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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	
	Filing Date	
	First Named Inventor	Ethan Hanan
	Art Unit	
	Examiner Name	
	Attorney Docket Number	A150-102

U.S.PATENTS						Remove
Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5435031	A	1995-07-25	Minami et al.	Entire Document
	2	5507058	A	1996-04-16	Minami et al.	Entire Document
	3	7398138	B2	2008-07-08	Emery et al.	Entire Document
	4	7993600	B2	2011-08-09	Doyle et al.	Entire Document
	5	8007653	B2	2011-08-30	Porat	Entire Document
	6	8043070	B2	2011-10-25	Stiles Jr et al.	Entire Document
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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Ethan Hanan
	Art Unit	
	Examiner Name	
	Attorney Docket Number	A150-102

	1	20070094817	A	2007-05-03	Stoltz et al.	Entire Document
	2	20110091329	A	2011-04-21	Stiles Jr et al.	Entire Document
	3	20110301752	A	2011-12-08	Finezilber	Entire Document

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FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	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]
	1							☐

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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]
	1		☐

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EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, 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.

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Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	
	Filing Date	
	First Named Inventor	Ethan Hanan
	Art Unit	
	Examiner Name	
	Attorney Docket Number	A150-102

[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 (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Ethan Hanan
	Art Unit	
	Examiner Name	
	Attorney Docket Number	A150-102

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 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 certification statement.

☐ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ None

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Todd Rathe/	Date (YYYY-MM-DD)	2012-06-29
Name/Print	Todd Rathe	Registration Number	38276

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.**

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 record s.

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 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.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	A150-102
	Application Number	
Title of Invention	POOL CLEANING SYSTEM AND METHOD	

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.

Secrecy Order 37 CFR 5.2

☐ 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.)

Applicant Information:

Applicant 1 Remove

Applicant Authority	◉ Inventor	○ Legal Representative under 35 U.S.C. 117	○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Kameshwar		Durvasula	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Lyndhurst	State/Province	NJ	Country of Residence [i]	US
Citizenship under 37 CFR 1.41(b) [i]	IN				

Mailing Address of Applicant:

Address 1	25 Rutgers Avenue		
Address 2			
City	Cedar Grove	State/Province	NJ
Postal Code	07009	Country [i]	US

Applicant 2 Remove

Applicant Authority	◉ Inventor	○ Legal Representative under 35 U.S.C. 117	○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	William	Londono	Correa	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Bloomfield	State/Province	NJ	Country of Residence [i]	US
Citizenship under 37 CFR 1.41(b) [i]	US				

Mailing Address of Applicant:

Address 1	25 Rutgers Avenue		
Address 2			
City	Cedar Grove	State/Province	NJ
Postal Code	07009	Country [i]	US

Applicant 3 Remove

Applicant Authority	◉ Inventor	○ Legal Representative under 35 U.S.C. 117	○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City		State/Province		Country of Residence [i]	

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	A150-102
	Application Number	
Title of Invention	POOL CLEANING SYSTEM AND METHOD	

Citizenship under 37 CFR 1.41(b) [i]			
Mailing Address of Applicant:			
Address 1			
Address 2			
City		**State/Province**	
Postal Code		**Country**[i]	

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	14326		
Email Address	keith.lindenbaum@rlpatent.com	Add Email	Remove Email

Application Information:

Title of the Invention	POOL CLEANING SYSTEM AND METHOD		
Attorney Docket Number	A150-102	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Suggested Class (if any)		**Sub Class (if any)**	
Suggested Technology Center (if any)			
Total Number of Drawing Sheets (if any)	4	**Suggested Figure for Publication (if any)**	

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.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Enter either Customer Number or complete the Representative Name section below. If both sections are completed the Customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	A150-102
	Application Number	
Title of Invention	POOL CLEANING SYSTEM AND METHOD	

Customer Number	14326

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78(a)(2) or CFR 1.78(a)(4), and need not otherwise be made part of the specification.

Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

Foreign Priority Information:

This section allows for the applicant to claim benefit of foreign priority and to identify any prior foreign application for which priority is not claimed. 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(a).

Remove

Application Number	Country [i]	Parent Filing Date (YYYY-MM-DD)	Priority Claimed
			◉ Yes ○ No

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

Assignee Information:

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

Assignee 1 Remove

If the Assignee is an Organization check here. ☒			
Organization Name	Aqua Products, Inc.		
Mailing Address Information:			
Address 1	25 Rutgers Avenue		
Address 2			
City	Cedar Grove	**State/Province**	NJ
Country [i] US		Postal Code	07009
Phone Number		Fax Number	
Email Address			

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

Signature:

A signature of the applicant or representative is required in accordance with 37 CFR 1.33 and 10.18. Please see 37 CFR 1.4(d) for the form of the signature.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	A150-102
	Application Number	
Title of Invention	POOL CLEANING SYSTEM AND METHOD	

Signature	/Keith Lindenbaum/			Date (YYYY-MM-DD)	2012-07-10
First Name	Keith	Last Name	Lindenbaum	Registration Number	40365

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 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 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.

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I HEREBY DECLARE:

THAT my residence, post office address, and citizenship are as stated below next to my name;

THAT I believe I am the original, first, and sole inventor (if only one inventor is named below) or an original, first, and joint inventor (if plural inventors are named below or in an attached Declaration) of the subject matter which is claimed and for which a patent is sought on the invention entitled

POOL CLEANING SYSTEM AND METHOD

(Attorney Docket No. A150-102)

the specification of which (check one):

X is attached hereto.

____ was filed on _____ as United States Application Number or PCT International Application Number _____ and was amended on _____ (if applicable).

THAT I do not know and do not believe that the same invention was ever known or used by others in the United States of America, or was patented or described in any printed publication in any country, before I (we) invented it;

THAT I do not know and do not believe that the same invention was patented or described in any printed publication in any country, or in public use or on sale in the United States of America, for more than one year prior to the filing date of this United States application;

THAT I do not know and do not believe that the same invention was first patented or made the subject of an inventor's certificate that issued in any country foreign to the United States of America before the filing date of this United States application if the foreign application was filed by me (us), or by my (our) legal representatives or assigns, more than twelve months (six months for design patents) prior to the filing date of this United States application;

THAT I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment specifically referred to above;

THAT I believe that the above-identified specification contains a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the invention, and sets forth the best mode contemplated by me of carrying out the invention; and

THAT I acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I HEREBY CLAIM foreign priority benefits under Title 35, United States Code §119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate, or §365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below any foreign application for patent or inventor's

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certificate or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number	Country	Foreign Filing Date	Priority Claimed?	Certified Copy Attached?

I HEREBY CLAIM the benefit under Title 35, United States Code § 119(e) of any United States provisional application(s) listed below.

U.S. Provisional Application Number	Filing Date

I HEREBY CLAIM the benefit under Title 35, United States Code, §120 of any United States application(s), or § 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application Number	PCT Parent Application Number	Parent Filing Date	Parent Patent Number

I HEREBY APPOINT the registered attorneys and agents at Customer Number

14326

PATENT TRADEMARK OFFICE

to have full power to prosecute this application and any continuations, divisions, reissues, and reexaminations thereof, to receive the patent, and to transact all business in the United States Patent and Trademark Office connected therewith.

Authorization to Permit Access to Application by Participating Offices

X If checked, the undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), and any other intellectual property offices in which a foreign application claiming priority to the above-identified application is filed access to the above-identified patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, or other intellectual property office in which a foreign application claiming party to the above-identified application is filed to have access to the application.

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Beatbot v. Zodiac, IPR2026-00200

In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the application-as-filed with respect to: 1) the above-identified application, 2) any foreign application to which the above-identified application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirements of 37 CFR 1.55 has been filed in the above-identified U.S. application, and 3) any U.S. application from which benefit is sought in the above-identified application.

In accordance with 37 CFR 1.14(c), axis may be provided to information concerning the date of filing the Authorization to Permit Axis to Application by Purchase paging Offices.

I request that all correspondence be directed to:

Keith D. Lindenbaum
Customer Number:
14326

PATENT TRADEMARK OFFICE

Telephone: (414) 839-7857
Facsimile: (262) 672-8313

I UNDERSTAND AND AGREE THAT the foregoing attorneys and agents appointed by me to prosecute this application do not personally represent me or my legal interests, but instead represent the interests of the legal owner(s) of the invention described in this application.

