控制该水池清洁机器人，也即是控制该水池清洁机器人执行该动作信息对应的动作和/或按照该运动信息进行移动。

[0146] 在这种实施方式下，通过该控制信息来快速实现对该水池清洁机器人的控制，控制的效率较高。

[0147] 在一些实施例中，在该水池清洁机器人移动的过程中，在该水池清洁机器人检测到障碍物的情况下，机器人控制器控制该水池清洁机器人避开该障碍物后回到原路径上。

[0148] 举例来说，在通过该水池清洁机器人的障碍物传感器检测到移动方向的前方存在障碍物的情况下，机器人控制器为该水池清洁机器人设置避障路线，比如，通过模拟退火算法、人工势场法、模糊逻辑算法、禁忌搜索算法等算法来设置避障路线。机器人控制器控制该水池清洁机器人按照该避障路线进行移动，从而避开该障碍物。在避开该障碍物的情况下，机器人控制器控制该水池清洁机器人回到原路径上继续进行移动。

[0149] 306、机器人控制设备在该机器人控制界面上显示该水池清洁机器人的当前位置和当前动作中的至少一项，该当前位置和该当前动作是基于该控制信息控制该水池清洁机器人后的位置和动作。

[0150] 在一种可能的实施方式中，机器人控制设备获取该水池清洁机器人的位置信息和

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动作执行信息中的至少一项。机器人控制设备基于该位置信息和该动作执行信息中的至少一项，在该机器人控制界面上显示该水池清洁机器人的当前位置和当前动作中的至少一项。

[0151] 其中，位置信息用于反映该水池清洁机器人在该池壁上的位置，动作执行信息用于反映该水池清洁机器人正在执行的动作。

[0152] 在这种实施方式下，机器人控制设备能够实时展示该水池清洁机器人的当前位置和当前动作，提供良好的控制反馈，从而提高控制效率。

[0153] 为了对上述实施方式进行更加清楚的说明，下面将分为两个部分对上述实施方式进行说明。

[0154] 第一部分、机器人控制设备获取该水池清洁机器人的位置信息和动作执行信息中的至少一项。

[0155] 在一种可能的实施方式中，机器人控制设备获取该水池清洁机器人返回的该位置信息和该动作执行信息中的至少一项。

[0156] 在一种可能的实施方式中，机器人控制设备获取该水池清洁机器人的基站返回的该位置信息和该动作执行信息中的至少一项。

[0157] 第二部分、机器人控制设备基于该位置信息和该动作执行信息中的至少一项，在该机器人控制界面上显示该水池清洁机器人的当前位置和当前动作中的至少一项。

[0158] 在一种可能的实施方式中，机器人控制设备基于该位置信息和该动作执行信息中的至少一项，在该机器人控制界面的全局地图上显示该水池清洁机器人的当前位置和当前动作中的至少一项。

[0159] 上述所有可选技术方案，可以采用任意结合形成本申请的可选实施例，在此不再一一赘述。

[0160] 通过本申请实施例提供的技术方案，在控制水池内的水池清洁机器人时，显示机器人控制界面。响应于在该机器人控制界面上的操作，确定对该水池清洁机器人进行控制时的控制信息。将该控制信息发送给水池清洁机器人，从而完成对该水池清洁机器人的控制。通过该机器人控制界面就能够方便快捷地实现对水池清洁机器人的控制，提高了控制水池清洁机器人的效率。

[0161] 还有，采用本申请实施例提供的技术方案之后，可以较为便捷地控制水池清洁机器人移动，实现清洁指定区域污垢的需求。也能够快捷移动水池清洁机器人至指定位置，实现清理该水池清洁机器人的需求。

[0162] 本申请实施例还提供了一种水池清洁机器人的控制系统。

[0163] 图5是本申请实施例提供的一种水池清洁机器人的控制系统的结构示意图，参见图5，系统包括：机器人控制设备501以及水池清洁机器人502。

[0164] 该机器人控制设备501用于显示机器人控制界面，该机器人控制界面用于控制水池清洁机器人502。

[0165] 该机器人控制设备501还用于响应于在该机器人控制界面上的操作，确定该水池清洁机器人的控制信息。

[0166] 该机器人控制设备501还用于向该水池清洁机器人502发送该控制信息。

[0167] 该水池清洁机器人502用于接收该控制信息。

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[0168] 该水池清洁机器人502还用于响应于该控制信息，执行该控制信息对应的控制动作。

[0169] 需要说明的是：上述实施例提供的水池清洁机器人的控制系统与水池清洁机器人的控制方法实施例属于同一构思，其具体实现过程详见方法实施例，这里不再赘述。

[0170] 通过本申请实施例提供的技术方案，在控制水池内的水池清洁机器人时，显示机器人控制界面。响应于在该机器人控制界面上的操作，确定对该水池清洁机器人进行控制时的控制信息。将该控制信息发送给水池清洁机器人，从而完成对该水池清洁机器人的控制。通过该机器人控制界面就能够方便快捷地实现对水池清洁机器人的控制，提高了控制水池清洁机器人的效率。

[0171] 图6是本申请实施例提供的一种水池清洁机器人的控制装置的结构示意图，参见图6，装置包括：界面显示模块601、控制信息确定模块602以及发送模块603。

[0172] 界面显示模块601，用于显示机器人控制界面，该机器人控制界面用于控制水池清洁机器人。

[0173] 控制信息确定模块602，用于响应于在该机器人控制界面上的操作，确定该水池清洁机器人的控制信息。

[0174] 发送模块603，用于向该水池清洁机器人发送该控制信息，以控制该水池清洁机器人。

[0175] 在一种可能的实施方式中，该控制信息确定模块602，用于执行下述任一项：

[0176] 响应于在该机器人控制界面上的滑动操作，确定该水池清洁机器人的控制信息，该控制信息用于控制该水池清洁机器人按照该滑动操作指示的方式进行移动。

[0177] 响应于在该机器人控制界面上的手势操作，确定该水池清洁机器人的控制信息，该控制信息用于控制该水池清洁机器人按照该手势操作指示的方式进行移动和/或执行该手势操作指示的动作。

[0178] 在一种可能的实施方式中，该控制信息确定模块602，用于响应于在该机器人控制界面上的滑动操作，确定该滑动操作的滑动方向和滑动距离。基于该滑动方向和该滑动距离，确定该控制信息，该控制信息用于控制该水池清洁机器人按照该滑动方向指示的方向和该滑动距离指示的距离进行移动。

[0179] 在一种可能的实施方式中，该机器人控制界面上显示有该水池清洁机器人的图标，该控制信息确定模块602，用于响应于在该机器人控制界面上对该图标的拖动操作，确定该拖动操作结束时该图标的最终位置。基于该图标的最终位置和该图标的起始位置，确定该滑动方向和该滑动距离。

[0180] 在一种可能的实施方式中，该控制信息确定模块602，用于基于该滑动方向，确定该水池清洁机器人的移动方向。基于该滑动距离，确定该水池清洁机器人的移动距离。基于该移动方向和该移动距离，确定该控制信息。

[0181] 在一种可能的实施方式中，该控制信息确定模块602，用于响应于在该机器人控制界面上的手势操作，确定该手势操作对应的第一动作和/或第一位置。基于该第一动作和/或该第一位置，确定该控制信息。

[0182] 在一种可能的实施方式中，该控制信息确定模块602，用于响应于在该机器人控制界面上对该目标功能控件的点击操作，确定该目标功能控件对应的第二动作和/或第二位

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置。基于该第二动作和/或该第二位置，确定该控制信息。

[0183] 在一种可能的实施方式中，该机器人控制界面上显示有该水池清洁机器人在该池壁上的起始位置和起始动作中的至少一项，该界面显示模块601还用于在该机器人控制界面上显示该水池清洁机器人的当前位置和当前动作中的至少一项，该当前位置和该当前动作是基于该控制信息控制该水池清洁机器人后的位置和动作。

[0184] 在一种可能的实施方式中，该界面显示模块601还用于获取该水池清洁机器人的位置信息和动作执行信息中的至少一项。基于该位置信息和该动作执行信息中的至少一项，在该机器人控制界面上显示该水池清洁机器人的当前位置和当前动作中的至少一项。

[0185] 在一种可能的实施方式中，该界面显示模块601还用于执行下述任一项：

[0186] 获取该水池清洁机器人返回的该位置信息和该动作执行信息中的至少一项。

[0187] 获取该水池清洁机器人的基站返回的该位置信息和该动作执行信息中的至少一项。

[0188] 在一种可能的实施方式中，该发送模块603，用于执行下述任一项：

[0189] 向该水池清洁机器人的通信单元发送该控制信息。

[0190] 向该水池清洁机器人的基站发送该控制信息，以使该基站向该水池清洁机器人转发该控制信息。

[0191] 需要说明的是：上述实施例提供的水池清洁机器人的控制装置在控制水池清洁机器人时，仅以上述各功能模块的划分进行举例说明，实际应用中，可以根据需要而将上述功能分配由不同的功能模块完成，即将机器人控制器的内部结构划分成不同的功能模块，以完成以上描述的全部或者部分功能。另外，上述实施例提供的水池清洁机器人的控制装置与水池清洁机器人的控制方法实施例属于同一构思，其具体实现过程详见方法实施例，这里不再赘述。

[0192] 通过本申请实施例提供的技术方案，在控制水池内的水池清洁机器人时，显示机器人控制界面。响应于在该机器人控制界面上的操作，确定对该水池清洁机器人进行控制时的控制信息。将该控制信息发送给水池清洁机器人，从而完成对该水池清洁机器人的控制。通过该机器人控制界面就能够方便快捷地实现对水池清洁机器人的控制，提高了控制水池清洁机器人的效率。

[0193] 本申请实施例还提供了一种机器人控制设备，图7是本申请实施例提供的一种机器人控制设备的结构示意图。该机器人控制设备700可以是：智能手机、平板电脑、笔记本电脑或台式电脑。

[0194] 通常，机器人控制设备700包括有：一个或多个处理器701和一个或多个存储器702。

[0195] 处理器701可以包括一个或多个处理核心，比如4核心处理器、8核心处理器等。处理器701可以采用DSP(Digital Signal Processing，数字信号处理)、FPGA(Field—Programmable Gate Array，现场可编程门阵列)、PLA(Programmable Logic Array，可编程逻辑阵列)中的至少一种硬件形式来实现。处理器701也可以包括主处理器和协处理器，主处理器是用于对在唤醒状态下的数据进行处理的处理器，也称CPU(Central Processing Unit，中央处理器)；协处理器是用于对在待机状态下的数据进行处理的低功耗处理器。在一些实施例中，处理器701可以在集成有GPU(Graphics Processing Unit，图像处理器)，

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GPU用于负责显示屏所需要显示的内容的渲染和绘制。一些实施例中，处理器701还可以包括AI(Artificial Intelligence，人工智能)处理器，该AI处理器用于处理有关机器学习的计算操作。

[0196] 存储器702可以包括一个或多个计算机可读存储介质，该计算机可读存储介质可以是非暂态的。存储器702还可包括高速随机存取存储器，以及非易失性存储器，比如一个或多个磁盘存储设备、闪存存储设备。在一些实施例中，存储器702中的非暂态的计算机可读存储介质用于存储至少一个计算机程序，该至少一个计算机程序用于被处理器701所执行以实现本申请中方法实施例提供的水池清洁机器人的控制方法。

[0197] 在一些实施例中，机器人控制设备700还可选包括有：外围设备接口703和至少一个外围设备。处理器701、存储器702和外围设备接口703之间可以通过总线或信号线相连。各个外围设备可以通过总线、信号线或电路板与外围设备接口703相连。具体地，外围设备包括：射频电路704、显示屏705、摄像头组件706、音频电路707和电源708中的至少一种。

[0198] 外围设备接口703可被用于将I/O(Input/Output，输入/输出)相关的至少一个外围设备连接到处理器701和存储器702。在一些实施例中，处理器701、存储器702和外围设备接口703被集成在同一芯片或电路板上；在一些其他实施例中，处理器701、存储器702和外围设备接口703中的任意一个或两个可以在单独的芯片或电路板上实现，本实施例对此不加以限定。

[0199] 射频电路704用于接收和发射RF(Radio Frequency，射频)信号，也称电磁信号。射频电路704通过电磁信号与通信网络以及其他通信设备进行通信。射频电路704将电信号转换为电磁信号进行发送，或者，将接收到的电磁信号转换为电信号。可选的，射频电路704包括：天线系统、RF收发器、一个或多个放大器、调谐器、振荡器、数字信号处理器、编解码芯片组、用户身份模块卡等等。

[0200] 显示屏705用于显示UI(User Interface，用户界面)。该UI可以包括图形、文本、图标、视频及其它们的任意组合。当显示屏705是触摸显示屏时，显示屏705还具有采集在显示屏705的表面或表面上方的触摸信号的能力。该触摸信号可以作为控制信号输入至处理器701进行处理。此时，显示屏705还可以用于提供虚拟按钮和/或虚拟键盘，也称软按钮和/或软键盘。

[0201] 摄像头组件706用于采集图像或视频。可选的，摄像头组件706包括前置摄像头和后置摄像头。通常，前置摄像头设置在机器人控制设备的前面板，后置摄像头设置在机器人控制设备的背面。

[0202] 音频电路707可以包括麦克风和扬声器。麦克风用于采集用户及环境的声波，并将声波转换为电信号输入至处理器701进行处理，或者输入至射频电路704以实现语音通信。

[0203] 电源708用于为机器人控制设备700中的各个组件进行供电。电源708可以是交流电、直流电、一次性电池或可充电电池。

[0204] 在一些实施例中，机器人控制设备700还包括有一个或多个传感器709。该一个或多个传感器709包括但不限于：加速度传感器710、陀螺仪传感器711、压力传感器712、光学传感器713以及接近传感器714。

[0205] 加速度传感器710可以检测以机器人控制设备700建立的坐标系的三个坐标轴上的加速度大小。

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[0206] 陀螺仪传感器711可以机器人控制设备700的机体方向及转动角度，陀螺仪传感器711可以与加速度传感器710协同采集用户对机器人控制设备700的3D动作。

[0207] 压力传感器712可以设置在机器人控制设备700的侧边框和/或显示屏705的下层。当压力传感器712设置在机器人控制设备700的侧边框时，可以检测用户对机器人控制设备700的握持信号，由处理器701根据压力传感器712采集的握持信号进行左右手识别或快捷操作。当压力传感器712设置在显示屏705的下层时，由处理器701根据用户对显示屏705的压力操作，实现对UI界面上的可操作性控件进行控制。

[0208] 光学传感器713用于采集环境光强度。在一个实施例中，处理器701可以根据光学传感器713采集的环境光强度，控制显示屏705的显示亮度。

[0209] 接近传感器714用于采集用户与机器人控制设备700的正面之间的距离。

[0210] 本领域技术人员可以理解，图7中示出的结构并不构成对机器人控制设备700的限定，可以包括比图示更多或更少的组件，或者组合某些组件，或者采用不同的组件布置。

[0211] 在示例性实施例中，还提供了一种计算机可读存储介质，例如包括计算机程序的存储器，上述计算机程序可由处理器执行以完成上述实施例中的水池清洁机器人的控制方法。例如，该计算机可读存储介质可以是只读存储器(Read-Only Memory，ROM)、随机存取存储器(Random Access Memory，RAM)、只读光盘(Compact Disc Read-Only Memory，CD-ROM)、磁带、软盘和光数据存储设备等。

[0212] 在示例性实施例中，还提供了一种计算机程序产品或计算机程序，该计算机程序产品或计算机程序包括程序代码，该程序代码存储在计算机可读存储介质中，机器人控制器的处理器从计算机可读存储介质读取该程序代码，处理器执行该程序代码，使得该机器人控制器执行上述水池清洁机器人的控制方法。

[0213] 在一些实施例中，本申请实施例所涉及的计算机程序可被部署在一个机器人控制器上执行，或者在位于一个地点的多个机器人控制器上执行，又或者，在分布在多个地点且通过通信网络互连的多个机器人控制器上执行，分布在多个地点且通过通信网络互连的多个机器人控制器可以组成区块链系统。

[0214] 本领域普通技术人员可以理解实现上述实施例的全部或部分步骤可以通过硬件来完成，也可以通过程序来指令相关的硬件完成，该程序可以存储于一种计算机可读存储介质中，上述提到的存储介质可以是只读存储器，磁盘或光盘等。

[0215] 上述仅为本申请的可选实施例，并不用以限制本申请，凡在本申请的精神和原则之内，所做的任何修改、等同替换、改进等，均应包含在本申请的保护范围之内。

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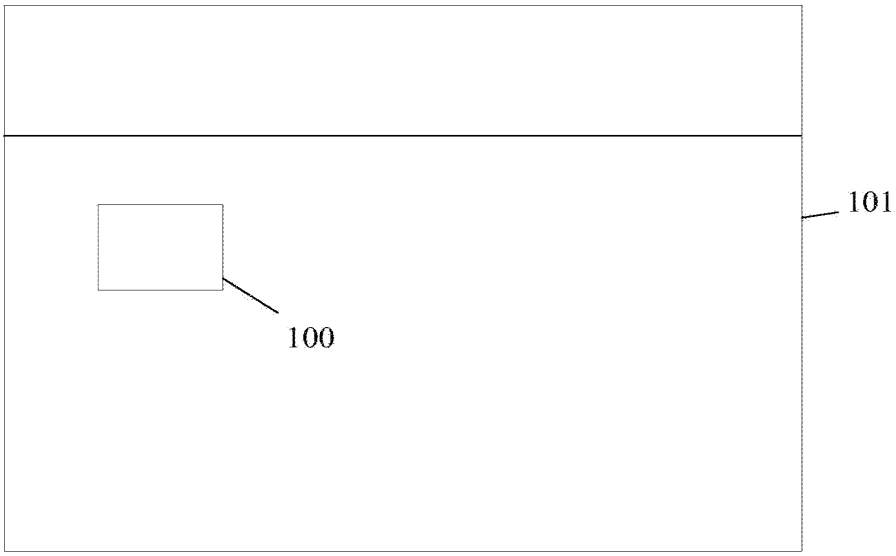