I FURTHER DECLARE THAT all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Name of first inventor	Kameshwar Duvvasula
Residence	Lyndhurst, New Jersey
Citizenship	~~United States~~ INDIA
Post Office Address	25 Rutgers Avenue, Cedar Grove, NJ 07009
Inventor's signature	
Date	10th July 2012
Name of second inventor	William Londono Correa
Residence	Bloomfield, New Jersey
Citizenship	United States
Post Office Address	25 Rutgers Avenue, Cedar Grove, NJ 07009
Inventor's signature	
Date	10th July 2012

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

Electronic Patent Application Fee Transmittal	
Application Number:	
Filing Date:	
Title of Invention:	POOL CLEANING SYSTEM AND METHOD
First Named Inventor/Applicant Name:	Kameshwar Durvasula
Filer:	Keith D. Lindenbaum/Janet Henning
Attorney Docket Number:	A150-102
Filed as Large Entity	

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Utility application filing	1011	1	380	380
Utility Search Fee	1111	1	620	620
Utility Examination Fee	1311	1	250	250
Pages:				
Claims:				
Independent claims in excess of 3	1201	1	250	250
Miscellaneous-Filing:				
Petition:				

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Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
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1	Abstract	A150-102_Abstract.pdf	63010 d0bfc9a9afc75b71012ba5ff2a5bc2296b3e1a41	no	1
Warnings:					
Information:					
2	Specification	A150-102_Specifications.pdf	142383 0eeb2239cbadc7bb666811565ae6fd430bdec3ce	no	14
Warnings:					
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3	Claims	A150-102_Claims.pdf	125998 8e5e7637904a9fcf30aefcc04b70a6dfb1e83642	no	4
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4	Drawings-only black and white line drawings	A150-102_Drawings.pdf	188199 0c9b40b97666cc167c74f06d98dee694c641c10c	no	4
Warnings:					
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5	Information Disclosure Statement (IDS) Form (SB08)	A150-102_IDS.pdf	612226 f56f4c496b5476a737b52a0db93b4d28f3aea079	no	5
Warnings:					
Information:					
6	Application Data Sheet	A150-102_ADS.pdf	1421144 99c295f42a7303b8756666ceb9d846efc3067587	no	5
Warnings:					
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Warnings:					
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8	Fee Worksheet (SB06)	fee-info.pdf	36480 ef1acce4f7bc682e7bf6a3d108270db4b52ffeb4	no	2
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ABSTRACT

A pool cleaning system utilizes a powered robotic surface cleaning vehicle to travel adjacent water containing surfaces of a pool while submerged within the pool. In one implementation, a camera captures movement of the vehicle. In one implementation, a dry station serve the intermediary across a wide area network between the vehicle and a server which communicates with the portable electronic device.

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POOL CLEANING SYSTEM AND METHOD

BACKGROUND

[0001] Manually cleaning the floor and sides of a swimming pool may be a tedious and time-consuming task. As a result, automated robotic pool cleaners have been developed. However, controlling and monitoring such automated robotic pool cleaners to insure that all portions of the pool surfaces are satisfactorily cleaned remains a challenge.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] Figure 1 is a schematic illustration of an example pool cleaning system.

[0003] Figure 2 is a schematic illustration of an implementation of the pool cleaning system of Figure 1.

[0004] Figure 2 is a schematic illustration of an implementation of the pool cleaning system of Figure 1.

[0005] Figure 3 is a schematic illustration of an implementation of the pool cleaning system of Figure 1.

[0006] Figure 4 is a schematic illustration of an implementation of the pool cleaning system of Figure 1.

[0007] Figure 5 is a schematic illustration of an implementation of the pool cleaning system of Figure 1.

[0008] Figure 6 is a flow diagram of an example method that may be carried out with the pool cleaning system of Figure 2-5.

[0009] Figure 7 is a plan view of an example display with an example graphical depiction.

[0010] Figure 8 is a plan view of another example display with an example graphical depiction.

[0011] Figure 9 is a schematic illustration of an implementation of the pool cleaning system of Figure 1 with an example pool cleaning vehicle.

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[0012] Figure 10 is a bottom perspective view of the example pool cleaning vehicle of the system of Figure 9.

DETAILED DESCRIPTION OF THE EXAMPLE EMBODIMENTS

[0013] Figure 1 schematically illustrates an example pool cleaning system 20. As schematically shown by Figure 1, pool cleaning system 20 is adapted to clean submerged surfaces of a pool 22 containing a liquid 24. In particular, pool cleaning system 20 is adapted to clean at least a bottom or floor surface 26 of the pool 22 and possibly to additionally clean surfaces 28 of pool 22. As will be described hereafter, pool cleaning system facilitates the control and monitoring of a robotic pool cleaner to better assure that all portions of pool 22 are satisfactorily cleaned.

[0014] Pool cleaning system 20 comprises vehicle 30, cameras 32 and controller 42. Vehicle 30 comprises an automated powered device configured to travel adjacent to submerged or water containing surfaces of pool 20 (such as floor 26 and/or side surfaces 28) while cleaning such surfaces. In one implementation, vehicle 30 may include vacuum or suction devices, a liquid circulation system and a filter to draw debris, such as bacterial growth or plant growth, from such pool surfaces, wherein the drawn liquid containing such residue or foreign matter is filtered to collect the debris. In other implementations, vehicle 30 may not collect such debris, wherein vehicle 30 merely loosens such debris on the pool surfaces such that the loosened or separated debris may be subsequently removed using the existing liquid filtering system of pool 22.

[0015] To assist in the loosening of debris, in one implementation, vehicle 30 may additionally include a chemical dispenser to closely apply pool cleaning chemicals to the pool surfaces as the vehicle 30 traverses such surfaces. In one implementation, vehicle 30 may additionally or alternatively include one or more scrubbing members, such as active (driven) or passive (undriven or idling) brushes, to assist in the removal of residue or foreign matter from such pool surfaces. In yet another implementation, vehicle 30 may additionally or alternatively include liquid jets to assist in the loosening of debris.

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[0016] To move along the submerged surfaces of pool 22, vehicle 30 includes one or more propulsion mechanisms. In one implementation, vehicle 30 is propelled along the submerged pool surfaces using wheels, rollers, tracks or other surface contacting members powered by a motor and the like. Such wheels, rollers or tracks may themselves include the scrubbing members used to clean the surfaces. In one implementation vehicle 30 may also alternatively be propelled by means of the vacuum or liquid jets. The vacuum or liquid jets used for such propulsion nozzle facilitate loosening of debris for collection by vehicle 30. In other implementations, vehicle 30 may include other propulsion mechanisms.

[0017] Cameras 32 comprise devices configured to capture video or time lapse images of pool 22. In the example illustrated, cameras 32 are mounted on structures external to pool 22. In other words, cameras 32 are not submerged. In other implementations, cameras 32 may alternatively be mounted to vehicle 30. In the example illustrated, cameras 32 capture movement of vehicle 30 while vehicle 30 is submerged within pool 22. In other implementations, cameras 32 merely capture images of submerged surfaces 26, 28 of pool 22.

[0018] In the example illustrated, cameras 32 comprise cameras serving as part of a home or pool security system, wherein such cameras detect the presence of a person at pool 22 satisfying a predefined characteristic and wherein an alert is output upon the person's detected presence. For example, in one implementation, cameras 32 are utilized as part of a security system that detects when a person below a predefined age, such as a child, is present at pool 22 without a detected presence of a recognized adult. In another implementation, cameras 32 may detect the presence of an unauthorized person or intruder at pool 22. Identification of the person may be achieved by an off-site human or computerized monitoring system, wherein signals from cameras 32 are transmitted across a wide area network or may be achieved with software of controller 42 which includes facial recognition or other identification programming.

[0019] Because pool cleaning system 20 utilizes pre-existing cameras 32 provided as part of a security system or shares the use of cameras 32 with such a home or pool

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security system, pool cleaning system 20 is easier to set up, less complex and less expensive. In other implementations, pool cleaning system 20 may utilize dedicated cameras 22 independent of any cameras associated with a home, facility or pool security system. In such an alternative system, cameras 32 may be more precisely focused upon pool 22 and surfaces 26, 28 while also including appropriate lenses or modifications to account for glare, refraction and the like to better facilitate the capture of surfaces and vehicle 30 which are submerged.

[0020] Controller 42 comprises one or more processing units in communication with vehicle 30 and cameras 32. For purposes of this application, the term "processing unit" shall mean a presently developed or future developed processing unit that executes sequences of instructions contained in a memory. Execution of the sequences of instructions causes the processing unit to perform steps such as generating control signals. The instructions may be loaded in a random access memory (RAM) for execution by the processing unit from a read only memory (ROM), a mass storage device, or some other persistent storage. In other embodiments, hard wired circuitry may be used in place of or in combination with software instructions to implement the functions described. For example, controller 42 may be embodied as part of one or more application-specific integrated circuits (ASICs). Unless otherwise specifically noted, the controller is not limited to any specific combination of hardware circuitry and software, nor to any particular source for the instructions executed by the processing unit.

[0021] In one implementation, controller 42 communicates with vehicle 30 and cameras 32 entirely across a wired connection. In another implementation, controller 42 communicates with vehicle 30 and cameras 32 across a wireless connection, such as cross a local area network (LAN) or a wide area network (WAN) such as the Internet. One of limitation, controller 42 may communicate with vehicle 30 and cameras 32 using a combination of both wired and wireless communication connections.

[0022] Controller 42 is configured to generate control signals for steering vehicle 30 based upon signals received from cameras 32. In one implementation, controller 42 provides the sole steering directions for vehicle 30 using signals from cameras 32.

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Because vehicle 30 is precisely steered under the control of controller 42, rather than traveling in a random manner, entire summer surfaces of pool 22 may be more quickly and efficiently covered and cleaned. Because controller 42 provides the only steering instructions for vehicle 30 and utilizes signals from cameras 32, complex steering algorithms or codes in either vehicle 30 or controller 42 may be omitted to reduce complexity and cost of system 20.

[0023] In another implementation, vehicle 30 may cover or travel across surfaces of pool 22 in either a random fashion or according to an automated pool coverage algorithm or pool coverage pattern stored in a memory associated with vehicle 30 or controller 42. In such an implementation, controller 42 utilizes signals from cameras 32 to verify that all of the surfaces of pool 22 have been cleaned, that no spots have been missed. Upon identifying a missed spot, controller 42 utilizes signals from camera 32 to steer vehicle 32 cover such missed portions of surfaces 26, 28. According to one example, controller 42 not only uses signals from camera 32 to determine whether any portions of surfaces 26, 28 have been missed entirely, but to also determine whether any portions of surfaces 26, 28 have been cleaned, but not to a satisfactory degree or extent. In such circumstances, controller 42 uses signals from cameras 32 to steer vehicle 34 such areas to re-clean such portions until such portions have been satisfactorily cleaned such that the portions have a cleanliness characteristic satisfying a predefined threshold.

[0024] Figure 2 schematically illustrates pool cleaning system 120, the particular example of pool cleaning system 20 described above. Pool cleaning system 120 is similar to pool cleaning system 20 except that pool cleaning system 120 additionally comprises dry station 46 and display 50. Those remaining components of pool cleaning system 120 which correspond to components of pool cleaning system 20 are numbered similarly.

[0025] Dry station 46 comprise a station in communication with vehicle 30 and cameras 32 outside of pool 22. Dry station 46 incorporates controller 42. In one implementation, dry station 46 communicates with vehicle 30 in a wired fashion. In such an implementation, dry station 46 further provides electrical power to vehicle 30 in a

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wired fashion. Dry station 46 communicates with cameras 32 and either a wired or wireless fashion.

[0026] Display 50 comprises a device to present a graphical images and text on a display screen. In one implementation, display 58 may be incorporated as part of dry station 46. In another implementation, display 50 may be provided on a portable electronic device, a computer, a television and the like. Display 50 is utilized by pool cleaning system 120 to present information regarding the cleaning of pool 22 to facilitate control of vehicle 30 by controller 42. In one implementation, display 50 is utilized by pool cleaning system 120 and a controller 42 to present a graphical depiction of those portions of surfaces 26, 28 of pool 22 have not been satisfactorily cleaned so as to satisfy a predefined cleanliness characteristic threshold. Such portions may comprise portions that have been completely missed by vehicle 30 as well as those portions that have been covered by vehicle 30 but have not been satisfactorily cleaned with the given number of passes of vehicle 30 or the existing cleaning settings of vehicle 30. The graphical depiction presented on display 50 enables a person view the quality of the prior cleaning session and to input commands causing controller 42 to generate control signals using signals from camera 32 to steer vehicle 30 back to such identified portions where such portions may be cleaned at the same or elevated cleaning aggressiveness settings.

[0027] Another implementation, display 50 may be further utilized by controller 42 to depict the progress of vehicle 30 in cleaning pool 22. Such a display 50 allows a person to visually determine how much of the pool has been currently cleaned and to estimate the remaining time before the pool cleaning task is completed. In certain circumstances, using display 50, a person may adjust a setting of vehicle 30 to accelerate a rate at which surfaces 26, 20 of pool 22 are cleaned to meet an earlier desired completion time for such pool cleaning.

[0028] Figure 3 schematically illustrates pool cleaning system 220, another example implementation of pool cleaning system 20. Pool cleaning system 220 is similar to pool cleaning system 20 except that pool cleaning system 220 additionally comprises dry station 246, display 50, and remote server 254. Those remaining components of pool

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cleaning system 220 which correspond to components of pool cleaning system 20 or pool cleaning system 120 are numbered similarly.

[0029] Dry station 246 is similar to dry station 46, described above, except that dry station 246 serves as a local interface for communication with controller 42 across a network 260. In one implementation, network 260 may comprise a local area network. In another implementation, network 260 may comprise a wide area network, such as the Internet. For example, in one implementation, dry station 246 may incorporate a modem. In one implementation, dry station 246 may communicate across a local area network to controller 42. In another implementation, dry station 246 may communicate through a router, across a local area network, to a local modem which communicates across a network 260. The example illustrated, dry station 246 further provides part of vehicle 30 across a wired cable or wired connection. Display 50 is described above with respect to system 120.

[0030] Remote server 254 comprises a server remote from dry station 246 which is in communication with dry station 246 across network 260. Remote server 254 includes controller 42. During operation, signals from cameras 32 are transmitted across dry station 246 across network 260 to controller 42 of remote server 254. Based upon such signals from cameras 32, controller 42 generates control signals which are transmitted back across network 260 and through dry station 246 to vehicle 30 to steer vehicle 30.

[0031] As shown by Figure 3, remote server 254 and network 260 may be shared as part of other pool cleaning systems 320, wherein controller 42 generates control signals for steering the pool cleaning vehicle 30 of system 320 based upon signals from cameras 32 transmitted across dry station 246 of system 320. In such an implementation, the cost and complexity of pool cleaning system 220 is reduced since controller 42 is remotely provided at remote server 254 which services multiple pool cleaning systems 220, 320. Upgrades to controller 42 and its software are also more easily achieved for all pool cleaning systems to 20, 320 and their pools 22, 222 being serviced. In one implementation, the supervised cleaning, inspection and possible re-cleaning facilitated by the use of cameras 32 may be provided as part of a subscription to users of vehicle 30.

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In such an implementation, a pool 22 having security cameras 32 may be upgraded with appropriate software or an appropriate software module added to dry station 246 to make a network connection with controller 42 which directs the security cameras 32 to capture vehicle 3020 utilizes such signals for steering vehicle 30.

[0032] Figure 4 schematically illustrates pool cleaning system 420, another particular implementation of pool cleaning system 20. Pool cleaning system 420 is similar to pull cleaning system 120 except that pool cleaning system 420 additionally comprises a portable electronic device 464. Those remaining components of pool cleaning system 420 which correspond to components of pool cleaning system 120 are numbered similarly.

[0033] Portable electronic device 464 comprises a portable handheld electronic device in communication with controller 42 and/or dry station 46 across network 260. Examples of such a portable electronic device (PED) 300 include, but are not limited to, a smart phone, a personal data assistant (PDA), laptop, notebook computer, tablet computer (e.g. IPAD) and MP3 player (e.g., IPOD TOUCH). In the example illustrated, PED 464 comprises input 466 and display 468.

[0034] Input 466 serves as a user interface for PED 464 by which inputs are made to PED 464. Input 466 facilitates entry of inputs or commands by a person to cause controller 42 to generate control signals varying the control of vehicle 30. In one implementation, input 466 comprise a keyboard. In other implementations, input 466 may comprise a touchpad, a stylus, a microphone with associated speech recognition software or programming, a touch screen, buttons, switches and the like. In some implementations, input 466 may comprise a touch screen incorporated as part of display 468.