图1

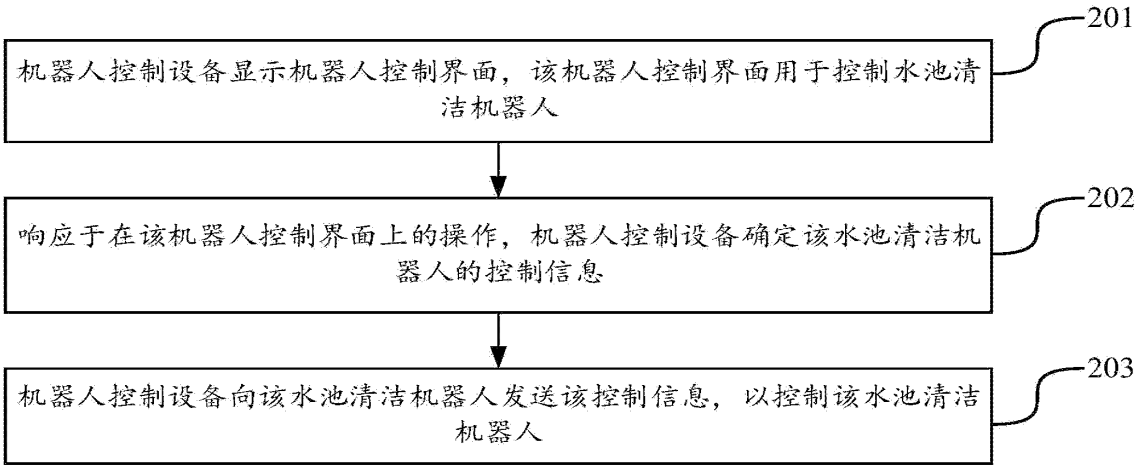


图2

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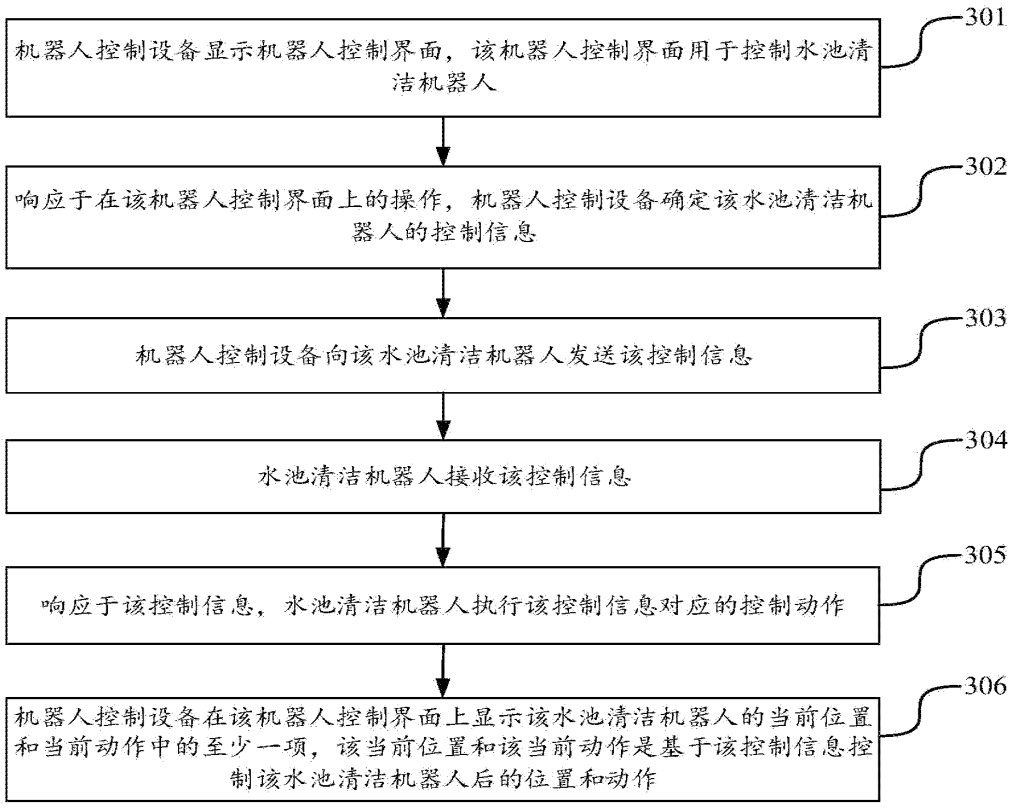


图3

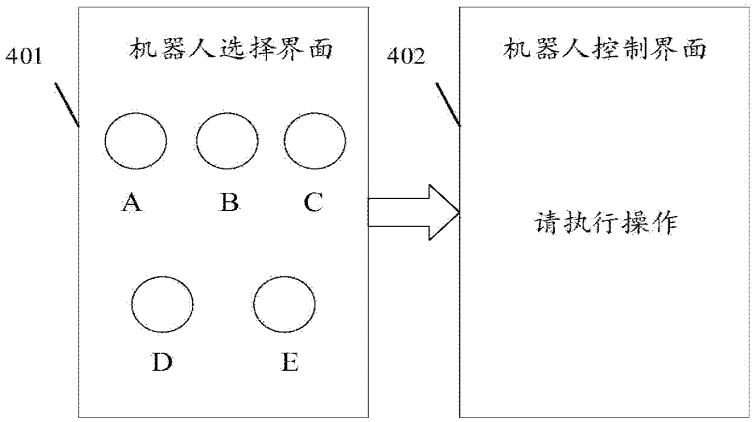


图4

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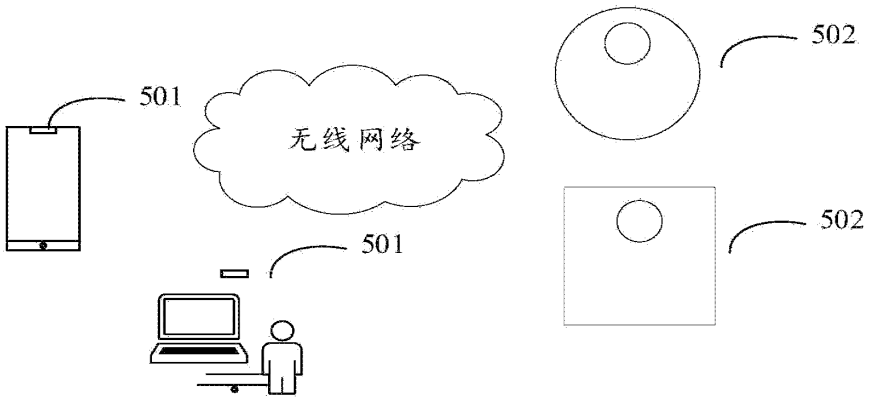


图5

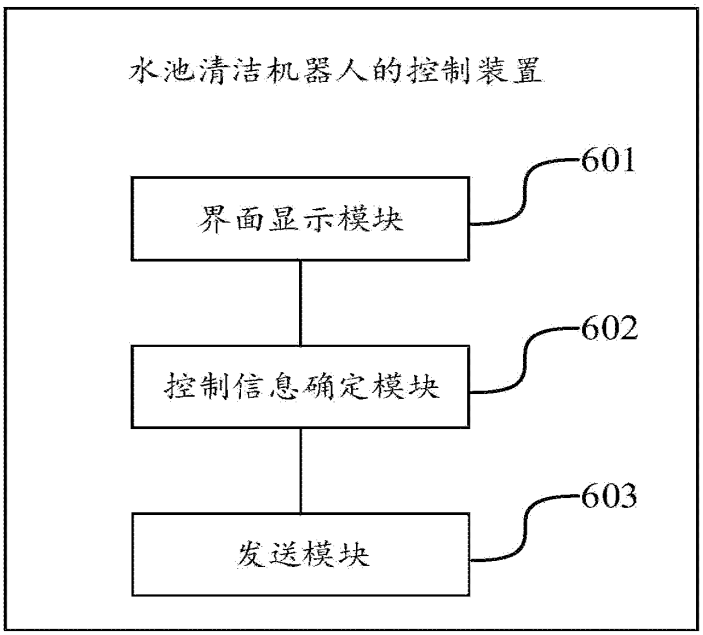


图6

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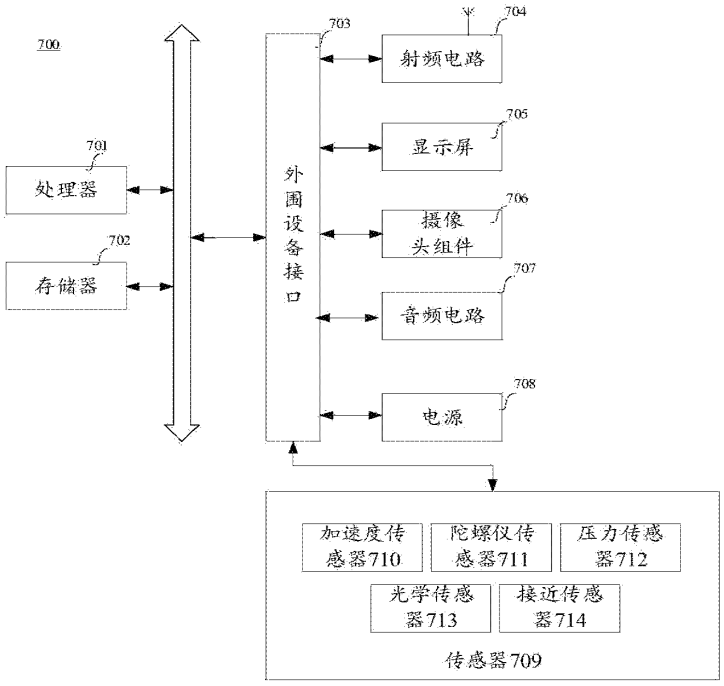


图7

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Espacenet

CN115454107A Path planning method for offshore inspection type AUV (Autonomous Underwater Vehicle)

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Path planning method for offshore inspection type AUV (Autonomous Underwater Vehicle)

Abstract

The invention discloses a path planning method of an offshore inspection type AUV (Autonomous Underwater Vehicle), and relates to the field of path planning of an AUV. The invention aims to solve the problem that the existing path planning method for the offshore inspection AUV is high in calculation overhead and extremely easy to fall into a local minimum value, so that the path planning cannot be completed in an offshore environment with complex dynamic and relatively large obstacles. The method comprises the following steps: step 1, initializing a map space V, a random tree space T, an expansion step length l, an AUV kinematics parameter and an adaptive sub-target point selection threshold k, and setting a starting point xrand and an end point xgoal; step 2, obtaining a planned global path by using the parameter values initialized in the step 1 and adopting an RRT algorithm; and step 3, processing the planned global path obtained in the step 2 by adopting a DWA algorithm by taking the kinematics parameters of the AUV as constraints, so that the AUV inspection path meets the kinematics constraints and realizes dynamic obstacle avoidance at the same time. The method is used for performing path planning on the inspection AUV.

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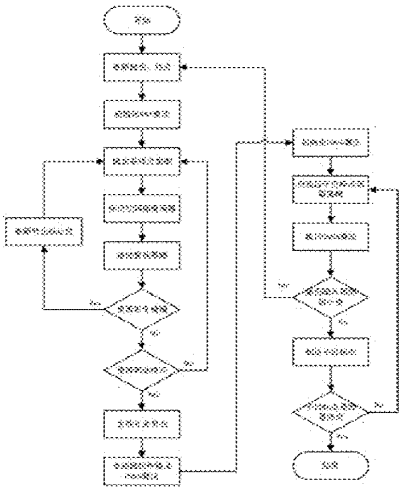
权利要求书3页 说明书5页 附图4页

(54)发明名称

一种近海巡检型AUV的路径规划方法

(57)摘要

一种近海巡检型AUV的路径规划方法，涉及自主水下航行器AUV的路径规划领域。本发明是为了解决现有的近海巡检AUV的路径规划方法还存在计算开销大、极易陷入局部最小值而导致的无法在存在复杂动态且较大障碍物的近海环境完成路径规划的问题。本发明包括：步骤一、初始化地图空间V，随机树空间T，拓展步长l，AUV运动学参数，自适应子目标点选取阈值k，设置起始点x_{rand}，终点x_{goal}；步骤二、利用步骤一初始化后的参数值采用RRT算法获得规划好的全局路径；步骤三、以AUV运动学参数为约束采用DWA算法对步骤二获得的规划好的全局路径进行处理，使AUV巡检路径在符合运动学约束的同时实现动态避障。本发明用于对巡检AUV进行路径规划。



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1.一种近海巡检型AUV的路径规划方法，其特征在于所述方法具体过程为：

步骤一、初始化地图空间V，随机树空间T，拓展步长l，AUV运动学参数，自适应子目标点选取阈值k，设置起始点x_{rand}，终点x_{goal}；

步骤二、利用步骤一初始化后的参数值采用RRT算法获得规划好的全局路径；

所述RRT算法为改进的RRT算法，具体包括：

首先，生成随机数，根据随机数确定采样点为终点还是随机点，从而生成拓展路径；

然后，对新生成的拓展路径进行碰撞检测，不产生碰撞的拓展路径构成从起点到终点的树；

最后，从终点开始依次寻找节点的父节点直至找到起始点，获得一条全局路径，再去除全局路径上的冗余节点，获得规划好的全局路径；

步骤三、以AUV运动学参数为约束，采用DWA算法对步骤二获得的规划好的全局路径进行处理，获得AUV巡检路径实现动态避障。

2.根据权利要求1所述的一种近海巡检型AUV的路径规划方法，特征在于：所述步骤二中的利用步骤一初始化后的参数值采用RRT算法获得规划好的全局路径，包括以下步骤：

步骤二一、生成随机数，将生成的随机数与第一阈值比较，根据比较结果确定采样点为随机采样点还是终点，若采样点为终点，则执行(i)；若采样点为随机采样点则执行(ii)；

(i)、以距离终点最近的节点朝向终点的矢量方向为拓展方向，按照拓展步长进行l拓展获得一个新的节点，判断新产生的路径是否产生碰撞，若没有产生碰撞则拓展成功，将该节点加入到随机树空间；若新产生的路径发生碰撞则拓展失败；

其中，每个节点包括：一个目标采样标记位和一个随机采样标记位；

所述目标采样标记位和随机采样标记位初值为0；

然后重新生成随机数将生成的随机数与第一阈值比较，根据比较结果确定采样点为随机采样点还是终点；若以终点为采样点，则以当前随机树空间中与终点距离最近的节点到终点的方向为拓展方向进行拓展；

(ii)以起点到随机采样点的方向为拓展方向，按照拓展步长l进行拓展获得一个新的节点，判断新产生的路径是否产生碰撞，若没有产生碰撞则拓展成功，将该节点加入到随机树空间；若新产生的路径发生碰撞则拓展失败；

然后重新生成随机数将生成的随机数与第一阈值比较，根据比较结果确定采样点为随机采样点还是终点；若以起点到随机采样点的方向为拓展方向，则以当前随机树空间中与随机采样点距离最近的节点到随机采样点的方向为拓展方向进行拓展；

步骤二二、重复执行步骤二一直至获得起点到终点的树；

步骤二三、在随机树空间中从终点开始依次寻找节点的父节点直至找到起始点，获得一条全局路径，然后去除全局路径上的冗余节点，获得去除冗余节点后的全局路径即规划好的全局路径。

3.根据权利要求2所述的一种近海巡检型AUV的路径规划方法，特征在于：所述步骤二一中的将生成的随机数与第一阈值比较，根据比较结果确定采样点为随机采样点还是终点，具体为：

若随机数小于第一阈值则以终点为采样点，若随机数大于第一阈值则以随机采样点为采样点。

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4.根据权利要求3所述的一种近海巡检型AUV的路径规划方法，特征在于：所述步骤二一中的判断新产生的路径是否产生碰撞采用路径膨胀策略，具体为：

首先，在路径拓展过程中，以节点的父节点为起点，以父节点到采样点的矢量方向为拓展方向，拓展1的距离获得拓展路径；

然后，在拓展路径的两侧延伸出预设安全距离的宽度，获得障碍物与延伸后的拓展路径之间的距离a，若a小于预设安全距离则拓展失败，则新产生的路径产生碰撞；若a大于等于预设安全距离则拓展成功，则新产生的路径没有产生碰撞。

5.根据权利要求4所述的一种近海巡检型AUV的路径规划方法，特征在于：所述步骤二一中的以当前随机树空间中与终点距离最近的节点到终点的方向为拓展方向进行拓展时，在随机树空间寻找父节点时忽略目标采样标记位为1的节点；

所述目标采样标记位为1的节点为目标采样失败的节点，即以终点作为采样点拓展失败时被选为父节点的节点；同时在使用终点作为采样点时此节点将不会被选为父节点。

6.根据权利要求5所述的一种近海巡检型AUV的路径规划方法，特征在于：所述步骤二一中的若以起点到随机采样点的方向为拓展方向，则以当前随机树空间中与随机采样点距离最近的节点到随机采样点的方向为拓展方向进行拓展时，在随机树空间中寻找父节点时忽略随机采样标记位标记次数到达阈值的节点；