[0035] Display 468 comprises a user interface by which graphical or textual data is presented to a user. Display 468 may present the same or similar information as presented at dry station 246 by display 50 as described above. In one implementation, display 468 comprises a liquid crystal display. In other implementations, display 468 may comprise other types of display technology such as a light emitting diode display, an

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organic light emitting diode display (OLED), an electronic ink (e-ink) display or other types of display technology in present use or developed in the future. Although system 420 is illustrated as including controller 422 is part of dry station 46, in some implementations, controller 42 may alternatively be located as part of PED 464.

[0036] PED 464 enables a person located remote from pool 22 to monitor the progress of the cleaning of pool 22 by vehicle 30 of system 420. PED 464 provides a person with a graphical presentation (described above with respect to display 50) indicating those portions of surfaces 26, 28 of pool 22 that have been completed as well as those portions 26, 20 and that remain to be cleaned. The person may also be provided with a graphical indication of what portions need to be re-cleaned to meet predetermined cleanliness thresholds. In the example illustrated, input 466 enables a person to enter commands or selections which are transmitted across network 260 to controller 42 to adjust operation of vehicle 30. For example, the path or route of vehicle 30 may be changed, the aggressiveness of the cleaning chemicals or mechanical cleaning devices may be adjusted, the speed at which vehicle 30 traverses surfaces 26, 28 may be adjusted. In response to such adjustment signals from PED 464, controller 42 may utilize signals from cameras 32 to adjust the steering of vehicle 30.

[0037] Figure 5 schematically illustrates pool cleaning system 520, another example implementation of pool cleaning system 20. Pool cleaning system 520 is similar to pool cleaning system 420 except that pool cleaning system 520 additionally comprises a remote server 554. Those remaining components of pool cleaning system 520 which correspond to components of pool cleaning system 420 are numbered similarly.

[0038] Remote server 554 is similar to remote server 254 described above with respect to system 220. Remote server 554 comprises a server remote from dry station 246 which is in communication with dry station 246 across network 260. Remote server 254 includes controller 42. During operation, signals from cameras 32 are transmitted across dry station 246 across network 260 to controller 42 of remote server 254. Based upon such signals from cameras 32, controller 42 generates control signals which are transmitted back across network 260 and through dry station 246 to vehicle 30 to steer

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vehicle 30. Controller 42 further relays either the raw signals from camera 32 or image signals generated based upon signals from cameras 32 to PED 464, wherein such images (described above) are presented on display 468. As noted above, PED may further receive commands through input 466, wherein such commands are transmitted to controller 42 which generates control signals that are ultimately transmitted to vehicle 30 for steering vehicle 30.

[0039] As with remote server 254, remote server 554 and network 260 may be shared as part of other pool cleaning systems 320 (shown in Figure 3), wherein controller 42 generates control signals for steering the pool cleaning vehicle 30 of system 320 based upon signals from cameras 32 transmitted across dry station 246 of system 320. In such implementations, controller 42 of remote server 554 may interact with other PEDs 464. In such an implementation, the cost and complexity of pool cleaning system 220 is reduced since controller 42 is remotely provided at remote server 254 which services multiple pool cleaning systems 220, 320. Upgrades to controller 42 and its software are also more easily achieved for all pool cleaning systems to 20, 320 and their pools 22, 222 being serviced. In one implementation, the supervised cleaning, inspection and possible re-cleaning facilitated by the use of cameras 32 may be provided as part of a subscription to users of vehicle 30. In such an implementation, a pool 22 having security cameras 32 may be upgraded with appropriate software or an appropriate software module added to dry station 246 to make a network connection with controller 42 which directs the security cameras 32 to capture vehicle 3020 utilizes such signals for steering vehicle 30. As indicated by broken lines, in other implementations, the controller 42 for generating control signals steering vehicle 30 based upon signals from cameras 32 may alternatively be relocated in PED 464.

[0040] Figure 6 is a flow diagram illustrating an example method 600 that may be carried out by any of systems 120-520. As indicated by step 602, cameras 32 capture images of pool cleaning by vehicle 30. As indicated by step 604, controller 42 obtain such signals from cameras 32 for the surfaces of pool 22 that have been cleaned. As indicated by step 606, controller 42 uses information gathered from the signals from

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cameras 32 to identify those portions of surfaces 26, 28 not satisfactorily cleaned--not satisfying a predefined cleanliness characteristic or measurement threshold. One example of a cleanliness characteristic measurement a threshold may be how well the color of a surface matches a predetermined desirable color for the pool surface (such as original color of the tile or surface). A surface that has been missed entirely by vehicle 30 during a pool cleaning session may be automatically deemed to not satisfy a predetermined cleanliness characteristic.

[0041] As indicated by step 608, based upon such determinations, controller 42 generates control signals resulting in the presentation of a graphical depiction of those portions of pool 22 that has not been satisfactorily cleaned. Such graphical representations or depictions may be presented on display 50 or display 468. Figures 7 and 8 illustrate examples of graphical depictions that may be presented.

[0042] Figure 7 illustrates display 468 presenting graphical depiction 620. Graphical depiction 620 comprises a first graphic 622 having a first portion 624 representing sides or walls 28 of pool 22 and a second portion 626 representing the floor 26 of pool 22. Graphical depiction 620 further comprises a moving icon 628 representing the current positioning of vehicle 30. In one implementation, the path of vehicle 30 may additionally be depicted by icon 628 shown in broken lines. As shown by Figure 7, those portions 632 of surfaces 26, 28 of pool 22 (shown in Figure 1) over which of vehicle 30 has moved are identified by graphical depiction 620 either by color, markings or other various distinctive attributes. Likewise, those portions 634 of surfaces 26, 28 of pool 22 that have not been covered by vehicle 30 are identified by a distinct color col marking or distinctive attribute of depiction 620. As a result, a person may view the current position of vehicle 30, the extent to which pool 22 has been cleaned or covered by vehicle 30 and the extent of pool 22 that remains to be cleaned. In the example illustrated, depiction 620 further identifies those portions 638 of surfaces 26, 28 that have been cleaned, but which have not been cleaned to a satisfactory degree or extent. In one implementation, portions 638 may be identified by colors, brightnesses, markings or other visually distinctive attributes that are visually distinct from both portions 632 and portions 634. In other

implementations, portions 638 may have the same characteristic of portions 634. In yet other implementations, different portions 638 may have different visual attributes depending upon a degree to which such clean portions have failed to satisfy the predefined cleanliness characteristic threshold. In some implementations, different port 638 may have different visual attributes depending upon different cleaning strategies that may be recommended for the different portions 638. For example, controller 42 may determine and recommend a first cleaning strategy (a first chemical solution jetted at a first rate and scrubbed at a first rate) with respect to a first portion 638 and may recommend a second different cleaning strategy (a second chemical solution jetted at a second rate is about a second rate) with respect to a second portion 638, wherein the different cleaning strategies are represented by different visual attributes presented in depiction 620.

[0043] Figure 8 illustrates display 468 presenting a graphical depiction 720. Graphical depiction 720 comprises a first graphic 622 having a first portion 624 representing sides or walls 28 of pool 22 and a second portion 626 representing the floor 26 of pool 22 (shown in Figure 1). Graphical depiction 720 is similar to graphical depiction 620 except that graphical depiction 720 omits icon 628 presenting vehicle 30. Like depiction 620, depiction 720 graphically depicts those portions 632 of surfaces 26, 28 over which vehicle 30 has traveled while in a cleaning mode. Depiction 720 also visually depicts those portions 634 that have not been covered by vehicle 30 in the cleaning mode and those portions 638 over which vehicle 30 has traveled while in the cleaning mode, but which have not been cleaned to a satisfactory degree. As illustrated in Figure 8, different portions 638 may be visibly distinguished from one another through color, text or markings indicating either differences in the cleanliness of such portions 638 or indicating different recommended cleaning strategies or approaches that may be selected by a person using input 466 when vehicle 30 is steered back to such portions 638 for re-cleaning using signals from camera 32.

[0044] As indicated by step 610 of Figure 6, controller 42 generates control signals steering vehicle 30 to re-clean portions of pool 22, such as portions 638. Such steering

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may be facilitated by using signals from cameras 32. As noted above, in some implementations, a person may be allowed choose a cleaning approach for a particular portion 638 using input 466. The selection may be facilitated by visual inspection of the different visual attributes for the particular portion 638 provided by depiction 720 (or depiction 620). In some implementations, input 466 may additionally be utilized by a person to prioritize an order in which portions 638 are re-cleaned.

[0045] Figure 9 illustrates pool cleaning system 820, an example implementation of pool cleaning system 20. Pool cleaning system 820 is similar to pool cleaning system 520 except the pool cleaning system 820 located controller 42 in dry station 246 and includes pool cleaning vehicle 830, a specific example of vehicle 30. As shown by Figure 9, in addition to transmitting control signals generated by controller 42 to vehicle 830, dry station 246 further transmits power from power source 831 through a power line or power cable 833 to vehicle 830. In the example illustrated, data communication and communication of control signals, also occurs across wired connections within or alongside the same line 833. In the example illustrated, remote server 554 serves as a communication link by which upgrades to controller 42 may be implemented across a wide number of pool cleaning systems and by which information from controller 42 is conveyed to one or more portable electronic devices 464 across network 260.

[0046] Vehicle 830 comprises a robotic or automated pool cleaning device. Vehicle 830 comprises a self-contained onboard filtration system with drive and pump motors. Vehicle 830 utilizes an internal microprocessor guided drive motor to systematically clean surfaces of pool 22. As shown by Figure 9 and 10, vehicle 830 utilizes a toothed track drive 900 provide traction and propulsion for vehicle 30. Vehicle 830 comprises rotating brushes 902 to loosen waterline buildup and breakdown large debris while power washing jets 904 flush out dirt from pores, seems in corners where brushes 902 may not be able to reach. The loosened dirt and debris is vacuumed through off-center vacuum ports 906 which passes the vacuumed debris through internally house filter bag. In the example illustrated, vehicle 830 further comprises rollers 908 which inhibit vehicle 830 from becoming impeded or stuck on raised drains or pop-up heads. Although illustrated

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as being employed with system 820, vehicle 830 may also be utilized with any of systems 20, 120, 220, 320 and 420. In other implementations, other robotic or automated pool cleaning vehicles may be utilized.

[0047] Although the present disclosure has been described with reference to example embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the claimed subject matter. For example, although different example embodiments may have been described as including one or more features providing one or more benefits, it is contemplated that the described features may be interchanged with one another or alternatively be combined with one another in the described example embodiments or in other alternative embodiments. Because the technology of the present disclosure is relatively complex, not all changes in the technology are foreseeable. The present disclosure described with reference to the example embodiments and set forth in the following claims is manifestly intended to be as broad as possible. For example, unless specifically otherwise noted, the claims reciting a single particular element also encompass a plurality of such particular elements.

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WHAT IS CLAIMED IS:

1. A pool cleaning system comprising:

a powered robotic surface cleaning vehicle to travel adjacent water containing surfaces of a pool while submerged within the pool;

a camera adapted to be mounted external the pool to capture movement of the vehicle while submerged within the pool; and

a controller to generate control signals steering the vehicle based on the signals from the camera.

2. The system of claim 1 further comprising a station remote from the vehicle and in communication with the vehicle, wherein the station includes the controller.

3. The system of claim 1 further comprising a station remote from the vehicle and in communication with the vehicle, wherein the controller is located remote from the vehicle and the station.

4. The system of claim 1 further comprising a portable electronic device in communication with the camera, with the portable electronic device includes a controller.

5. The system of claim 1 further comprising a portable electronic device having a display, wherein the portable electronic device is configured to present a graphic on the display, the graphic depicting water containing surfaces of the pool and those portions of the water containing surfaces that remain uncleaned as a vehicle traverses the water containing surfaces.

6. The system of claim 5, wherein the portable electronic device depicts movement of the vehicle on the display.

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7. The system of claim 1, wherein the controller generates second control signals steering the vehicle based on a coverage algorithm independent of signals from the camera and wherein the control signals based on the captured coverage steer the vehicle to clean portions of the water containing surfaces missed by the vehicle while being steered according to the second control signals.

8. The system of claim 1, wherein the portable electronic device is configured to output an alert based on signals from the camera indicating presence of a person at pool satisfying a predefined characteristic.

9. The system of claim 1 further comprising:

a portable electronic device having a display; and

sensors carried by the vehicle, wherein the display presents information based on characteristics of the water containing surfaces of the pool sensed by the sensors.

10. The system of claim 1 further comprising a server remote from the camera and the vehicle, the server comprising the controller, wherein the controller generates control signals for steering a plurality of vehicles across a plurality of pools based on signals from a plurality of cameras associated with the plurality of pools.

11. The system of claim 1 further comprising sensors carried by the vehicle to sense the water containing surfaces of the pool after the water containing surfaces of the pool have been cleaned by the vehicle during a pass of the vehicle under control of a pool coverage algorithm, wherein the control signals steer the vehicle so as to reclean the water containing surfaces having a cleanliness characteristic sensed by the sensors failing to satisfy a predefined threshold.

12. An apparatus comprising:

a non-transient computer-readable medium comprising code configured to cause a processor to:

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obtain signals from a camera representing water containing surfaces of a pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool;

identify portions of the water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle to satisfy a predefined threshold;

present a graphical depiction of the identified portions.

13. The apparatus of claim 12, wherein the code is further configured to direct the processing unit to generate control signals steering the robotic pool cleaning vehicle so as to clean the identified portions.

14. The apparatus of claim 12 further comprising a portable electronic device comprising:

a processing unit;

a display to present the graphical depiction; and

the non-transient computer readable medium.

15. A method comprising:

capturing images of a pool being cleaned with a robotic pool cleaning vehicle operating according to a steering algorithm;

obtaining signals from a camera representing water containing surfaces of the pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool;

identifying portions of the water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle to satisfy a predefined threshold;

presenting a graphical depiction of the identified portions.

16. The method of claim 15 further comprising steering the robotic pool cleaning vehicle based upon signals from the camera to reclean the identified portions.

17. A pool cleaning system comprising:

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a powered robotic pool cleaning vehicle to travel adjacent to water containing surfaces of a pool while submerged within the pool;

a dry station remote from the pool and in communication with the vehicle;

a server in communication with the dry station across a wide area network; and

a portable electronic device in communication with the server.

18. The system of claim 17, further comprising:

one or more processing units;

at least one non-transient computer-readable medium comprising code configured to direct the one or more processing units to cause the portable electronic device to display coverage of the water containing surfaces of the pool by the vehicle.

19. The system of claim 18 further comprising a camera to capture movement of the vehicle while the vehicle is submerged within the pool.

20. The system of claim 19, wherein the camera comprises a pool security camera and wherein the at least one non-transient computer-readable medium causes the portable electronic device to output an alert based on signals from the camera indicating presence of a person at pool satisfying a predefined characteristic.

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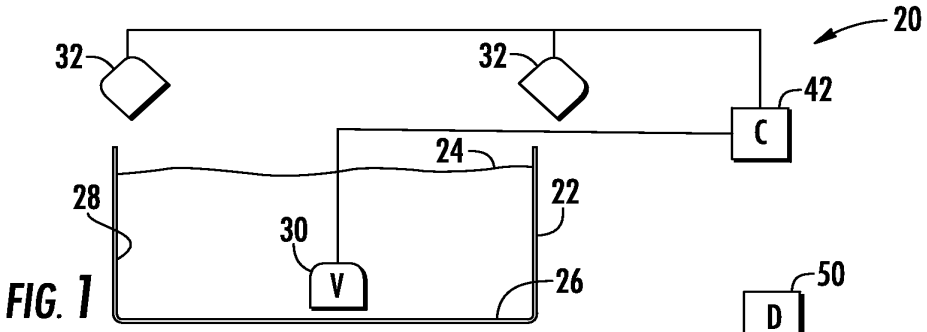