所述随机采样标记位标记次数到达阈值的节点通过以下方式获得：当以随机点作为拓展点拓展失败时，将节点n的随机采样标记位数字加一，当节点n的随机采样标记位的值大于预设第二阈值时，再以随机点作为采样点时此节点将不会被选为父节点；

所述节点n为以随机点作为拓展点拓展失败时，被选为父节点的节点。

7.根据权利要求6所述的一种近海巡检型AUV的路径规划方法，特征在于：所述步骤二三中的去除全局路径上的冗余节点，获得去除冗余节点后的全局路径即规划好的全局路径，具体为：

连接起始点和下一个节点执行碰撞检测，如果没有发生碰撞则检测下一个节点与起始的连线是否发生碰撞，逐点检测直至连接至发生碰撞的节点，去除此节点和起始点中间的冗余节点，获得去除冗余节点后的全局路径即规划好的全局路径。

8.根据权利要求7所述的一种近海巡检型AUV的路径规划方法，特征在于：所述步骤三中的以AUV运动学参数为约束采用DWA算法对步骤二获得的规划好的全局路径进行处理，获得AUV巡检路径实现动态避障，包括以下步骤：

步骤三一、对步骤二三获得的去除冗余节点后的全局路径上的节点进行延伸，获得延伸后的全局路径；

步骤三二、按照延伸后的全局路径进行巡检，若陷入局部极小值，则以当前AUV位置为起点，重新执行步骤一到三获得重新规划后的AUV巡检路径。

9.根据权利要求8所述的一种近海巡检型AUV的路径规划方法，特征在于：所述步骤三一中的对步骤二三获得的去除冗余节点后的全局路径上的节点进行延伸，获得延伸后的全局路径，包括以下步骤：

S1、设置初始子目标点，计算d_{path_dis}与d_{path_dis}的比值b：

其中，d_{path_dis}为当前起点沿着全局路径到达子目标点的距离，d_{euc_dis}为当前起点到达子目标点的欧氏距离；

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S2、当b小于阈值k时在全局路径上延伸子目标点，直至b等于阈值k获得子目标点；当拓展至终点时，即使比值仍小于阈值，也将使用终点作为子目标点；

S3、在到达子目标点之后，以当前位置为起点重新执行S1，进行下次动态轨迹规划。

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一种近海巡检型AUV的路径规划方法

技术领域

[0001] 本发明涉及自主水下航行器AUV的路径规划领域，特别涉及一种近海巡检型AUV的路径规划方法。

背景技术

[0002] 自主水下航行器(Autonomous Underwater Vehicle，AUV)在水下搜救、地形勘探、探测资源等领域有着重要的地位，而自主路径规划是AUV的核心技术之一，其决定着AUV执行任务的效率和安全性。近海环境下由于存在大量礁石、人工建筑物以及航行的渔船导致AUV的航行情况变得极其复杂，相应的对路径规划的快速性要求也更高。

[0003] 目前快速拓展随机树算法(Rapid-exploration Random Tree，RRT)被广泛用于解决路径规划问题，但是RRT算法存在拓展盲目性、路径冗余度高、路径不平滑等问题，主要的改进方向有增加算法的导向性和提高的路径可行性。增加算法导向性的改进有刘成菊在《基于改进RRT算法的RoboCup机器人动态路径规划》中提出的在拓展阶段以一定概率选择目标点，采样的其他点则增加引力分量使其偏向目标点，同时使用路径缓存策略以及动态扩展策略解决动态避碰问题。在提高路径可行性方面的改进有尹高扬在《基于改进RRT算法的无人机航迹规划》中提出的节点拓展阶段添加运动学约束、航迹距离约以达到增加路径的可行性以及缩短距离的作用。上述提出的算法存在计算开销大、不适用于近海环境存在复杂动态障碍物的路径规划问题。动态窗口法(Dynamic Window Approach，DWA)是一种在线规划的算法，是根据AUV当前时刻的状态、外部环境以及AUV自身性能，将下一时刻AUV的性能离散出一系列符合AUV运动学约束的轨迹。之后根据评价函数对各个轨迹的得分选择出众多轨迹中得分最高一条轨迹的运动状态作为AUV下一时刻的运动参数。评价函数由艏向角得分、安全距离得分以及速度得分三部分构成。其中艏向角得分为越朝向目标点得分越高，安全距离得分为以当前状态速度航行直至遇到障碍物，航行距离越远得分越高，速度得分为航行速度越快得分越高。但是DWA算法仅能对窗口大小的范围内的运送参数做评估，所以在一些狭小空间内做规划路径，极易陷入局部最小值，导致在遇到较大的障碍物时无法完成路径规划。

发明内容

[0004] 本发明目的是为了解决现有的近海巡检AUV的路径规划方法还存在计算开销大、极易陷入局部最小值而导致的无法在存在复杂动态且较大障碍物的近海环境完成路径规划的问题，而提出了一种近海巡检型AUV的路径规划方法。

[0005] 一种近海巡检型AUV的路径规划方法具体过程为：

[0006] 步骤一、初始化地图空间V，随机树空间T，拓展步长l，AUV运动学参数，自适应子目标点选取阈值k，设置起始点x_{rand}，终点x_{goal}；

[0007] 步骤二、利用步骤一初始化后的参数值采用RRT算法获得规划好的全局路径；

[0008] 所述RRT算法为改进的RRT算法，具体包括：

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[0009] 首先，生成随机数，根据随机数确定采样点为终点还是随机点，从而生成拓展路径；

[0010] 然后，对新生成的拓展路径进行碰撞检测，不产生碰撞的拓展路径构成从起点到终点的树；

[0011] 最后，从终点开始依次寻找节点的父节点直至找到起始点，获得一条全局路径，再去除全局路径上的冗余节点，获得规划好的全局路径；

[0012] 步骤三、以AUV运动学参数为约束，采用DWA算法对步骤二获得的规划好的全局路径进行处理，获得AUV巡检路径实现动态避障。

[0013] 本发明的有益效果为：

[0014] 本发明提出了一种改进的RRT算法，其中包括标记空间拓展策略，即给每个节点设置目标采样以及随机采样两个标记位：首先生成一个随机数，当随机数小于阈值时选择目标点作为采样节点，如果拓展失败此节点的目标采样标记位被标记为失败，当随机数大于阈值时在采样空间进行随机采样，如果拓展失败此节点的随机采样标记位加一；之后在使用目标点作为采样点进行拓展时，父节点的选取则去除目标采样标记位被标记为失败的节点，当时使用随机节点进行拓展时，父节点的选取则去除随机采样标记位到达阈值的节点。改进的RRT算法减少了无效路径的拓展，加快收敛速度；之后执行路径膨胀策略，在碰撞检测的过程中对路径的检测添加安全距离的约束，增加路径和障碍物之间的距离，提高路径的安全性，减少了AUV发生碰撞的概率。本发明在完成规划全局路径后，从起点回溯至终点将全局路径的冗余节点去除，提高路径的平滑性，使本发明提出的RRT算法与DWA可以更好的结合，从而进行AUV路径规划。

[0015] 本发明将改进RRT算法与DWA算法融合算法，规划出一条符合运动学约束的路径，同时实现了对未知动态障碍物的避障功能，弥补仅使用改进RRT算法规划的路径不符合AUV的运动学约束问题和改进RRT算法无法对未知动态障碍物避障的问题，以及DWA算法不能利用地图全局信息进行路径规划导致的极易陷入局部极小值的缺陷。本发明提出的自适应子目标点选取策略，提高了DWA算法绕过障碍物时的平滑度，防止陷入局部极小值问题的发生；本发明提出重规划策略在路径规划过程中出现较大未知障碍物导致没有可行路径时，以当前位置为起点调用改进RRT算法重新规划出一条全局可行安全路径，之后以新规划的路径为基础重新执行DWA算法，使路径规划快速摆脱极小值，从而完成在存在复杂动态且较大障碍物的近海环境的路径规划。

附图说明

[0016] 图1为本发明总流程图；

[0017] 图2为路径膨胀策略示意图；

[0018] 图3为去除冗余节点示意图；

[0019] 图4为自适应子目标点选取示意图；

[0020] 图5为重规划策略结果图。

具体实施方式

[0021] 具体实施方式一：如图1所示，本实施方式一种近海巡检型AUV的路径规划方法具

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体过程为：

[0022] 步骤一、初始化地图空间V,随机树空间T,拓展步长l,AUV运动学参数,自适应子目标点选取阈值k,设置起始点x_{rand},终点x_{goal}；

[0023] 步骤二、采用RRT算法利用步骤一初始化后的参数值获得规划好的全局路径：

[0024] 步骤二一、如图4所示,生成随机数,将生成的随机数与第一阈值比较,根据比较结果确定采样点为随机采样点还是终点,若采样点为终点,则执行(i)；若采样点为随机采样点则执行(ii)；

[0025] 若随机数小于第一阈值则以终点为采样点,若随机数大于第一阈值则以随机采样点为采样点；

[0026] (i)、若采样点为终点则以距离终点最近的节点朝向终点的矢量方向为拓展方向,按照拓展步长进行l拓展获得一个新的节点,此时判断新产生的路径是否产生碰撞,若没有产生碰撞则拓展成功,将该节点加入到随机树空间；若新产生的路径发生碰撞则拓展失败；

[0027] 然后重新生成随机数将生成的随机数与第一阈值比较,根据比较结果确定采样点为随机采样点还是终点；若以终点为采样点,则以当前随机树空间中与终点距离最近的节点到终点的方向为拓展方向进行拓展；

[0028] 其中,每个节点包括：一个目标采样标记位和一个随机采样标记位；

[0029] 所述目标采样标记位和随机采样标记位初值为0；

[0030] 在判断新产生的路径是否产生碰撞采用路径膨胀策略,如图2所示具体为：

[0031] 首先,在路径拓展的过程中,以节点的父节点为起点,以父节点到采样点的矢量方向为拓展方向,拓展l的距离获得拓展路径；

[0032] 然后,在拓展路径的两侧延伸出预设安全距离的宽度,获得障碍物与延伸后的拓展路径之间的距离a,若a小于预设安全距离则拓展失败,则新产生的路径产生碰撞；若a大于等于预设安全距离则拓展成功,则新产生的路径没有产生碰撞；

[0033] (ii)、若采样点为随机采样点,则以起点到随机点采样点的方向为拓展方向,按照拓展步长l进行拓展获得一个新的节点,此时判断新产生的路径是否产生碰撞,若没有产生碰撞则拓展成功,将该节点加入到随机树空间；若新产生的路径发生碰撞则拓展失败；

[0034] 然后重新生成随机数将生成的随机数与第一阈值比较,根据比较结果确定采样点为随机采样点还是终点；若以起点到随机采样点的方向为拓展方向,则以当前随机树空间中与随机采样点距离最近的节点到随机采样点的方向为拓展方向进行拓展；

[0035] 当以当前随机树空间中与终点最近的节点的连接方向为拓展方向进行拓展时,在随机树空间寻找父节点时忽略目标采样标记位为1的节点；

[0036] 所述目标采样标记位为1的节点为目标采样失败的节点,即以终点作为采样点拓展失败时被选为父节点的节点；同时在使用终点作为采样点时此节点将不会被选为父节点。

[0037] 当以当前随机树空间中与随机采样点最近的节点的连接方向为拓展方向进行拓展时,在随机树空间中寻找父节点时忽略随机采样标记位标记次数到达阈值的节点；

[0038] 所述随机采样标记位标记次数到达阈值的节点通过以下方式获得：当以随机点作为拓展点拓展失败时,将节点n的随机采样标记位数字加一,当节点n的随机采样标记位的值大于预设第二阈值时,再以随机点作为采样点时此节点将不会被选为父节点；

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[0039] 所述节点n为以随机点作为拓展点拓展失败时，被选为父节点的节点。

[0040] 步骤二二、重复执行步骤二一直至获得起点到终点的树；

[0041] 步骤二三、在随机树空间中从终点开始依次寻找节点的父节点直至找到起始点，获得一条全局路径，然后去除全局路径上的冗余节点，获得去除冗余节点后的全局路径即规划好的全局路径：

[0042] 如图3所示，连接起始点和下一个子节点执行进行碰撞检测，如果没有发生碰撞则检测下一个子目标和起始点连线是否发生碰撞，逐点检测直至连接至发生碰撞的子目标点，去除此子目标点和起始中间的冗余节点，获得去除冗余节点后的全局路径即规划好的全局路径。

[0043] 步骤三、以AUV运动学参数为约束采用DWA算法对步骤二获得的规划好的全局路径进行处理，获得AUV巡检路径：

[0044] 步骤三一、对步骤二一获得的去除冗余节点后的全局路径上的节点进行延伸，获得延伸后的全局路径，具体为：

[0045] S1、计算AUV当前位置和子目标点沿着全局路径的距离和AUV当前位置和子目标点欧式距离的比值b；

[0046] $$b=\frac{d_{path\_dis}}{d_{euc\_dis}}$$

[0047] 其中，d_{path_dis}为当前起点沿着全局路径到达子目标点的距离，d_{euc_dis}为当前起点到达子目标点的欧氏距离；

[0048] S2、当b小于阈值k时在全局路径上延伸子目标点，直至等于阈值k；当拓展至终点时，即使比值仍小于阈值，也将使用终点作为子目标点；S3、在到达子目标点之后，以当前位置为起点重新执行S1使用自适应子目标点选取策略选取新的子目标点，进行下一次DWA的动态轨迹规划；

[0049] 步骤三二、如图5所示，按照延伸后的全局路径进行巡检，若陷入局部极小值，则以当前AUV位置为起点，重新执行步骤一到三获得重新规划后的巡检路径：

[0050] 当遇到较大的障碍物时可能会出现无法绕过此障碍物的情况，进而使DWA算法陷入局部极小值，当DWA算法陷入局部极小值之后使用重规划策略，即以当前位置为新的起点重新执行步骤一使用改进RRT算法重现规划出一条全局路径，之后再启用DWA算法以重新规划的全局路径为基础重新进行路径规划。

[0051] 本实施方式中，本发明的改进RRT算法使用概率选择目标点作为采样节点，减少算法的无效拓展，加快算法的收敛速度；使用的标记空间拓展策略，防止随机树空间拓展成功率较低的节点被选为父节点，以避免无效拓展；使用的路径膨胀策略，在碰撞检测的过程中对路径的检测添加安全距离的约束，增加路径和障碍物之间的距离，提高路径的安全性，减少AUV发生碰撞的概率。对使用不同拓展方式失败的父节点进行标记处理，在选择目标点作为拓展点失败时其父节点如果再次被选为拓展点也会拓展失败，因此在下次拓展时将其剔除，将会避免无效拓展；在使用随机点作为拓展点时，某一节点在被选为父节点时拓展失败次数越多，代表其成功拓展的概率越低，标记在到达一定阈值之后其拓展的成功的概率将会降低至一个极小值，在使用随机节点作为拓展点时将其剔除将会避免一定的无效拓展。最后规划的全局路径将其冗余节点去除，提高路径的平滑性，便于后续DWA算法对全局路径

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的使用。

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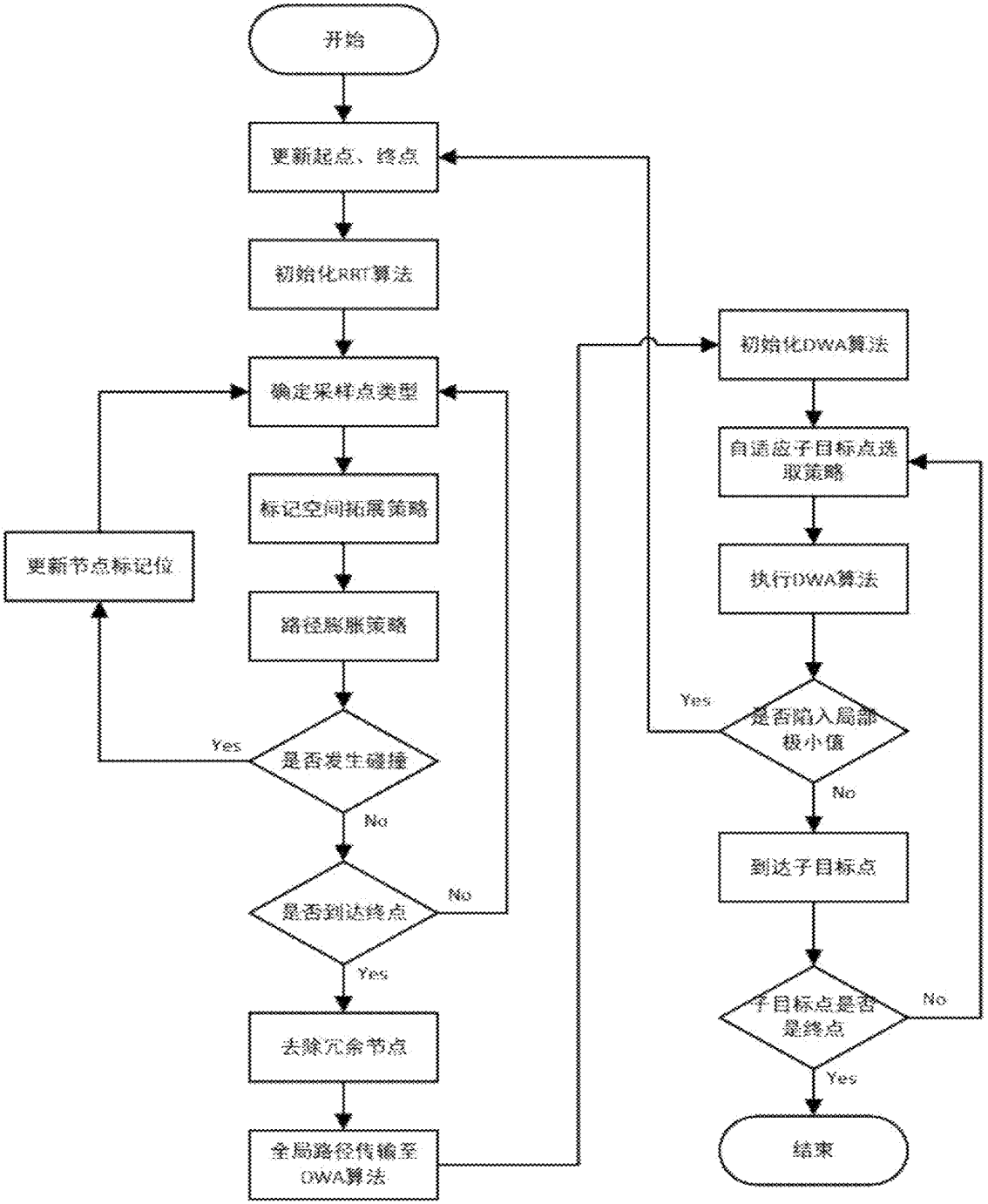