FIG. 1

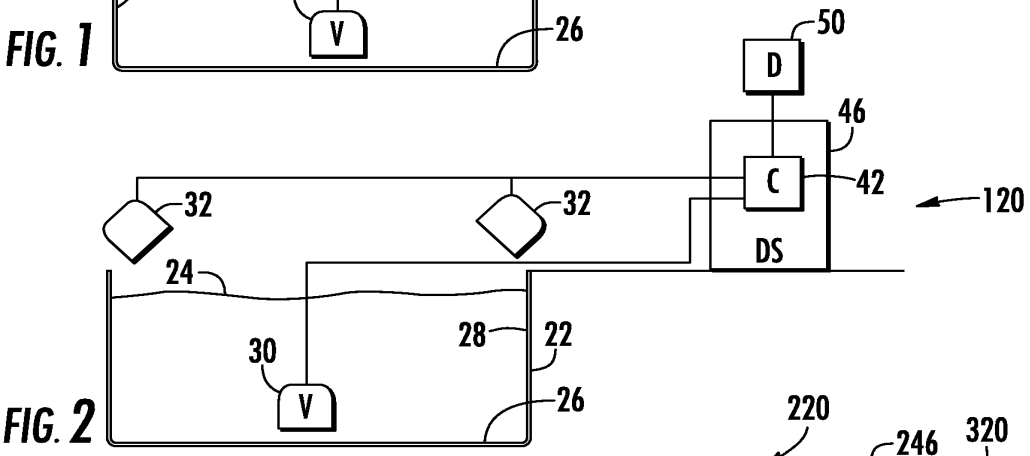

FIG. 2

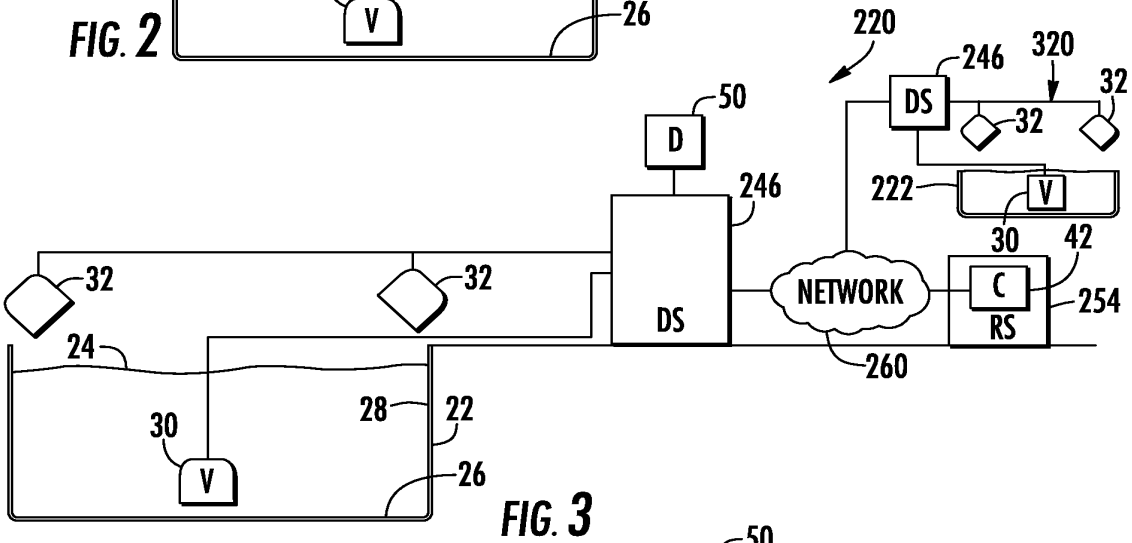

FIG. 3

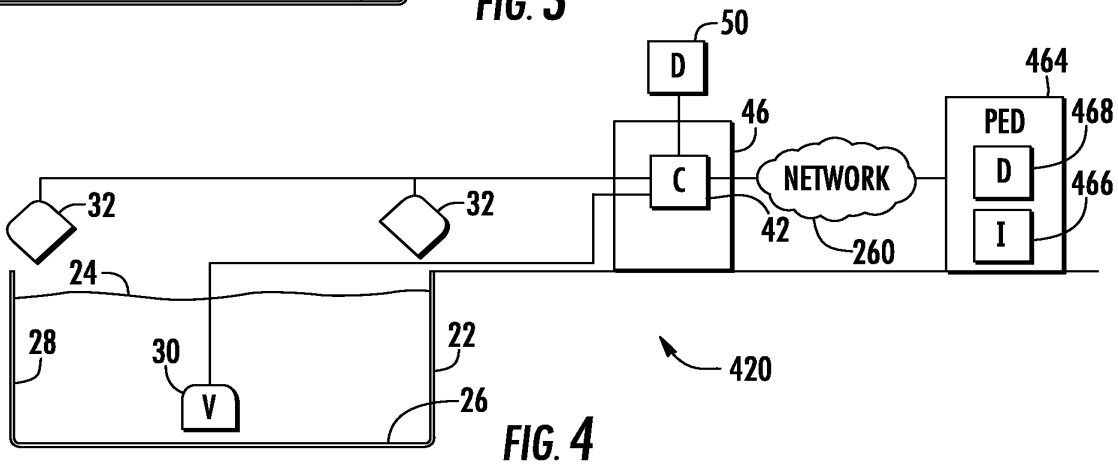

FIG. 4

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Beatbot v. Zodiac, IPR2026-00200

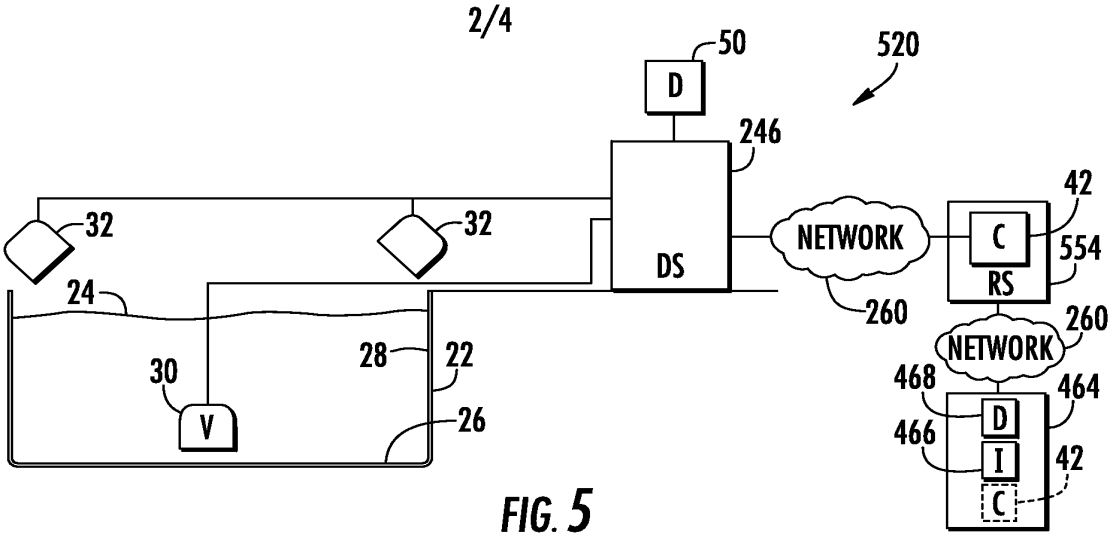

FIG. 5

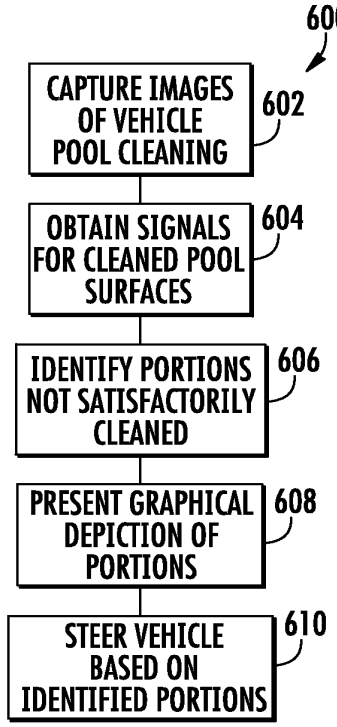

FIG. 6

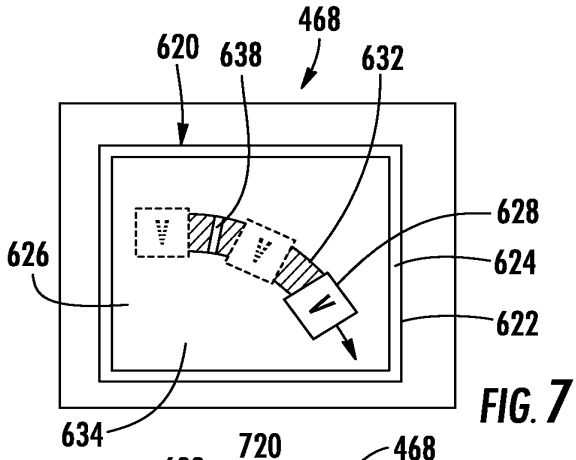

FIG. 7

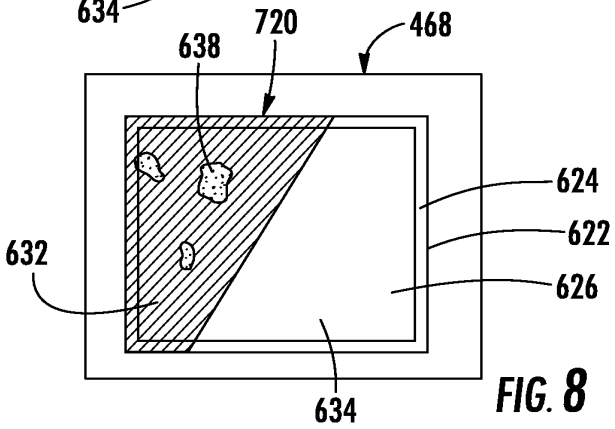

FIG. 8

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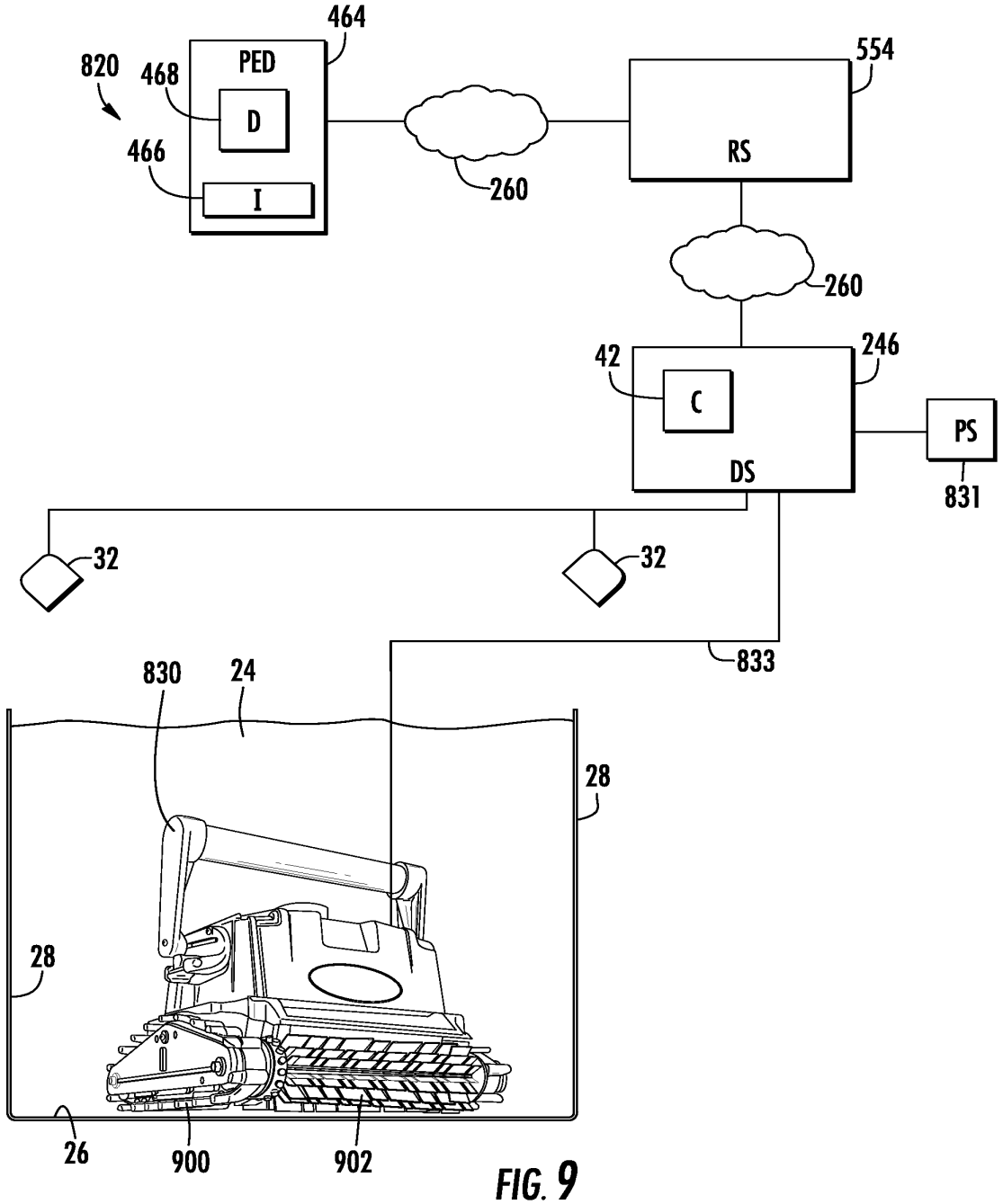

FIG. 9

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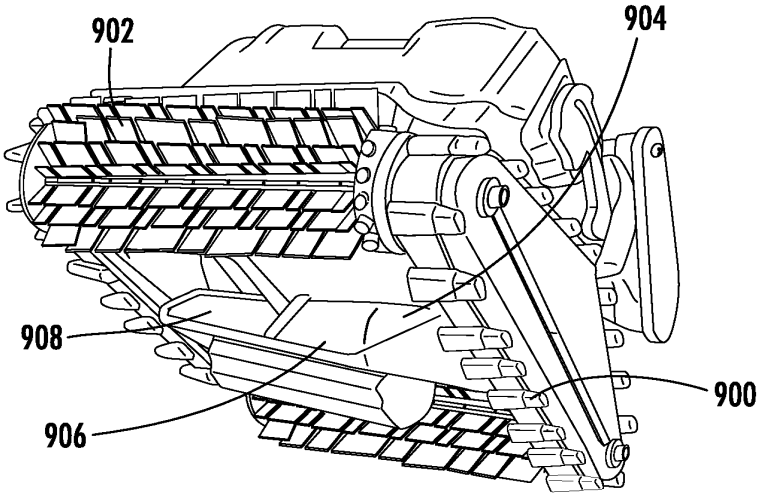

FIG. 10

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Beatbot v. Zodiac, IPR2026-00200

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 13/545,918

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			N/A	380
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	620
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	250
TOTAL CLAIMS (37 CFR 1.16(i))	20 minus 20 =	*			OR	x 60 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	4 minus 3 =	* 1				x 250 =	250
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).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1500

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	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
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.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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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
13/545,918	07/10/2012	1778	1500	A150-102	20	4

CONFIRMATION NO. 9590

14326
Rathe Lindenbaum LLP
10611 W. Hawthrone Farms Lane
Mequon, WI 53097

FILING RECEIPT

OC000000055516502

Date Mailed: 07/24/2012

Receipt is acknowledged of this non-provisional 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 APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

Kameshwar Durvasula, Lyndhurst, NJ;
William Londono Correa, Bloomfield, NJ;

Assignment For Published Patent Application

AQUA PRODUCTS, INC., Cedar Grove, NJ

Power of Attorney: The patent practitioners associated with Customer Number 14326

Domestic Priority data as claimed by applicant

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)

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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 13/545,918**

Projected Publication Date: 01/16/2014

Non-Publication Request: No

Early Publication Request: No

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

Title

POOL CLEANING SYSTEM AND METHOD

Preliminary Class

210

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APPLICATION NUMBER	PATENT NUMBER	GROUP ART UNIT	FILE WRAPPER LOCATION
13/545,918		2486	

OC000000068379627

Correspondence Address/Fee Address Change

The following fields have been set to Customer Number 112708 on 04/09/2013

- **Correspondence Address**

The address of record for Customer Number 112708 is:

112708
Rathe Lindenbaum LLP
700 W. Virginia Street
Suite 302
Milwaukee, WI 53204

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page 1 of 1

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/545,918	07/10/2012	Kameshwar Durvasula	A150-102

CONFIRMATION NO. 9590

112708
Rathe Lindenbaum LLP
700 W. Virginia Street
Suite 302
Milwaukee, WI 53204

PUBLICATION NOTICE

OC000000066120448

Title:POOL CLEANING SYSTEM AND METHOD

Publication No.US-2014-0015959-A1
Publication Date:01/16/2014

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The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

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THIRD-PARTY SUBMISSION UNDER 37 CFR 1.290
CONCISE DESCRIPTION OF RELEVANCE

Application Number	13545918

U.S. PATENTS

Cite No	Patent Number	Concise Description of Relevance
1	5886630	Basis and contents of observations may be viewed in the attached uploaded Word file document.
2	7362351	Basis and contents of observations may be viewed in the attached uploaded Word file document.
3	7123746	Basis and contents of observations may be viewed in the attached uploaded Word file document.