图1

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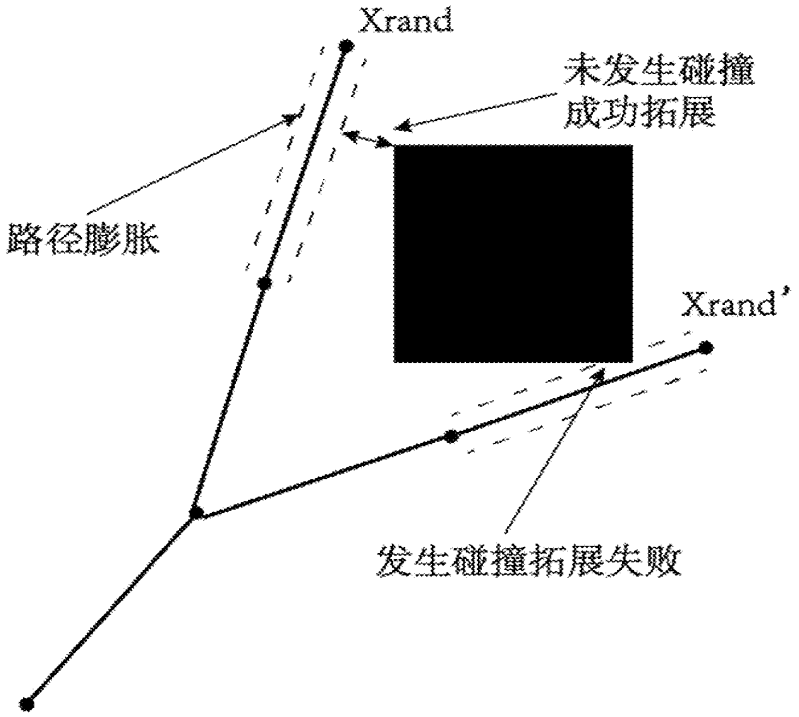


图2

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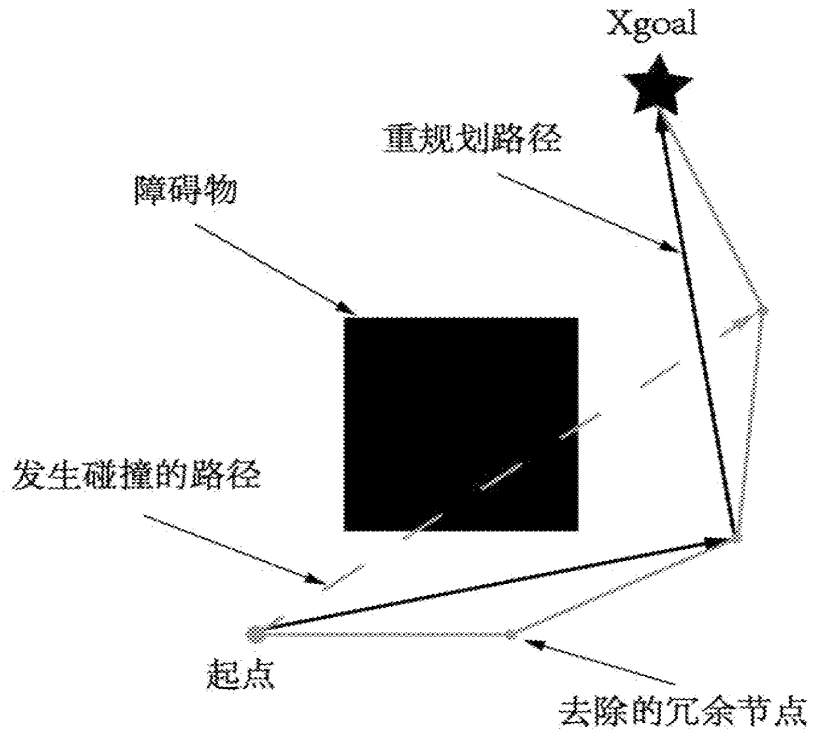


图3

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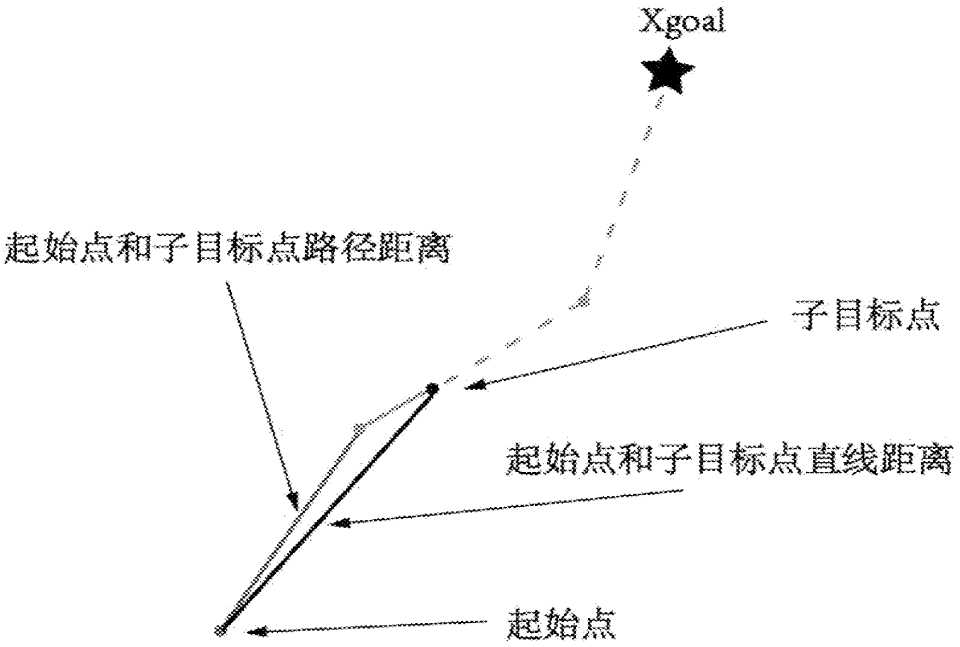


图4

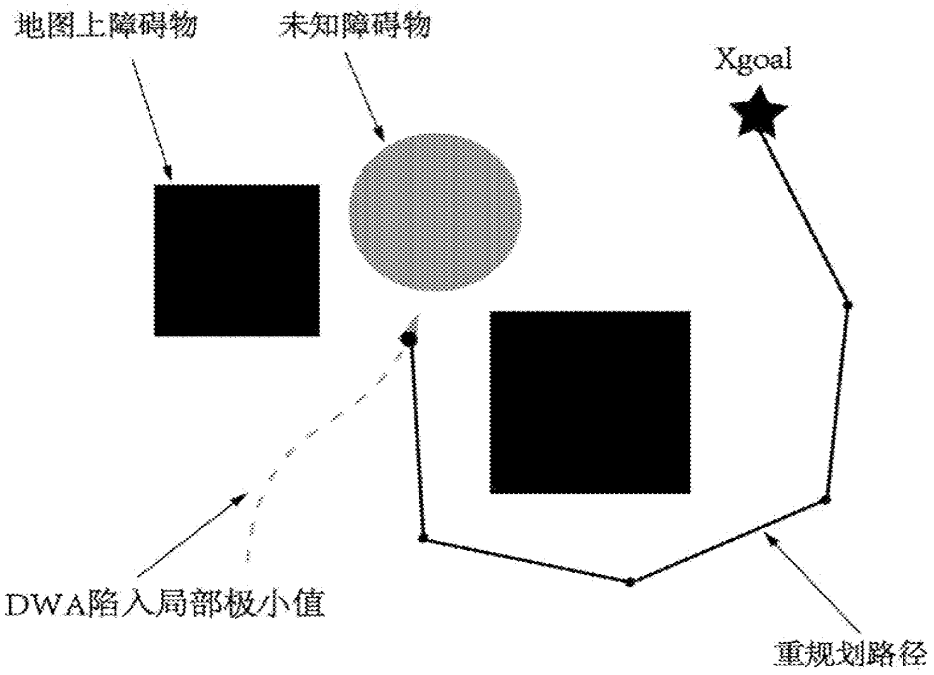


图5

Patent Owner Zodiac Pool Systems LLC
Exhibit 2023 - Page 309 of 377

PTO/SB/08 (01-25)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT		
	Application Number	19342629
	Filing Date	2025-09-28
	First Named Inventor	Shilei ZHANG
	Art Unit	7873
	Examiner Name	NICHOLAS F STRYKER
	Attorney Docket Number	2024009-016

U.S. PATENTS Remove

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Inventor or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear
	1	20200311227	A1	2020-10-01	BENNETT JAMES DUANE	
	2	20220129005	A1	2022-04-28	ZODIAC POOL SYSTEMS LLC	

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	1	116679716	CN	A	2023-09-01	XINGMAI INNOVATION TECH SUZHOU CO LTD		☒
	2	114987721	CN	A	2022-09-02	UNIV SOUTHERN SCI & TECH		☒

INFORMATION DISCLOSURE STATEMENT BY APPLICANT		
	Application Number	19342629
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	First Named Inventor	Shilei ZHANG
	Art Unit	7873
	Examiner Name	NICHOLAS F STRYKER
	Attorney Docket Number	2024009-016

	3	112936313	CN	A	2021-06-11	UNIV GUIZHOU ENGINEERING SCIENCE		☒
	4	214996404	CN	U	2021-12-03	UNIV DALIAN JIAOTONG		☒
	5	113653020	CN	A	2021-11-16	NAT UNIV DEFENSE TECHNOLOGY PLA		☒
	6	114995381	CN	A	2022-09-02	STATE GRID SHANGHAI MUNICIPAL ELECTRIC POWER CO		☒
	7	115517581	CN	A	2022-12-27	NANJING FUYI INTELLIGENT ROBOT TECH CO LTD		☒
	8	20090061355	KR	A	2009-06-16	POSDATA CO LTD		☒
	9	114794993	CN	A	2022-07-29	SHANXI JIA SHI DA ROBOT TECH CO LTD		☒
	10	116197932	CN	A	2023-06-02	TIANJIN WANGYUAN INTELLIGENT TECH CO LTD		☒
	11	115454107	CN	A	2022-12-09	UNIV HARBIN ENG		☒

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

PC.1.19.25

INFORMATION DISCLOSURE STATEMENT BY APPLICANT		
	Application Number	19342629
	Filing Date	2025-09-28
	First Named Inventor	Shilei ZHANG
	Art Unit	7873
	Examiner Name	NICHOLAS F STRYKER
	Attorney Docket Number	2024009-016

	1	International Search Report&Written Opinion of the International Searching Authority（PCT/CN2023/116834）	☒
	2	First Office Action & Search Report（CN2023107686783）	☒

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EXAMINER SIGNATURE

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*EXAMINER: Initial if reference considered and whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

Application Number	19342629
Filing Date	2025-09-28
First Named Inventor	Shilei ZHANG
Art Unit	7873
Examiner Name	NICHOLAS F STRYKER
Attorney Docket Number	2024009-016

TIMING STATEMENT

Please see 37 CFR 1.97(e) to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached timing statement under 37 CFR 1.97(e).

☒ A timing statement under 37 CFR 1.97(e) is not submitted herewith.

TIMING FEE

☒ The fee set forth in 37 CFR 1.17(p) has been submitted herewith.

COPIES

☐ An identification of an earlier application pursuant to 37 CFR 1.98(d)(1) is attached.

SIZE FEE ASSERTION

Please see 37 CFR 1.17(v) and the IDS Auto-Load Instructions for completing this form to make the appropriate selection of an assertion under 37 CFR 1.98. For the information disclosure statement (IDS) submitted herewith, the applicant or patent owner certifies the following with respect to the cumulative number of applicant-provided or patent-owner provided items of information submitted to date including those in the accompanying IDS (select only one):

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SIGNATURE

A signature of the applicant or representative is required in accordance with 37 CFR 1.33 and 11.18. Please see 37 CFR 1.4(d) for the form of the signature.

Signature	/WANYING LI/	Date (YYYY-MM-DD)	2025-12-22
Name/Print	WANYING LI	Registration Number	81553

PC.1.19.25

INFORMATION DISCLOSURE STATEMENT BY APPLICANT		
	Application Number	19342629
	Filing Date	2025-09-28
	First Named Inventor	Shilei ZHANG
	Art Unit	7873
	Examiner Name	NICHOLAS F STRYKER
	Attorney Docket Number	2024009-016

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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ELECTRONIC PAYMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
19/342,629	**12/22/2025 08:10:40 PM Z ET**	**2024009-016**

Title of Invention

POOL ROBOT CONTROL METHOD AND APPARATUS, STORAGE MEDIUM, AND POOL ROBOT

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	7873	FILED BY	Wanying Li
PATENT CENTER #	73719084	AUTHORIZED BY	-
CUSTOMER #	204084	FILING DATE	09/28/2025
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Shilei ZHANG

Payment Information

PAYMENT METHOD	PAYMENT TRANSACTION ID	PAYMENT AUTHORIZED BY
CARD / 8009	**E2025BLK12025513**	**Wanying Li**

PRE-AUTHORIZED ACCOUNT	PRE-AUTHORIZED CATEGORY
606842	**37 CFR 1.16 (National application filing, search, and examination fees); 37 CFR 1.17 (Patent application and reexamination processing fees); 37 CFR 1.19 (Document supply fees); 37 CFR 1.20 (Post Issuance fees); 37 CFR 1.21 (Miscellaneous fees and charges)**

FEE CODE	DESCRIPTION	ITEM PRICE($)	QUANTITY	ITEM TOTAL($)
2806	SUBMISSION OF AN INFORMATION DISCLOSURE STATEMENT	112.00	1	112.00
			TOTAL AMOUNT:	**$112.00**

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New International Application Filed with the USPTO as a Receiving Office

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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
19/342,629	**12/22/2025 08:45:28 PM Z ET**	**2024009-016**

Title of Invention

POOL ROBOT CONTROL METHOD AND APPARATUS, STORAGE MEDIUM, AND POOL ROBOT

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	7873	FILED BY	Wanying Li
PATENT CENTER #	73718937	FILING DATE	09/28/2025
CUSTOMER #	204084	FIRST NAMED INVENTOR	Shilei ZHANG
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	-

Documents

TOTAL DOCUMENTS: 1

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
FINAL_NFOA Response_2024009-016_19342629_2025-12-22.pdf	17	Amendment/Request for Reconsideration-After Non-Final Rejection	267 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
FINAL_NFOA Response_2024009-016_19342629_2025-12-22.pdf	A0C14B2F76992F2A7F7F5675B0C22DC454092905C2568C2D524050D3D3D49926D427FC7A13A42C46ECF28551D685507D4283C275507E4A944597EEA606676823

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Shilei ZHANG Application No.: 19/342,629 Filed: September 28, 2025 For: POOL ROBOT CONTROL METHOD AND APPARATUS, STORAGE MEDIUM, AND POOL ROBOT Customer No.: 204084	Confirmation No.: 7873 Examiner: NICHOLAS F STRYKER Technology Center/Art Unit: 3665 **AMENDMENT**

Mail Stop Amendment

Commissioner for Patents

P.O. Box 1450

Alexandria, VA 22313-1450

Commissioner:

In response to the Office Action mailed November 28, 2025, please enter the following amendments and consider the following remarks:

Amendments to the Claims are reflected in the listing of claims, which begins on page 2 of this paper.

Remarks begin on page 8 of this paper.

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AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings of claims in the application.

Listing of Claims:

1. (Currently Amended) A pool robot control method, comprising:

controlling a pool robot to perform a task in a target water region, wherein the task comprises performing a target operation along an edge of the target water region, performing the target operation in the target water region along a planned route, and performing the target operation along the edge of the target water region again;

after it is determined that the pool robot completes the task, controlling the pool robot to perform a patrolling operation in the target water region;

in a process in which the pool robot performs the patrolling operation, obtaining image information of [[a]]the target water region captured by [[a]]the pool robot, wherein the pool robot operates in a first operation mode or a second operation mode in the target water region, wherein the first operation mode is a mode in which the pool robot operates along a random route, and the second operation mode is a mode in which the pool robot operates along a fixed route, wherein the image information comprises a frame of image or a plurality of frames of images;

analyzing the image information to determine an analysis result; and

determining a target position of a target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform a target operation corresponding to a type of the target object.

2. (Currently Amended) The method according to claim 1, wherein the obtaining image information of[[a]] the target water region captured by[[a]] the pool robot comprises:

obtaining the image information of the target water region captured by the pool robot when the pool robot operates in[[a]] the first operation mode, wherein the first operation mode is a mode in which the pool robot operates between a plurality of preset positions along[[a]] the random route based on a preset time period.

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Exhibit 2023 - Page 321 of 377

3. (Original) The method according to claim 1, wherein the determining a target position of a target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform a target operation corresponding to a type of the target object comprises:

if the analysis result indicates that there is the target object in the target water region, determining the target position based on the image information; and

controlling the pool robot to move to the target position and perform the target operation corresponding to the type of the target object.

4. (Currently Amended) The method according to claim 1, wherein the obtaining image information of [[a]]the target water region captured by [[a]]the pool robot comprises:

obtaining the image information of the target water region captured by the pool robot when the pool robot operates in [[a]]the second operation mode, wherein the second operation mode is a mode in which the pool robot operates between a plurality of preset positions along [[a]]the fixed route based on a preset time period.

5. (Original) The method according to claim 4, wherein the determining a target position of a target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform a target operation corresponding to a type of the target object comprises:

when the pool robot operates in the second operation mode, determining the target position of the target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform the target operation corresponding to the type of the target object.

6. (Original) The method according to claim 4, wherein the determining a target position of a target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform a target operation corresponding to a type of the target object comprises:

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Exhibit 2023 - Page 322 of 377

after the pool robot operates in the second operation mode, marking positions of a plurality of target objects on a map if the analysis result indicates that there is the plurality of target objects in the target water region, wherein the map is constructed in a process in which the pool robot operates in the target water region;

determining an operation route based on the positions of the plurality of target objects; and

controlling the pool robot to move to the positions of the plurality of target objects along the operation route and perform a target operation corresponding to a type of each target object.

7. (Canceled) ~~The method according to claim 1, wherein before the obtaining image information of a target water region captured by a pool robot, the method further comprises:~~

~~controlling the pool robot to perform the target operation along an edge in the target water region; and~~

~~after it is determined that the pool robot completes the target operation along the edge, controlling the pool robot to perform a patrolling operation in the target water region, wherein the patrolling operation comprises controlling the pool robot to capture the image information in the target water region.~~

8. (Canceled) ~~The method according to claim 1, wherein before the obtaining image information of a target water region captured by a pool robot, the method further comprises:~~

~~controlling the pool robot to perform a task in the target water region, wherein the task comprises performing the target operation along an edge of the target water region, performing the target operation in the target water region along a planned route, and performing the target operation along the edge of the target water region again; and~~

~~after it is determined that the pool robot completes the task, controlling the pool robot to perform a patrolling operation in the target water region, wherein the patrolling operation comprises controlling the pool robot to capture the image information in the target water region.~~

9. (Currently Amended) A pool robot control method, wherein a pool robot is configured to perform a cleaning operation in a target water region, and a camera is disposed on the pool robot, wherein the method comprises:

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controlling the pool robot to perform a patrolling operation in a first operation mode or a second operation mode in the target water region, enabling the camera to capture an image of the target water region in a process [[of]]in which the pool robot ~~performing~~ performs the patrolling operation, wherein the first operation mode is a mode of performing the patrolling operation along a random route, and the second operation mode is a mode of performing the patrolling operation along a fixed route, wherein the image is used to determine whether there is a target object in the target water region, wherein the target object needs to be cleaned, wherein the patrolling operation is performed after the pool robot completes a task, wherein the task comprises performing the cleaning operation along an edge of the target water region, performing the cleaning operation in the target water region along a planned route, and performing the cleaning operation along the edge of the target water region again; and

controlling, if it is determined that there is the target object, the pool robot to move to a target position of the target object and perform the cleaning operation on the target object.

10. (Canceled) ~~The method according to claim 9, further comprising:~~

~~controlling the pool robot to perform the cleaning operation in the target water region along an edge of the target water region; and~~

~~after the pool robot completes the cleaning operation along the edge of the target water region, controlling the pool robot to perform the patrolling operation in the target water region.~~

11. (Canceled) ~~The method according to claim 9, wherein the patrolling operation is performed after the pool robot completes a task, wherein the task comprises performing the cleaning operation along an edge of the target water region, performing the cleaning operation in the target water region along a planned route, and performing the cleaning operation along the edge of the target water region again.~~

12. (Original) The method according to claim 9, comprising: if it is determined that there is the target object, controlling the pool robot to directly move to the target position of the target object and perform the cleaning operation on the target object.

13. (Canceled) ~~The method according to claim 9, wherein the controlling the pool robot to perform a patrolling operation in the target water region comprises:~~

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~~controlling the pool robot to perform the patrolling operation in a first operation mode, wherein the first operation mode is a mode of performing the patrolling operation along a random route.~~

14. (Currently Amended) The method according to claim [[13]]9, wherein the controlling the pool robot to perform a patrolling operation in a first operation mode or a second operation mode in the target water region comprises:

controlling the pool robot to perform the patrolling operation in the first operation mode, wherein the first operation mode is a mode in which the pool robot operates between a plurality of preset positions along the random route based on a preset time period.

15. (Canceled) ~~The method according to claim 9, wherein the controlling the pool robot to perform a patrolling operation in the target water region comprises:~~

~~controlling the pool robot to perform the patrolling operation in a second operation mode, wherein the second operation mode is a mode of performing the patrolling operation along a fixed route.~~

16. (Currently Amended) The method according to claim [[15]]9, wherein the controlling the pool robot to perform a patrolling operation in a first operation mode or a second operation mode in the target water region comprises:

controlling the pool robot to perform the patrolling operation in the second operation mode, wherein the second operation mode is a mode in which the pool robot operates between a plurality of preset positions along the fixed route based on a preset time period.

17. (Currently Amended) The method according to claim [[15]]9, wherein the controlling, if it is determined that there is the target object, the pool robot to move to a target position of the target object and perform the cleaning operation on the target object comprises:

when the pool robot is controlled to perform the patrolling operation in the second operation mode, controlling, if it is determined that there is the target object, the pool robot to move to the target position of the target object and perform the cleaning operation on the target object.

18. (Currently Amended) The method according to claim [[15]]9, comprising:

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in a process of controlling the pool robot to perform the patrolling operation in the second operation mode, if it is determined that there is the target object, recording the target position of the target object, or after the pool robot is controlled to perform the patrolling operation in the second operation mode, if it is determined that there is a plurality of target objects, marking target positions of the plurality of target objects on a map, wherein the map is constructed in a process in which the pool robot operates in the target water region; and

the controlling, if it is determined that there is the target object, the pool robot to move to a target position of the target object and perform the cleaning operation on the target object comprises: after the patrolling operation is completed, controlling the pool robot to move to the target positions of the plurality of target objects along an operation route and perform the cleaning operation on each target object.

19. (Original) The method according to claim 9, comprising: when the pool robot performs the cleaning operation at a water surface or a bottom of the target water region, controlling the pool robot to perform the patrolling operation in the target water region.

20. (Original) The method according to claim 9, comprising:

if it is determined that there is the target object, determining the target position of the target object and controlling the pool robot to move to the target position of the target object, wherein the image is used to determine the target position of the target object.

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REMARKS

This paper is responsive to the Office Action mailed on November 28, 2025 (hereinafter, "Office Action"). Claims 1-20 were pending before submission of this paper. Specifically, the Office Action includes the following rejections:

- Claims 1-5, 9, 12-17, and 19-20 were rejected under 35 U.S.C. § 102(a)(1)/(a)(2) as allegedly being anticipated by Braidic, U.S. Pat. App. Pub. No. 2019/0085579 (hereinafter, "Braidic"). *Office Action*, pp. 3-7.
- Claims 6 and 18 were rejected under 35 U.S.C. § 103 as allegedly being unpatentable over Braidic in view of Regev, U.S. Pat. App. Pub. No. 2020/0249690 (hereinafter, "Regev"). *Id.* at pp. 8-10.
- Claims 7-8 and 10-11 were rejected under 35 U.S.C. § 103 as allegedly being unpatentable over Braidic in view of Goldenberg, U.S. Pat. App. Pub. No. 2018/0073266 (hereinafter, "Goldenberg"). *Id.* at pp. 11-14.

Applicant respectfully disagrees with the above rejections. Nevertheless, for at least the purpose of expediting prosecution, and without conceding the propriety of the Office's rejections, Applicant herein amends claims 1-2, 4, 9, 14, and 16-18 and cancels claims 7-8, 10-11, 13, and 15. Upon entry of the present amendment, claims 1-6, 9, 12, 14, and 16-20 will be pending in this application. Support for all amended claims can be found in the specification, and no new matter has been added by these amendments. Reconsideration of the claims in view of the amendments and the following remarks is respectfully requested.

I. Braidic Fails to Disclose Each And Every Element of Claim 1 and Claim 9

Claims 1-5, 9, 12-17, and 19-20 were rejected under 35 U.S.C. § 102(a)(1)/(a)(2) as allegedly being anticipated by Braidic. Applicant respectfully disagrees.

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Applicant respectfully submits that Braidic does not disclose all elements of the pending claims.

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A. Independent Claim 1

Claim 1, as amended, recites:

> A pool robot control method, comprising:
> controlling a pool robot to perform a task in a target water region, wherein the task comprises performing a target operation along an edge of the target water region, performing the target operation in the target water region along a planned route, and performing the target operation along the edge of the target water region again;
> after it is determined that the pool robot completes the task, controlling the pool robot to perform a patrolling operation in the target water region;
> in a process in which the pool robot performs the patrolling operation, obtaining image information of the target water region captured by the pool robot, wherein the pool robot operates in a first operation mode or a second operation mode in the target water region, wherein the first operation mode is a mode in which the pool robot operates along a random route, and the second operation mode is a mode in which the pool robot operates along a fixed route, wherein the image information comprises a frame of image or a plurality of frames of images;
> analyzing the image information to determine an analysis result; and
> determining a target position of a target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform a target operation corresponding to a type of the target object.

Applicant respectfully submits that Braidic fails to disclose all of these features. For example, amended claim 1 recites, among other things, that "controlling a pool robot to perform a task in a target water region, wherein the task comprises performing a target operation along an edge of the target water region, performing the target operation in the target water region along a planned route, and performing the target operation along the edge of the target water region again," "after it is determined that the pool robot completes the task, controlling the pool robot to perform a patrolling operation in the target water region," and "in a process in which the pool robot performs the patrolling operation, obtaining image information of the target water region captured by the pool robot, wherein the pool robot operates in a first operation mode or a second operation mode in the target water region, wherein the first operation mode is a mode in which the pool robot operates along a random route, and the second operation mode is a mode in which the pool robot operates along a fixed route."

As acknowledged in the Office Action, Braidic fails to disclose, among other things, "controlling the pool robot to perform a task in the target water region, wherein the task

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comprises performing the target operation along an edge of the target water region, performing the target operation in the target water region along a planned route, and performing the target operation along the edge of the target water region again." *Office Action*, pp. 11-12.

Moreover, Braidic also fails to disclose, among other things, "after it is determined that the pool robot completes the task, controlling the pool robot to perform a patrolling operation in the target water region, wherein the patrolling operation comprises controlling the pool robot to capture the image information in the target water region" as alleged in the Office Action. *Id.* at pp. 12.

The pending Application provides a pool robot control method including first controlling the pool cleaning robot to perform a task within a target water area, and subsequently, after completing the task, controlling the pool robot to perform a patrolling operation in the target water area. The pool robot control method achieves rapid and high-quality coverage cleaning of the pool and minimizing missed debris to the greatest extent possible by "controlling a pool robot to perform a task in a target water region, wherein the task comprises performing a target operation along an edge of the target water region, performing the target operation in the target water region along a planned route, and performing the target operation along the edge of the target water region again." On this basis, the pool robot is then controlled to perform a patrolling operation over the target water area. Upon detecting missed debris via image recognition, the pool robot is controlled to navigate to the location of the debris to perform spot cleaning. Since full coverage cleaning has already been performed via the completed task, the number of remaining debris is minimal. Consequently, the subsequent patrolling operation can efficiently clean the missed debris, thereby ensuring both cleaning quality and cleaning efficiency.

Braidic is directed to determining a cleaning pathway for at least one primary image of the aquatic environment and navigating a pool cleaner along the determined cleaning pathway. *Braidic*, para. [0006]-[0014]. More specifically, Braidic utilizes image recognition results to optimize and adjust the path during cleaning, which is compared against random path methods to show improved efficiency.

The pending Application, however, utilizes a distinct two-step cleaning method, in which a first-step cleaning of the pool is achieved by "controlling a pool robot to perform a task in a

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target water region, wherein the task comprises performing a target operation along an edge of the target water region, performing the target operation in the target water region along a planned route, and performing the target operation along the edge of the target water region again." Only after the first-step cleaning is completed does the pool robot utilize a patrolling operation to perform supplemental cleaning based on image recognition results. Therefore, the method disclosed by the pending Application should be distinguished from the method disclosed by Braidic.

Furthermore, Braidic discloses an algorithm identifying a number of candidate (or potential) paths a pool cleaner may take, identifying all debris objects on each candidate path, scoring each path as a function of debris, applying penalties, and choosing candidate path with the best path score. *Braidic*, para. [0048]. By controlling the pool cleaner to **only** traverse the determined path with **the best path score**, the algorithm disclosed by Braidic allows the pool cleaner to collect scattered debris objects in a shorter period of time. *Braidic*, para. [0083]. Braidic, however, fails to disclose "**after** it is determined that the pool robot **completes the task**, controlling the pool robot to perform a **patrolling operation** in the target water region, wherein the patrolling operation comprises controlling the pool robot to capture the image information in the target water region," as alleged in the Office Action. *Office Action*, pp. 12. On the contrary, Braidic merely discloses an algorithm of determining a **cleaning pathway** that the pool cleaner navigates along to collect debris objects, rather than disclosing "**after** it is determined that the pool robot **completes the task**, controlling the pool robot to perform **a patrolling operation** in the target water region." Therefore, Braidic fails to disclose "after it is determined that the pool robot completes the task, controlling the pool robot to perform a patrolling operation in the target water region," as amended claim 1 recites.

Finally, the Office Action alleges that Braidic discloses "the controlling the pool robot to perform a patrolling operation in the target water region comprises: controlling the pool robot to perform the patrolling operation in a first operation mode, wherein the first operation mode is a mode of performing the patrolling operation along a random route. ([0081]-[0082] teach the robot system navigating by a random pathing for a time period)." *Office Action*, pp. 6. Applicant respectfully disagrees.

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Contrary to the Office Action's allegations, Braidic fails to disclose, among other things, "in a process in which the pool robot performs the patrolling operation, obtaining image information of the target water region captured by the pool robot, wherein the pool robot operates in a first operation mode or a second operation mode in the target water region, wherein the first operation mode is a mode in which the pool robot operates along a random route, and the second operation mode is a mode in which the pool robot operates along a fixed route."

Specifically, Braidic relates to real-time path optimization to achieve the cleaning of debris in a pool and actually compares its disclosed real-time path optimization against random path methods to show improved efficiency. Para. [0081]-[0082] of Braidic merely mention a pool robot uses a random algorithm to clean a pool. Braidic explicitly presents the random algorithm as a comparative example to the real-time path optimization and fails to disclose the random algorithm as a cleaning mode performed by the pool cleaner with the acquisition component activated. *Braidic*, para. [0081]-[0082]. Contrary to the Office Action's allegations, Braidic indeed teaches away from utilizing the random algorithm, since, when compared with simulations utilizing the control algorithm that selects the "optimal pathway" as described by Braidic, simulations utilizing the random algorithm take a longer time to remove 99% of the debris on the surface. *Braidic*, para. [0081]-[0086].

Meanwhile, the pending Application explicitly provides that, when controlling the pool robot to perform a patrolling operation, by selecting a **random path** or a fixed path to determine individual target objects present in the target water region, the pool robot can achieve improved efficiency of handling specific objects. Specification, para. [0054]-[0057]. Therefore, Braidic fails to disclose "wherein the pool robot operates in a first operation mode or a second operation mode in the target water region, wherein the first operation mode is a mode in which the pool robot operates along a **random route**, and the second operation mode is a mode in which the pool robot operates along a fixed route," as recited in amended claim 1.

The Office Action also alleges that Braidic discloses, among other things, "the second operation mode is a mode in which the pool robot operates along a fixed route." *Office Action*, pp. 6. Specifically, the Office Action points to para. [0047]-[0048] and para. [0054]-[0059] of Braidic, alleging that Braidic teaches the robot pathing along a preset path. *Id.* at pp. 6. Applicant respectfully disagrees.

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Para. [0054]-[0059] of Braidic disclose the specific implementation of real-time path optimization, and the path is adjusted based on images captured in real-time (*e.g.*, identifying the specific locations of debris within the aquatic environment, as well as the size and position of debris on each potential path and the smoothness of each potential path, to determine the optimal cleaning path). *Braidic*, para. [0054]-[0059]. Specifically, para. [0058] of Braidic explicitly provides that "[t]he path score is calculated for each potential path. The control algorithm is **continuously** making these path score calculations (for each image that is taken and manipulated per steps 202 through 210 of FIG. 3) to determine **whether to stay on the current path or change its course to a different path**." *Braidic*, para. [0058]. Thus, the calculated path is not fixed. Therefore, Braidic does not disclose, among other things, "in a process in which the pool robot performs the patrolling operation … wherein the pool robot operates in a first operation mode or a second operation mode in the target water region, wherein the first operation mode is a mode in which the pool robot operates along a random route, and the second operation mode is a mode in which the pool robot operates along a **fixed route**," as recited in amended claim 1.

For at least the reasons above, Braidic fails to disclose all elements of amended independent claim 1. Accordingly, Applicant respectfully submits that claim 1 is allowable over Braidic. Thus, Applicant respectfully requests the withdrawal of the pending rejection under 35 U.S.C. § 102(a)(1)/(a)(2).

B. Independent Claim 9

Claim 9 has been amended to include similar subject matter as claim 1. In particular, claim 9, as amended, recites among other things "controlling the pool robot to perform a patrolling operation in a first operation mode or a second operation mode in the target water region, enabling the camera to capture an image of the target water region in a process in which the pool robot performs the patrolling operation, wherein the first operation mode is a mode of performing the patrolling operation along a random route, and the second operation mode is a mode of performing the patrolling operation along a fixed route, wherein the image is used to determine whether there is a target object in the target water region, wherein the target object needs to be cleaned, wherein the patrolling operation is performed after the pool robot completes a task, wherein the task comprises performing the cleaning operation along an edge of the target

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water region, performing the cleaning operation in the target water region along a planned route, and performing the cleaning operation along the edge of the target water region again."

Applicant respectfully submits that claim 9 is allowable at least for reasons including some of those discussed above in connection with claim 1. As described herein above, Braidic has not been shown to disclose all elements of claim 9. Accordingly, Applicant respectfully submits that claim 9 is allowable under 35 U.S.C. § 102(a)(1)/(a)(2) over Braidic. Withdrawal of the pending rejection under 35 U.S.C. § 102(a)(1)/(a)(2) is, therefore, respectfully requested.

II. Goldenberg Fails to Cure the Deficiencies of Braidic

Claims 6 and 18 were rejected under 35 U.S.C. § 103 as allegedly being unpatentable over Braidic in view of Regev, U.S. Pat. App. Pub. No. 2020/0249690 (hereinafter, "Regev"). *Office Action* at pp. 8-10.

Claims 7-8 and 10-11 were rejected under 35 U.S.C. § 103 as allegedly being unpatentable over Braidic in view of Goldenberg, U.S. Pat. App. Pub. No. 2018/0073266 (hereinafter, "Goldenberg"). *Id.* at pp. 11-14.

With regard to rejections under 35 U.S.C. § 103, the Examiner must provide evidence which as a whole shows that the legal determination sought to be proved *(i.e.,* the reference teachings establish a *prima facie* case of obviousness) is more probable than not. M.P.E.P. § 2142. Accordingly, "the key to supporting any rejection under 35 U.S.C. § 103 is the clear articulation of the reason(s) why the claimed invention would have been obvious." M.P.E.P. § 2142; *see KSR International Co. v. Teleflex, Inc.,* 550 U.S.398, 82 USPQ 2d 1385, 1395-97 (2007).

As discussed above, the Office Action acknowledges that Braidic fails to disclose, among other things, "controlling the pool robot to perform a task in the target water region, wherein the task comprises performing the target operation along an edge of the target water region, performing the target operation in the target water region along a planned route, and performing the target operation along the edge of the target water region again." *Office Action*, pp. 11-12. To cure the deficiency of Braidic, the Office Action further cites Goldenberg (*e.g.*, FIG. 1 and para. [0306] of Goldenberg) and alleges that Goldenberg teaches "controlling a pool robot to perform a task in a target water region, wherein the task comprises performing a target operation along an

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edge of the target water region," "performing the target operation in the target water region along a planned route," and "performing the target operation along the edge of the target water region again." *Office Action* at pp. 11-13. Applicant respectfully disagrees.

Goldenberg is directed to coordinating multiple pool cleaners and how a pool cleaner operates across multiple distinct regions, which is clearly distinct from the method (*i.e.*, a two-step cleaning method including a patrolling operation to achieve high-quality coverage cleaning of the pool) disclosed in the pending Application.

In particular, Goldenberg fails to teach or suggest "controlling a pool robot to perform a task in a target water region, wherein the task comprises performing a target operation along an edge of the target water region," "performing the target operation in the target water region along a planned route," and "performing the target operation along the edge of the target water region again." Para. [0306] of Goldenberg provides "[f]irst pool cleaning robot 21 is configured to clean a region of the pool that includes a first bottom portion 31 and a first sidewall portion 31'. First pool cleaning robot 21 follows a cleaning path 41 for cleaning first bottom portion 31 and follows a cleaning path 41' for cleaning first sidewall portion 31." *Goldenberg*, para. [0306]. In other words, Goldenberg discloses controlling the robot to clean the pool surfaces (*e.g.*, first bottom portion 31, first sidewall portion 31') **within** a region, rather than cleaning the **borders** of that region. In Goldenberg, as illustrated by FIG. 1, the borders of the region are explicitly indicated as border 35 and border 36, which should be distinguished from surfaces (*e.g.*, first bottom portion 31, first sidewall portion 31') included in the region of the pool. *Goldenberg*, para. [0306] and [0311].

Furthermore, although FIG. 1 of Goldenberg mentions borders 35 and 36, the disclosure is limited to addressing how to avoid robot collisions near the borders and, when two or more robots operate in different regions, how to avoid overlapping cleaning near the borders.

Thus, Goldenberg fails to provide "controlling a pool robot to perform a task in a target water region, wherein the task comprises performing a target operation along an edge of the target water region," "performing the target operation in the target water region along a planned route," and "performing the target operation along the edge of the target water region again," as alleged by the Office Action.

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Additionally, Goldenberg also fails to cure the deficiency of Braidic by failing to include any disclosure of "after it is determined that the pool robot completes the task, controlling the pool robot to perform a patrolling operation in the target water region."

Thus, Braidic in combination with Goldenberg still fails to disclose, teach, or suggest each and every element of amended independent claim 1 and claim 9.

III. Dependent Claims 2-6, 12, 14, and 16-20

Claims 2-6, 12, 14, and 16-20 each depend from one of claims 1 and 9 described above. As described above, claims 1 and 9 are allowable. Accordingly, Applicant respectfully submits that claims 2-6, 12, 14, and 16-20 are allowable at least for depending from an allowable independent claim. In addition, Applicant respectfully submits that at least some of claims 2-6, 12, 14, and 16-20 additionally recite patentable subject matter not taught or otherwise rendered obvious by, Braidic, Regev, and Goldenberg, individually or in combination. For at least reasons discussed above, Applicant respectfully submits that claims 2-6, 12, 14, and 16-20 are allowable under 35 U.S.C. § 102(a)(1)/(a)(2) over Braidic and under 35 U.S.C. § 103 over Braidic, Regev, and Goldenberg. Withdrawal of the pending rejections of these claims is, therefore, respectfully requested.

IV. Amendment to The Claims

Unless otherwise specified or addressed in the remarks section, amendments to the claims are made for purposes of clarity. The amendments are supported by the specification and do not add new matter. In addition, by focusing on specific claims and claim elements in the discussion above, Applicant does not imply that other claim elements are disclosed or suggested by the references. In addition, any characterizations of claims and/or cited art are being made to facilitate expeditious prosecution of this application. Applicant reserves the right to pursue at a later date any other broader or narrower claims that capture any subject matter supported by the present disclosure, including subject matter found to be specifically disclaimed herein or by another prosecution. Accordingly, reviewers of this or any child or related prosecution history shall not reasonably infer that Applicant has made any disclaimers or disavowals of any subject matter supported by the present disclosure.

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CONCLUSION

In view of the foregoing, Applicant believes all claims now pending in this application are in condition for allowance. The issuance of a formal Notice of Allowance at an early date is respectfully requested.

Except for the issue fees payable under 37 C.F.R. § 1.18, the Director is authorized to charge any additional fees during pendency of this application, including any required extension of time fees, or credit any overpayment to Deposit Account Number 606842. This paragraph is intended to be a constructive petition for extension of time in accordance with 37 C.F.R. § 1.136(a)(3).

If the Examiner believes a telephone conference would expedite prosecution of this application, please contact the undersigned at 408-647-6075 or wli@soleadolaw.com.

Respectfully submitted,

/WANYING LI/
WANYING LI
Registration No. 81,553

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EXAMINER
STRYKER, NICHOLAS F

ART UNIT	PAPER NUMBER
3665	

NOTIFICATION DATE	DELIVERY MODE
01/27/2026	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

contact@soleadolaw.com

Office Action Summary	Application No. 19/342,629	Applicant(s) ZHANG, Shilei	
	Examiner NICHOLAS STRYKER	Art Unit 3665	AIA (First Inventor to File) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 12/22/2025.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☑ This action is **FINAL.** 2b) ☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1-6,9,12,14 and 16-20 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1-6,9,12,14 and 16-20 is/are rejected.

8) ☑ Claim(s) 14 and 16 is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date 12/25/2025.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

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DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Information Disclosure Statement

2. The information disclosure statement(s) (IDS) submitted on **12/25/2025**, are in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statements have been considered by the examiner.

3. In the future applicant is encouraged to submit each foreign reference as a unique document and to not submit them as one giant foreign reference.

Response to Amendment

4. This action is in response to amendments and remarks filed on **12/22/2025**. Claim(s) **1-2, 4, 9, 14, and 16-18** have been amended. Claim(s) **7-8, 10-11, 13, and 15** have been cancelled. Claim(s) **1-6, 9, 12, 14, and 16-20** are pending examination. **This action is made final.**

Response to Arguments

5. Applicant presents the following argument(s) regarding the previous office action:

A. Applicant asserts that the 35 USC 102 and 35 USC 103 rejections of claims 1-20 is improper because the cited prior art fails to teach all claim limitations as taught/amended. Accordingly the claims are allowable.

6. Applicant's arguments with respect to claim(s) 1-20 have been considered but are moot because the new ground of rejection does not rely on any reference applied in the prior rejection of record for any teaching or matter specifically challenged in the argument.

7. Regarding applicant's argument A, the examiner finds it moot. With further search and consideration the examiner will now rely on newly cited art Regev (US PG Pub 2020/0249690) and Attar

(US PG Pub 2019/0243379) as well as the previously cited art, Braidic, to teach the claim limitations. Erlich broadly teaches a system that does pathing for a robotic pool system, while Attar has teachings regarding the initial steps a robot takes, including going to an edge of an area first. In light of these newly cited arts the examiner would find the claims to be rejected under 35 USC 103, as obvious. Further detailed explanation and mapping can be found below in the section titled, "Claim Rejections – 35 USC 103."

Claim Objections

8. Claims **14 and 16** objected to because of the following informalities:

- Claims 14 recites "a first operation mode or a second operation mode" it should be "the first operation mode or the second operation mode"
- Claims 16 recites "a first operation mode or a second operation mode" it should be "the first operation mode or the second operation mode"

9. Appropriate correction is required.

Claim Rejections - 35 USC § 103

10. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

11. Claim(s) **1-6, 9, 12, 14, and 16-20** is/are rejected under 35 U.S.C. 103 as being unpatentable over **Braidic (US PG Pub 2019/0085579) in view of Regev (US PG Pub 2020/0249690) and Attar (US PG Pub 2019/0243379).**

12. Regarding claim 1, Braidic teaches a pool robot control method, comprising:

- controlling the pool robot to perform a task in the target water region, **([0047]-[0048] teach the pool cleaning robot performing a task, i.e. patrolling/cleaning, in the target water region, i.e. a pool)** ~~wherein the task comprises performing the target operation along an edge of the target~~

~~water region, performing the target operation in the target water region along a planned route, and performing the target operation along the edge of the target water region again~~; and

- after it is determined that the pool robot completes the task, controlling the pool robot to perform a patrolling operation in the target water region, **([0047]-[0048] and [0054]-[0059] teach the robot patrolling the pool as it moves in a preset path)**
- in a process in which the pool robot performs the patrolling operation obtaining image information of the target water region captured by the pool robot, **([0042]-[0045] and [0048]-[0049] teach an aquatic robot that obtains images in a target region)** wherein the pool robot operates in a first operation mode or a second operation mode in the target water region, **([0047]-[0048] teach the robot moving through the environment based on a mode of operation, this includes different kinds of pathing based on the best way to clean the pool)**
- wherein the first operation mode is a mode in which ~~the pool robot operates along a random route~~, and the second operation mode is a mode in which the pool robot operates along a fixed route, **([0047]-[0048] and [0054]-[0059] teach the robot pathing along a preset path between preset points. [0070] teaches that the robot can follow a "singular pathway" i.e. fixed route, along the pool surface to ensure that the pool is cleaned)** wherein the image information comprises a frame of image or a plurality of frames of images; **([0048] teaches the robot collecting a series of images at it moves in the environment)**
- analyzing the image information to determine an analysis result; **([0048]-[0055] teach the system analyzing the image captured by the robot)** and
- determining a target position of a target object if the analysis result indicates that there is the target object in the target water region, **([0054]-[0055] teaches the robot system tracking the target objects, "debris" in the pool)** and controlling the pool robot to move to the target position and perform a target operation corresponding to a type of the target object. **([0056]-**

[0057] teaches the system determining a track to the objects and performing an operation to remove the debris based on the type of debris)

13. Braidic does not teach wherein the task comprises performing the target operation along an edge of the target water region, performing the target operation in the target water region along a planned route, and performing the target operation along the edge of the target water region again; and the pool robot operates along a random route.

14. However, Attar teaches "wherein the task comprises performing the target operation along an edge of the target water region, performing the target operation in the target water region along a planned route, and performing the target operation along the edge of the target water region again;" **(Figs. 2 and 3B; and [0097]-[0100] and [0115]-[0118] teach the robotic cleaner being tasked with cleaning a pool, water region. The system begins by going to the edge of the pool and mapping it, this would perform the target operation along the edge. After the edge is done the robot uses the data gathered to a further operation along the pool, this would be akin to a cleaning path designed as a series of parallel lines, this would be performing the operation in the target region. After the inner part is clean the robot returns to the edge, as this is the end point of the cleaning pathway.)**

15. It would have been prima facie obvious to one of ordinary skill in the art, before the effective filing date, to incorporate the teachings of Braidic with Attar; and have a reasonable expectation of success. Both relate to the cleaning operation of pool robots and ensuring that the pool is cleaned effectively. By performing the perimeter/edge cleaning first the robot gains valuable information it can use to determine further cleaning metrics, such as time, duration, etc. This is taught in Attar [0116]. The use of these metrics allows the system to efficiently clean the pool. [0047] of Attar further shows that the edge of the pool/perimeter is useful in determining the direction of travel for the robot. This again allows for efficient mapping of the system.

16. The combination of Braidic and Attar does not teach the pool robot operates along a random route.

17. However, Regev teaches "the pool robot operates along a random route." **(0222] teaches a pool cleaning robot that operates with a random cleaning pathing.)**

18. It would have been prima facie obvious to one of ordinary skill in the art, before the effective filing date, to incorporate the teachings of Braidic and Attar with Regev; and have a reasonable expectation of success. All relate to the control of pool cleaning robots. Regev [0222] teaches that the random pathing of the robot can be as effective as the regular "raster scan cleaning path." This random pathing is best used for simple cleaning tasks that are not as important. The random pathing does not ensure a full clean as taught by Braidic, [0003]. However, this random pathing element is well established in the art. As Braidic teaches in [0085] the random pathing is most effective in smaller pools. This random patrolling pathway still allows for Braidic to use its algorithm to further find the leaves as the system can randomly navigate until it spots a leaf, then perform a controlled navigation to the leaf/debris.

19. Regarding claim 2, Braidic teaches the method according to claim 1, wherein the obtaining image information of the target water region captured by the pool robot comprises: obtaining the image information of the target water region captured by the pool robot when the pool robot operates in the first operation mode, **([0042]-[0045] and [0048]-[0049] teach an aquatic robot that obtains images in a target region, while operating in a specific operation mode)** ~~wherein the first operation mode is a mode in which the pool robot operates between a plurality of preset positions along a random route based on a preset time period~~.

20. Braidic does not teach wherein the first operation mode is a mode in which the pool robot operates between a plurality of preset positions along a random route based on a preset time period.

21. However, Regev teaches "wherein the first operation mode is a mode in which the pool robot operates between a plurality of preset positions along a random route based on a preset time period." **(0222] teaches a pool cleaning robot that operates with a random cleaning pathing.)**

22. It would have been prima facie obvious to one of ordinary skill in the art, before the effective filing date, to incorporate the teachings of Braidic and Attar with Regev; and have a reasonable expectation of success. All relate to the control of pool cleaning robots. Regev [0222] teaches that the random pathing of the robot can be as effective as the regular "raster scan cleaning path." This random pathing is best used for simple cleaning tasks that are not as important. The random pathing does not ensure a full clean as taught by Braidic, [0003]. However, this random pathing element is well established in the art. As Braidic teaches in [0085] the random pathing is most effective in smaller pools. This random patrolling pathway still allows for Braidic to use its algorithm to further find the leaves as the system can randomly navigate until it spots a leaf, then perform a controlled navigation to the leaf/debris.

23. Regarding claim 3, Braidic teaches the method according to claim 1, wherein the determining a target position of a target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform a target operation corresponding to a type of the target object comprises: if the analysis result indicates that there is the target object in the target water region, determining the target position based on the image information; **([0054]-[0055] teaches the robot system tracking the target objects, "debris" in the pool)** and

- controlling the pool robot to move to the target position and perform the target operation corresponding to the type of the target object. **([0056]-[0057] teaches the system determining a track to the objects and performing an operation to remove the debris based on the type of debris)**

24. Regarding claim 4, Braidic teaches method according to claim 1, wherein the obtaining image information of the target water region captured by the pool robot comprises: obtaining the image information of the target water region captured by the pool robot when the pool robot operates in a second operation mode, **([0042]-[0045] and [0048]-[0049] teach the robot operating in a specific control mode and an aquatic robot that obtains images in a target region)** wherein the second operation mode is a mode in which the pool robot operates between a plurality of preset positions along the fixed route based on a preset time period. **([0047]-[0048] and [0054]-[0059] teach the robot pathing along a preset path between preset points. [0070] teaches that the robot can follow a "singular pathway" i.e. fixed route, along the pool surface to ensure that the pool is cleaned.)**

25. Regarding claim 5, Braidic teaches the method according to claim 4, wherein the determining a target position of a target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform a target operation corresponding to a type of the target object comprises: when the pool robot operates in the second operation mode, determining the target position of the target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform the target operation corresponding to the type of the target object. **([0047]-[0048] and [0054]-[0059] teach the robot operating in the second pathing mode, and determining the location of a target object. The robot then navigates to the debris and performs an operation based on the type of debris)**

26. Regarding claim 6, Braidic teaches the method according to claim 4, wherein the determining a target position of a target object if the analysis result indicates that there is the target object in the target water region, and controlling the pool robot to move to the target position and perform a target operation corresponding to a type of the target object comprises: after the pool robot operates in the second operation mode, marking positions of a plurality of target objects on a map if the analysis result

indicates that there is the plurality of target objects in the target water region, **([0047]-[0048] teaches the system recording a series of debris objects in the pool as it navigates)** ~~wherein the map is constructed in a process in which the pool robot operates in the target water region~~;

- determining an operation route based on the positions of the plurality of target objects; **([0077]-[0078] teach the system determining a pathing for a plurality of objects)** and
- controlling the pool robot to move to the positions of the plurality of target objects along the operation route and perform a target operation corresponding to a type of each target object. **([0077]-[0079] teaches the robot moving along the selected pathing in order to perform the operation)**

27. Braidic does not teach wherein the map is constructed in a process in which the pool robot operates in the target water region.

28. However, Regev teaches "wherein the map is constructed in a process in which the pool robot operates in the target water region" **([0215] teaches the system generating a map of a pool during operation in order to better operate)**

29. It would have been prima facie obvious to one of ordinary skill in the art, before the effective filing date, to incorporate the teachings of Braidic and Attar with Regev; and have a reasonable expectation of success. All relate to the control of pool robots. As Regev teaches in [0107] the creation of a map of the pool allows for the system to better control the cleaning trajectory. The cleaning robot is not moving in the dark and can more effectively plan a route. As seen in Braidic, the robot can determine multiple debris fields in a row and better plan how to get to all debris. The use of a map would improve this functionality by knowing the entire pool structure.

30. Regarding claim 9, Braidic teaches a pool robot control method, wherein a pool robot is configured to perform a cleaning operation in a target water region, and a camera is disposed on the pool robot, wherein the method comprises: controlling the pool robot to perform a patrolling operation

in a first operation mode or a second operation mode in the target water region, in the target water region, **([0047]-[0048] and [0054]-[0059] teach the robot moving through the environment based on a mode of operation, this includes different kinds of pathing based on the best way to clean the pool)** enabling the camera to capture an image of the target water region in a process in which the pool robot performs the patrolling operation, **([0042]-[0043] teaches a camera capturing images of the water area where the robot operates)** wherein the first operation mode is a mode of ~~performing the patrolling operation along a random route~~, and the second operation mode is a mode of performing the patrolling operation along a fixed route, **([0047]-[0048] and [0054]-[0059] teach the robot pathing along a preset path between preset points. [0070] teaches that the robot can follow a "singular pathway" i.e. fixed route, along the pool surface to ensure that the pool is cleaned)** wherein the image is used to determine whether there is a target object in the target water region, wherein the target object needs to be cleaned, **([0048]-[0055] teach the system analyzing the image captured by the robot and determining if there is an object in the target area)** wherein the patrolling operation is performed after the pool robot completes a task, **([0047]-[0048] and [0054]-[0059] teach the robot patrolling the pool as it moves in a preset path)** ~~wherein the task comprises performing the target operation along an edge of the target water region, performing the target operation in the target water region along a planned route, and performing the target operation along the edge of the target water region again~~; and

- controlling, if it is determined that there is the target object, the pool robot to move to a target position of the target object and perform the cleaning operation on the target object. **([0056]-[0057] teaches the system determining a track to the objects and performing an operation to remove the debris based on the type of debris)**

31. Braidic does not teach wherein the task comprises performing the target operation along an edge of the target water region, performing the target operation in the target water region along a

planned route, and performing the target operation along the edge of the target water region again; and performing the patrolling operation along a random route.

32. However, Attar teaches "wherein the task comprises performing the target operation along an edge of the target water region, performing the target operation in the target water region along a planned route, and performing the target operation along the edge of the target water region again;" **(Figs. 2 and 3B; and [0097]-[0100] and [0115]-[0118] teach the robotic cleaner being tasked with cleaning a pool, water region. The system begins by going to the edge of the pool and mapping it, this would perform the target operation along the edge. After the edge is done the robot uses the data gathered to a further operation along the pool, this would be akin to a cleaning path designed as a series of parallel lines, this would be performing the operation in the target region. After the inner part is clean the robot returns to the edge, as this is the end point of the cleaning pathway.)**

33. It would have been prima facie obvious to one of ordinary skill in the art, before the effective filing date, to incorporate the teachings of Braidic with Attar; and have a reasonable expectation of success. Both relate to the cleaning operation of pool robots and ensuring that the pool is cleaned effectively. By performing the perimeter/edge cleaning first the robot gains valuable information it can use to determine further cleaning metrics, such as time, duration, etc. This is taught in Attar [0116]. The use of these metrics allows the system to efficiently clean the pool. [0047] of Attar further shows that the edge of the pool/perimeter is useful in determining the direction of travel for the robot. This again allows for efficient mapping of the system.

34. The combination of Braidic and Attar does not teach performing the patrolling operation along a random route

35. However, Regev teaches "performing the patrolling operation along a random route." **(0222] teaches a pool cleaning robot that operates with a random cleaning pathing.)**

36. It would have been prima facie obvious to one of ordinary skill in the art, before the effective filing date, to incorporate the teachings of Braidic and Attar with Regev; and have a reasonable expectation of success. All relate to the control of pool cleaning robots. Regev [0222] teaches that the random pathing of the robot can be as effective as the regular "raster scan cleaning path." This random pathing is best used for simple cleaning tasks that are not as important. The random pathing does not ensure a full clean as taught by Braidic, [0003]. However, this random pathing element is well established in the art. As Braidic teaches in [0085] the random pathing is most effective in smaller pools. This random patrolling pathway still allows for Braidic to use its algorithm to further find the leaves as the system can randomly navigate until it spots a leaf, then perform a controlled navigation to the leaf/debris.

37. Regarding claim 12, Braidic teaches the method according to claim 9, comprising: if it is determined that there is the target object, controlling the pool robot to directly move to the target position of the target object and perform the cleaning operation on the target object. **([0056]-[0057] teach the robot moving directly to the debris to remove it)**

38. Regarding claim 14, Braidic teaches the method according to claim 9, wherein the controlling the pool robot to perform a patrolling operation in a first operation mode or a second operation mode in the target water region comprises: **([0047]-[0048] teach the robot moving through the environment based on a mode of operation, this includes different kinds of pathing based on the best way to clean the pool)** controlling the pool robot to perform the patrolling operation in the first operation mode, **([0047]-[0048] and [0054]-[0059] teach the robot operating in a specific control mode)** ~~wherein the first operation mode is a mode in which the pool robot operates between a plurality of preset positions along the random route based on a preset time period~~.

39. Braidic does not teach wherein the first operation mode is a mode in which the pool robot operates between a plurality of preset positions along the random route based on a preset time period.

40. However, Regev teaches "wherein the first operation mode is a mode in which the pool robot operates between a plurality of preset positions along the random route based on a preset time period." **(0222] teaches a pool cleaning robot that operates with a random cleaning pathing.)**

41. It would have been prima facie obvious to one of ordinary skill in the art, before the effective filing date, to incorporate the teachings of Braidic and Attar with Regev; and have a reasonable expectation of success. All relate to the control of pool cleaning robots. Regev [0222] teaches that the random pathing of the robot can be as effective as the regular "raster scan cleaning path." This random pathing is best used for simple cleaning tasks that are not as important. The random pathing does not ensure a full clean as taught by Braidic, [0003]. However, this random pathing element is well established in the art. As Braidic teaches in [0085] the random pathing is most effective in smaller pools. This random patrolling pathway still allows for Braidic to use its algorithm to further find the leaves as the system can randomly navigate until it spots a leaf, then perform a controlled navigation to the leaf/debris.

42. Regarding claim 16, Braidic teaches the method according to claim 15, wherein the controlling the pool robot to perform a patrolling operation in a first operation mode or a second operation mode in the target water region comprises: **([0047]-[0048] teach the robot moving through the environment based on a mode of operation, this includes different kinds of pathing based on the best way to clean the pool)**: controlling the pool robot to perform the patrolling operation in the second operation mode, **([0047]-[0048] and [0054]-[0059] teach the robot operating in a specific control mode)** wherein the second operation mode is a mode in which the pool robot operates between a plurality of preset positions along the fixed route based on a preset time period. **([0047]-[0048] and [0054]-[0059] teach the robot pathing along a preset path between preset points. [0070] teaches that the robot can follow a "singular pathway" i.e. fixed route, along the pool surface to ensure that the pool is cleaned.)**

43. Regarding claim 17, Braidic teaches the method according to claim 9, wherein the controlling, if it is determined that there is the target object, the pool robot to move to a target position of the target object and perform the cleaning operation on the target object comprises: when the pool robot is controlled to perform the patrolling operation in the second operation mode, **([0047]-[0048] and [0054]-[0059] teach the robot operating in a specific control mode)** controlling, if it is determined that there is the target object, the pool robot to move to the target position of the target object and perform the cleaning operation on the target object. **([0047]-[0048] and [0054]-[0059] teach the robot operating in the second pathing mode, and determining the location of a target object. The robot then navigates to the debris and performs an operation based on the type of debris)**

44. Regarding claim 18, Braidic teaches the method according to claim 19 comprising: in a process of controlling the pool robot to perform the patrolling operation in the second operation mode, if it is determined that there is the target object, recording the target position of the target object, or after the pool robot is controlled to perform the patrolling operation in the second operation mode, if it is determined that there is a plurality of target objects, marking target positions of the plurality of target objects on a map, **([0047]-[0048] teaches the system recording a series of debris objects in the pool as it navigates)** ~~wherein the map is constructed in a process in which the pool robot operates in the target water region~~; and

- the controlling, if it is determined that there is the target object, the pool robot to move to a target position of the target object and perform the cleaning operation on the target object **([0077]-[0078] teach the system determining a pathing for a plurality of objects)** comprises: after the patrolling operation is completed, controlling the pool robot to move to the target positions of the plurality of target objects along an operation route and perform the cleaning operation on each target object. **([0077]-[0079] teaches the robot moving along the selected pathing in order to perform the operation)**

45. Braidic does not teach wherein the map is constructed in a process in which the pool robot operates in the target water region.

46. However, Regev teaches "wherein the map is constructed in a process in which the pool robot operates in the target water region" **([0215] teaches the system generating a map of a pool during operation in order to better operate)**

47. It would have been prima facie obvious to one of ordinary skill in the art, before the effective filing date, to incorporate the teachings of Braidic with Regev; and have a reasonable expectation of success. Both relate to the control of pool robots. As Regev teaches in [0107] the creation of a map of the pool allows for the system to better control the cleaning trajectory. The cleaning robot is not moving in the dark and can more effectively plan a route. As seen in Braidic, the robot can determine multiple debris fields in a row and better plan how to get to all debris. The use of a map would improve this functionality by knowing the entire pool structure.

48. Regarding claim 19, Braidic teaches the method according to claim 9, comprising: when the pool robot performs the cleaning operation at a water surface or a bottom of the target water region, controlling the pool robot to perform the patrolling operation in the target water region. **([0047] teaches the robot patrolling an aquatic environment. This environment comprises a pool, the robot cleans the entirety of the pool, surface and bottom, and patrols the rest)**

49. Regarding claim 20, Braidic teaches the method according to claim 9, comprising: if it is determined that there is the target object, determining the target position of the target object **([0054]-[0055] teaches the robot system tracking the target objects, "debris" in the pool)** and controlling the pool robot to move to the target position of the target object, wherein the image is used to determine the target position of the target object. **([0056]-[0057] teaches the system determining a track to the objects and performing an operation to remove the debris based on the type of debris)**

Conclusion

50. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

51. A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any nonprovisional extension fee (37 CFR 1.17(a)) pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

52. Any inquiry concerning this communication or earlier communications from the examiner should be directed to NICHOLAS STRYKER whose telephone number is (571)272-4659. The examiner can normally be reached Monday-Friday 7:30-5:00.

53. Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

54. If attempts to reach the examiner by telephone are unsuccessful, the examiner’s supervisor, Christian Chace can be reached at (571) 272-4190. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

55. Information regarding the status of published or unpublished applications may be obtained from Patent Center. Unpublished application information in Patent Center is available to registered users. To file and manage patent submissions in Patent Center, visit: https://patentcenter.uspto.gov. Visit https://www.uspto.gov/patents/apply/patent-center for more information about Patent Center and https://www.uspto.gov/patents/docx for information about filing in DOCX format. For additional

questions, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/N.S./
Examiner, Art Unit 3665
/CHRISTIAN CHACE/
Supervisory Patent Examiner, Art Unit 3665

Notice of References Cited	Application/Control No. 19/342,629	Applicant(s)/Patent Under Reexamination ZHANG, Shilei	
	Examiner NICHOLAS STRYKER	Art Unit 3665	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date YYYY-MM-DD	Name	CPC Classification	US Classification
*	A	US-20190243379-A1	2019-08-08	ATTAR; Benjamin	E04H4/1654	1/1
	B					
	C					
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date YYYY-MM-DD	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title, Date, Publisher, Edition or Volume, Pertinent Pages
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in YYYY-MM-DD format are publication dates. Classifications may be US or foreign.

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Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	19/342,629	ZHANG, Shilei
	Examiner	**Art Unit**
	NICHOLAS STRYKER	3665

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	11/14/2025	01/22/2026							
	1	✓	✓							
	2	✓	✓							
	3	✓	✓							
	4	✓	✓							
	5	✓	✓							
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	16	✓	✓							
	17	✓	✓							
	18	✓	✓							
	19	✓	✓							
	20	✓	✓							

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	19/342,629	ZHANG, Shilei
	Examiner	Art Unit
	NICHOLAS STRYKER	3665

CPC - Searched*		
Symbol	**Date**	**Examiner**
E04H4/1654	11/14/2025	NS
G05D1/648 G05D1/6484 G05D1/6486 G05D2105/10 G05D2107/29	11/14/2025	NS
G06T7/70	11/14/2025	NS
G06V20/05 G06V2201/07	11/14/2025	NS

CPC Combination Sets - Searched*		
Symbol	**Date**	**Examiner**

US Classification - Searched*			
Class	**Subclass**	**Date**	**Examiner**

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	**Date**	**Examiner**
Synonym and CPC search	11/14/2025	NS
IP.com patent and NPL search	11/14/2025	NS
AI search tools in PE2E, including similarity search - see srnt	11/14/2025	NS
Inventor and assignee search	11/14/2025	NS
Updated search for final rejection	01/22/2026	NS

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	Examiner	Art Unit
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Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

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19342629 Xingmai Pool Robot

Report Run Date: 2026-01-22 UTC
Searches: 3
Markers: 0

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Search #	Timestamp	Results	Page
1	2026-01-22 15:37 UTC	~24,805,909	3
2	2026-01-22 16:14 UTC	~19,201,271	4
3	2026-01-22 16:14 UTC	~1,849,734	4

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Content: Patents + NPL (195)

US Patents | US Designs | US Applications | EPO Patents | EPO Applications | China Patents | China Applications | Japan Patents | Japan Applications | Korea Patents | Korea Applications | WIPO Applications | Argentina Patents | Argentina Applications | Brazil Patents | Brazil Applications | Canada Patents | Canada Applications | Chile Patents | Chile Applications | Colombia Applications | Costa Rica Applications | Cuba Patents | Cuba Applications | Dominican Republic Applications | Ecuador Patents | Ecuador Applications | El Salvador Applications | Guatemala Applications | Honduras Applications | Mexico Patents | Mexico Applications | Nicaragua Patents | Panama Applications | Peru Applications | Trinidad & Tobago Patents | Uruguay Applications | Austria Patents | Austria Applications | Belarus Patents | Belgium Patents | Belgium Applications | Bosnia & Herzegovina Patents | Bosnia & Herzegovina Applications | Bulgaria Patents | Bulgaria Applications | Croatia Patents | Croatia Applications | Czech Republic Patents | Czech Republic Applications | Czechoslovakia Patents | Czechoslovakia Applications | Denmark Patents | Denmark Applications | Estonia Patents | Estonia Applications | EUIPO Patents | Finland Patents | Finland Applications | France Patents | France Applications | Germany Patents | Germany Applications | Great Britain Patents | Great Britain Applications | Greece Patents | Greece Applications | Hungary Patents | Hungary Applications | Iceland Patents | Iceland Applications | Ireland Patents | Ireland Applications | Italy Patents | Italy Applications | Latvia Patents | Latvia Applications | Lithuania Patents | Lithuania Applications | Luxembourg Patents | Luxembourg Applications | Malta Patents | Monaco Patents | Montenegro Patents | Montenegro Applications | Netherlands Patents | Netherlands Applications | Norway Patents | Norway Applications | Poland Patents | Poland Applications | Portugal Patents | Portugal Applications | Republic of Moldova Patents | Republic of Moldova Applications | Romania Patents | Romania Applications | San Marino Patents | San Marino Applications | Serbia Patents | Serbia Applications | Slovakia Patents | Slovakia Applications | Slovenia Patents | Spain Patents | Spain Applications | Sweden Patents | Sweden Applications | Switzerland Patents | Switzerland Applications | Ukraine Patents | Yugoslavia/Serbia and Montenegro Patents | Yugoslavia/Serbia and Montenegro Applications | Armenia Patents | Australia Patents | Australia Applications | Cyprus Patents | Gulf Cooperation Council Patents | Hong Kong Patents | India Patents | India Applications | Indonesia Patents | Indonesia Applications | Israel Patents | Israel Applications | Jordan Patents | Jordan Applications | Kyrgyzstan Patents | Macao Applications | Malaysia Patents | Mongolia Patents | New Zealand Patents | Philippines Patents | Philippines Applications | Saudi Arabia Patents | Saudi Arabia Applications | Singapore Patents | Singapore Applications | Taiwan Patents | Taiwan Applications | Tajikistan Patents | Tajikistan Applications | Thailand Patents | Thailand Applications | Uzbekistan Patents | Vietnam Patents | Algeria Patents | ARIPO Patents | ARIPO Applications | Egypt Patents | Kenya Patents | Malawi Patents | Morocco Patents | Morocco Applications | OAPI Patents | South Africa Patents | Tunisia Applications | Zambia Patents | Zimbabwe Patents | EAPO Patents | EAPO Applications | Georgia Patents | Georgia Applications | Kazakhstan Patents | Kazakhstan Applications | Russia Patents | Russia Applications | Turkey Patents | Turkey Applications | IEEE Xplore Publications: IEEE Periodicals | IEEE Xplore Publications: IEEE Conferences | IEEE Xplore Publications: IEEE Standards | IEEE Xplore Publications: IEEE Early Access | IEEE Xplore Publications: SMPTE Periodicals | IEEE Xplore Publications: SMPTE Conferences | IEEE Xplore Publications: SMPTE Standards | IEEE Xplore Publications: MIT Press eBooks | IEEE Xplore Publications: Wiley-IEEE eBooks | IEEE Xplore Publications: IBM Periodicals | IEEE Xplore Publications: URSI Periodicals | IEEE Xplore Publications: VDE Conferences | IEEE Xplore Publications: Periodicals from China | IEEE Xplore Publications: Ericsson Technology Review | IEEE Xplore Publications: Manning Books | IEEE Xplore Publications: Packt Books | IP.com Prior Art Database: The IP.com Journal | IP.com Prior Art Database: Internet Society RFC | IP.com Prior Art Database: IBM TDB Archive | IP.com Prior Art Database: Legacy Journals | IP.com Prior Art Database: Software Patent Institute | OnePetro.org: Periodicals at OnePetro.org | OnePetro.org: Conferences at OnePetro.org | Other Literature: IBM Redbooks | Other Literature: PubMed Central | Other Literature: arXiv.org

1 2026-01-22 15:37 UTC | ~24,805,909 results from

De-Dup: Simple Family Numbers (PAT only) | **Relevance Cut-off:** None | **Sort:** Relevance

Main Concept: Text

Patent Owner Zodiac Pool Systems LLC
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cleaning robot with random and fixed pathing

Concept Modifiers: None

Filters: None

2 **2026-01-22 16:14 UTC | ~19,201,271 results from**

De-Dup: Simple Family Numbers (PAT only) | **Relevance Cut-off:** None | **Sort:** Relevance

Main Concept: Same as Search 1

Concept Modifiers: None

Filters (1):
Publication Date: To 2023-06-27

3 **2026-01-22 16:14 UTC | ~1,849,734 results from**

De-Dup: Simple Family Numbers (PAT only) | **Relevance Cut-off:** None | **Sort:** Relevance

Main Concept: Same as Search 1

Concept Modifiers (1):
1. More Like Text: pool edge cleaning

Filters: Same as Search 2

Patent Owner Zodiac Pool Systems LLC
Exhibit 2023 - Page 362 of 377

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08 (01-25)
Approved for use through 11/30/2027. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

Application Number	19342629
Filing Date	2025-09-28
First Named Inventor	Shilei ZHANG
Art Unit	7873
Examiner Name	NICHOLAS F STRYKER
Attorney Docket Number	2024009-016

U.S. PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Inventor of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear
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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Inventor or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear
/N.S./	1	20200311227	A1	2020-10-01	BENNETT JAMES DUANE	
/N.S./	2	20220129005	A1	2022-04-28	ZODIAC POOL SYSTEMS LLC	

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T[5]
/N.S./	1	116679716	CN	A	2023-09-01	XINGMAI INNOVATION TECH SUZHOU CO LTD		☒
/N.S./	2	114987721	CN	A	2022-09-02	UNIV SOUTHERN SCI & TECH		☒

PC.1.19.25

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /N.S./

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	Filing Date	2025-09-28
	First Named Inventor	Shilei ZHANG
	Art Unit	7873
	Examiner Name	NICHOLAS F STRYKER
	Attorney Docket Number	2024009-016

/N.S./	3	112936313	CN	A	2021-06-11	UNIV GUIZHOU ENGINEERING SCIENCE		☒
/N.S./	4	214996404	CN	U	2021-12-03	UNIV DALIAN JIAOTONG		☒
/N.S./	5	113653020	CN	A	2021-11-16	NAT UNIV DEFENSE TECHNOLOGY PLA		☒
/N.S./	6	114995381	CN	A	2022-09-02	STATE GRID SHANGHAI MUNICIPAL ELECTRIC POWER CO		☒
/N.S./	7	115517581	CN	A	2022-12-27	NANJING FUYI INTELLIGENT ROBOT TECH CO LTD		☒
/N.S./	8	20090061355	KR	A	2009-06-16	POSDATA CO LTD		☒
/N.S./	9	114794993	CN	A	2022-07-29	SHANXI JIA SHI DA ROBOT TECH CO LTD		☒
/N.S./	10	116197932	CN	A	2023-06-02	TIANJIN WANGYUAN INTELLIGENT TECH CO LTD		☒
/N.S./	11	115454107	CN	A	2022-12-09	UNIV HARBIN ENG		☒

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NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

PC.1.19.25

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	Examiner Name	NICHOLAS F STRYKER
	Attorney Docket Number	2024009-016

/N.S./	1	International Search Report&Written Opinion of the International Searching Authority（PCT/CN2023/116834）	☒
/N.S./	2	First Office Action & Search Report（CN2023107686783）	☒

If you wish to add additional non-patent literature document citation information, please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature	/NICHOLAS STRYKER/	Date Considered	01/22/2026

*EXAMINER: Initial if reference considered and whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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	Examiner Name	NICHOLAS F STRYKER
	Attorney Docket Number	2024009-016

TIMING STATEMENT

Please see 37 CFR 1.97(e) to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached timing statement under 37 CFR 1.97(e).

☒ A timing statement under 37 CFR 1.97(e) is not submitted herewith.

TIMING FEE

☒ The fee set forth in 37 CFR 1.17(p) has been submitted herewith.

COPIES

☐ An identification of an earlier application pursuant to 37 CFR 1.98(d)(1) is attached.

SIZE FEE ASSERTION

Please see 37 CFR 1.17(v) and the IDS Auto-Load Instructions for completing this form to make the appropriate selection of an assertion under 37 CFR 1.98. For the information disclosure statement (IDS) submitted herewith, the applicant or patent owner certifies the following with respect to the cumulative number of applicant-provided or patent-owner provided items of information submitted to date including those in the accompanying IDS (select only one):

☒ No IDS size fee is required under 37 CFR 1.17(v) at this time.

☐ The IDS is accompanied by the IDS size fee under 37 CFR 1.17(v)(1).

☐ The IDS is accompanied by the IDS size fee under 37 CFR 1.17(v)(2).

☐ The IDS is accompanied by the IDS size fee under 37 CFR 1.17(v)(3).

SIGNATURE

A signature of the applicant or representative is required in accordance with 37 CFR 1.33 and 11.18. Please see 37 CFR 1.4(d) for the form of the signature.

Signature	/WANYING LI/	Date (YYYY-MM-DD)	2025-12-22
Name/Print	WANYING LI	Registration Number	81553

PC.1.19.25

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /N.S./

INFORMATION DISCLOSURE STATEMENT BY APPLICANT		
	Application Number	19342629
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	First Named Inventor	Shilei ZHANG
	Art Unit	7873
	Examiner Name	NICHOLAS F STRYKER
	Attorney Docket Number	2024009-016

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

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2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L1	45	(ZHANG NEAR Shilei).in,inv.	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/10 03:51 PM
L2	28	(XINGMAI near2 INNOVATION near2 TECHNOLOGY).as,aanm.	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/10 03:51 PM
L3	21	L1 AND L2	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/10 03:52 PM
L4	50	(Artificial Intelligence) Similar to: 19/342,629 with 0 CPC Selections and 0 Text Selections Text: (CN-119516248-A OR CN-118534413-A OR US-7769203-B2 OR CN-113065392-A OR US-11907838-B2 OR CN-114078232-A OR CN-111678522-A OR CN-120515099-A OR US-20250127362-A1 OR CN-108537843-A OR AU-2021290427-A1 OR US-20220122353-A1 OR WO-2021236939-A1 OR CN-110558902-B OR US-20200012288-A1 OR CN-112766241-B OR CN-110619298-A OR CN-112766241-A OR CN-112277783-A OR CN-116977576-B OR AU-2021290427-B2 OR CN-119883070-A OR US-11488390-B2 OR CN-111246110-B OR CN-118212625-A OR US-20200074196-A1 OR CN-113627412-A OR CN-112699888-A OR CN-111325117-B OR US-10812761-B2 OR JP-2022552772-A OR CN-110558902-A OR JP-7250924-B2 OR KR-20210144887-A OR US-20090059002-A1 OR US-20200364863-	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2025/11/10 03:53 PM

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Exhibit 2023 - Page 369 of 377

		A1 OR EP-4390599-A1 OR CN-111340030-A OR CN-110287778-B OR US-20240203107-A1 OR US-20180032833-A1 OR CN-111612812-B OR US-7953245-B2 OR CN-113514053-B OR CN-113787517-A OR CN-110491060-A OR CN-114820785-A OR US-9818038-B2 OR CN-111340030-B OR CN-108921894-B).did.					
L5	50	(Artificial Intelligence) Similar to: 19/342,629 with 5 CPC Selections and 5 Text Selections Text: (US-20180032833-A1 OR US-9818038-B2 OR JP-2017512991-A OR US-20170193319-A1 OR CN-111612812-B OR US-11941836-B2 OR US-10095943-B2 OR CN-113657518-A OR WO-2023286217-A1 OR CN-114078232-A OR WO-2022213867-A1 OR US-11907838-B2 OR CN-113657518-B OR CN-108537843-A OR CN-115534802-A OR US-7769203-B2 OR US-20220405952-A1 OR US-11776158-B2 OR US-20220392101-A1 OR CN-113065392-A OR US-20220351514-A1 OR CN-112598729-B OR JP-7597224-B2 OR DE-112021001872-T5 OR JP-2024020532-A OR US-20180246521-A1 OR US-20240386596-A1 OR CN-112766241-B OR US-11488390-B2 OR KR-20240019763-A OR CN-112766241-A OR US-20200333796-A1 OR TW-I796952-B OR US-20240203107-A1 OR EP-4546292-A1	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2025/11/10 03:54 PM

Patent Owner Zodiac Pool Systems LLC
Exhibit 2023 - Page 370 of 377

		OR US-20240312047-A1 OR CN-117523541-A OR JP-7660356-B2 OR US-11409303-B2 OR JP-2021516817-A OR WO-2022260755-A1 OR US-20230222838-A1 OR US-20240009851-A1 OR CN-119516248-A OR CN-118212625-A OR KR-102596388-B1 OR US-20200074196-A1 OR WO-2021236939-A1 OR CN-112560592-B OR KR-20250029083-A).did.					
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L18	20017	((obtain$3 OR captur$3 OR receiv$3 OR get$4 OR collect$4 OR procur$3 OR captur$3 OR tak$3 OR record$3) near4 (image OR video OR picture OR photograph OR photo)) SAME ((clean$3 OR cleans$3 OR scrub$4 OR wash$3 OR vacuum$4 OR brush$3 OR wip$3) near3 (robot OR roomba OR	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/12 11:30 AM

Patent Owner Zodiac Pool Systems LLC
Exhibit 2023 - Page 371 of 377

		automaton OR dorid OR machine OR bot OR mechanism OR device))					
L19	1684	L18 AND ((target OR goal OR purpose OR objective OR intention) near3 (object OR location OR spot OR locale OR mark OR intent OR focus OR spill OR debris OR rubbish OR wast OR junk OR litter OR scrp OR residue))	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/12 11:31 AM
L20	61	L19 AND ((pool OR underwater OR spa OR pond OR swimming$1pool OR lake OR lagoon OR submersible OR submerged OR submarine OR aquatic OR marine) near4 (robot OR roomba OR automaton OR dorid OR machine OR bot OR mechanism OR device))	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/12 11:33 AM
L21	65640	(self ADJ moving OR servomechanism OR servo OR automat$2 OR robot$2) NEAR2 (cleaner OR cleaning OR vacuum OR vaccum OR home) OR roomba OR scooba OR dirt ADJ dog OR dirtdog OR verro OR looj	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/12 11:33 AM
L22	225	L21 near4 (underwater OR under$water OR marine OR undersea OR subaquatic OR subsurface OR sub$aquatic OR oceanic OR submers$3 OR nautical OR (deep ADJ ocean) OR sea$dwell$3 OR oceanographic OR hydrographic)	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/12 11:34 AM
L23	185	L22 AND @ad<"20230627"	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/12 01:19 PM
L24	13	L23 AND L18	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/12 01:25 PM

Patent Owner Zodiac Pool Systems LLC
Exhibit 2023 - Page 372 of 377

L25	2	(20200237176|20190208979).pn.	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/12 01:27 PM
L26	308	L11 AND ((perimeter OR edge OR border OR boundary OR periphery) near4 (clean$3 OR cleans$3 OR scrub$4 OR wash$3 OR vacuum$4 OR brush$3 OR wip$3))	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/13 02:45 PM
L27	277	L26 AND @ad<"20230627"	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/13 02:45 PM
L28	28	(L11 AND ((perimeter OR edge OR border OR boundary OR periphery) near4 (map$4 OR chart$3 OR diagram$4 OR plot$4))) AND @ad<"20230627"	(US-PGPUB; USPAT)	OR	ON	ON	2025/11/13 03:43 PM
L29	50	(Artificial Intelligence) Similar to: 19/342,629 with 0 CPC Selections and 0 Text Selections Text: (CN-119839883-B OR CN-118534413-A OR EP-1672456-B1 OR CN-116977576-A OR US-20210366151-A1 OR CN-113065392-A OR US-11907838-B2 OR CN-114078232-A OR CN-120515099-A OR CN-110558902-B OR CN-110619298-A OR WO-2021236939-A1 OR CN-112277783-A OR CN-108537843-A OR CN-112766241-A OR US-11488390-B2 OR US-20220122353-A1 OR CN-107225570-A OR CN-111246110-B OR CN-119883070-A OR AU-2021290427-B2 OR CN-116977576-B OR KR-20210144887-A OR CN-110558902-A OR CN-119251606-A OR CN-111340030-A OR JP-2022552772-A OR CN-111325117-B OR US-20240203107-A1 OR US-20180032833-A1 OR	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2026/01/22 10:30 AM

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		JP-2022546883-A OR JP-7250924-B2 OR CN-113627412-A OR CN-113787517-A OR ES-2955667-T3 OR KR-20200080404-A OR CN-113838125-B OR CN-111340030-B OR CN-110163834-B OR US-9818038-B2 OR CN-112258363-B OR CN-110287778-B OR CN-119152456-A OR US-20170193319-A1 OR CN-116416361-A OR WO-2022213867-A1 OR WO-2022029482-A1 OR WO-2015064991-A2 OR CN-118366452-A OR CN-111080693-A).did.					
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		CN-114761997-A OR WO-2022260755-A1 OR CN-119836786-A OR US-20190236414-A1 OR US-20240312047-A1 OR IL-318139-A OR US-12230006-B2 OR US-20230222761-A1 OR US-20250182440-A1 OR CN-116958195-A OR CN-116390885-A OR ES-2938091-A2 OR US-10984543-B1 OR CN-119723023-A OR US-20230215185-A1 OR US-12266153-B2 OR US-11346951-B2 OR TW-I851992-B OR US-20250104264-A1 OR US-20240005631-A1 OR CN-118261952-A OR JP-7597224-B2 OR US-20150332102-A1).did.					
L31	3	("20200311227"|"20220129005").PN.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2026/01/22 11:21 AM
L32	4201	L21 AND ((edge OR perimeter OR wall OR barrier OR fence OR partition) near3 (identify$3 OR identification OR measur$5 OR assess$4 OR gaug$3 OR determin$5))	(US-PGPUB; USPAT)	OR	ON	ON	2026/01/22 11:24 AM
L33	159	L32 AND ((random OR unfixed OR haphazard OR chance OR indiscriminate OR unplanned OR aimless OR erratic) near2 (path$3 OR pathfinding OR wayfind$3 OR navigat$3))	(US-PGPUB; USPAT)	OR	ON	ON	2026/01/22 11:29 AM

PE2E SEARCH - Search History (Interference)

There are no Interference searches to show.

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19/342,629	09/28/2025	Shilei ZHANG	2024009-016

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