U.S. PATENT APPLICATION PUBLICATION

Cite No	Publication Number	Concise Description of Relevance
1	20130151061	Basis and contents of observations may be viewed in the attached uploaded Word file document.

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2	20140009748	Basis and contents of observations may be viewed in the attached uploaded Word file document.
3	20040040581	Basis and contents of observations may be viewed in the attached uploaded Word file document.
4	20130269097	Basis and contents of observations may be viewed in the attached uploaded Word file document.

FOREIGN PATENT DOCUMENTS		
CiteNo	**Foreign Document Number**	**Concise Description of Relevance**

NON-PATENT PUBLICATIONS		
Cite No	**Reference**	**Concise Description of Relevance**

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PTO/SB/429(08-12)
Approved for use through 07/31/2015. OMB 0651-0031
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THIRD-PARTY SUBMISSION UNDER 37 CFR 1.290	Application Number	13545918

U.S. PATENTS				
Cite No	Patent Number	Kind Code [1]	Issue Date (YYYY-MM-DD)	First Named Inventor
1	7123746		2006-10-17	Jerome Meniere
2	7362351		2008-04-22	Jerome Meniere
3	5886630		1999-03-23	EDOUARD MENOUD

U.S. PATENT APPLICATION PUBLICATIONS				
Cite No	Publication Number	Kind Code [1]	Publication Date (YYYY-MM-DD)	First Named Inventor
1	20130269097		2013-10-17	Fahad M. ALAMMARI
2	20040040581	A1	2004-03-04	Frederick Bruwer
3	20140009748	A1	2014-01-03	Alexander Leonessa
4	20130151061	A1	2013-06-13	Young Jin Hong

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THIRD-PARTY SUBMISSION UNDER 37 CFR 1.290	Application Number	13545918

FOREIGN PATENTS AND PUBLISHED FOREIGN PATENT APPLICATIONS						
Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[1]	Publication Date (YYYY-MM-DD)	Applicant, Patentee or First Named Inventor	T[5]
						☐

NON-PATENT PUBLICATIONS (e.g., journal article, Office action)			
Cite No	Author (if any), title of the publication, page(s) being submitted, publication date, publisher (where available), place of publication (where available).	T[5]	E[6]
		☐	☐

STATEMENTS

The party making the submission is not an individual who has a duty to disclose information with respect to the above-identified application under 37 CFR 1.56.

This submission complies with the requirements of 35 U.S.C. 122(e) and 37 CFR 1.290.

☒ The fee set forth in 37 CFR 1.290(f) has been submitted herewith.

☐ The fee set forth in 37 CFR 1.290(f) is not required because this submission lists three or fewer total items and, to the knowledge of the person signing the statement after making reasonable inquiry, this submission is the first and the only submission under 35 U.S.C 122(e) filed in the above-identified application by the party making the submission or by a party in privity with the party.

EFS Web 2.1.17

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THIRD-PARTY SUBMISSION UNDER 37 CFR 1.290	Application Number	13545918

Signature	/OREN RECHES/		
Name/Print	Oren Reches	Registration Number (if applicable)	53506

Examiner Signature		Date Considered	

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First reference – US patent application 2013015106 of Hong

20140015959 CLAIMS	**US20130151061 of Hong**	**Remarks**
1. A pool cleaning system comprising:	1. A cleaning robot comprising:	
a powered robotic surface cleaning vehicle to travel adjacent water containing surfaces of a pool while submerged within the pool;	[0002] The present invention relates to a cleaning robot and an underwater sediment cleaning apparatus and method and, more particularly, to a cleaning robot and an underwater sediment cleaning apparatus and method for cleaning sediment accumulated in a water tank.	**Hong** in [0002] describes a powered robotic surface cleaning vehicle to travel adjacent water containing surfaces of a pool while submerged within the pool;
a camera adapted to be mounted external the pool to capture movement of the vehicle while submerged within the pool; and a controller to generate control signals steering the vehicle based on the signals from the camera.	[0030] The controller may further comprise a camera unit controlling an image captured by a camera included in the cleaning robot, a light unit controlling the brightness of a light included in the cleaning robot, a sensor unit controlling a sensing signal generated from sensors included in the cleaning robot, and an automatic cleaning unit receiving location information from the cleaning robot and controlling the location of the cleaning robot. The camera unit, the light unit, the sensor unit and the automatic cleaning unit may be connected to the central processing unit, and the central processing unit may process control commands generated from the camera unit, the light unit, the sensor unit and the automatic cleaning unit. [0036] An automatic cleaning operation according to selection of the automatic cleaning mode may comprise a control step of receiving location information from the cleaning robot and controlling the location of the cleaning robot, a moving step of moving the cleaning robot along the route, a target	**Hong** teaches [0030] that processing unit or Controller generates control signals from camera signal captures. It may therefore be able to generate and memorize in the controller any steering commands based on signals from the camera. Hong further teaches [0036] that an Automatic steering mode differs from a Manual steering. Nevertheless, since Hong does anyway comprise of an automatic cleaning operation, it would have been obvious to Hong or to a person skilled in the art to either use the memorized generated camera signals to steer the vehicle in an Automatic mode and not solely in the Manual mode. It would have been equally obvious to keep the camera online in the Automatic mode and to combine camera signals with steering commands to steer the vehicle.

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	point arrival determination unit of determining whether the cleaning robot arrives at a target point, and a cleaning completion determination step of determining whether the cleaning robot reaches a final target point.	
5. The system of claim 1 further comprising a portable electronic device having a display, wherein the portable electronic device is configured to present a graphic on the display, the graphic depicting water containing surfaces of the pool and those portions of the water containing surfaces that remain unclean as a vehicle traverses the water containing surfaces.	[0030] The controller may further comprise a camera unit controlling an image captured by a camera included in the cleaning robot, a light unit controlling the brightness of a light included in the cleaning robot, a sensor unit controlling a sensing signal generated from sensors included in the cleaning robot, and an automatic cleaning unit receiving location information from the cleaning robot and controlling the location of the cleaning robot. The camera unit, the light unit, the sensor unit and the automatic cleaning unit may be connected to the central processing unit, and the central processing unit may process control commands generated from the camera unit, the light unit, the sensor unit and the automatic cleaning unit. [0031] The underwater sediment cleaning apparatus may further comprise an operation console set in a bag carried by an operator, connected to the controller and allowing the operator to operate the cleaning robot. [0134] The output plugs 365 provide power to a terminal, a portable device, etc. other than the operation console 400 using the power supplied to the controller 300. The LAN port 365 allows the terminal, portable device, etc. and the controller	Within the framework of a system comprising a camera adapted to be mounted external to the pool to capture movement of the vehicle while submerged within the pool; and a controller to generate control signals steering the vehicle based on the signals from the camera. **Hong** teaches in [0031] a portable electronic device that has a display that may be connected to a controller and/ or camera (or sensors) that may as per [0134] display the image or a graphic depiction of the pool water surfaces and those portions of the water containing surfaces that remain unclean. Or, in other words, as per [0153] the area which has been cleaned by the cleaning robot and the area which is not cleaned as the vehicle or pool cleaner traverses the water surfaces. Or, in other words, as per [0030] the system receives signals as to the location information and controlling the said location of the cleaning robot or "vehicle" as it traverses the water containing surfaces.

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	300 to exchange data. The image output port 367 transmits an image signal corresponding to an image photographed by the camera 168 to the operation console 400 such that a display 414 provided to the operation console 400 displays the image. [0153] It is possible to display the number of times cleaning is repeated, the area which has been cleaned by the cleaning robot 100 and the area which is not cleaned.	
6. The system of claim 5, wherein the portable electronic device depicts movement of the vehicle on the display.	[0031] The underwater sediment cleaning apparatus may further comprise an operation console set in a bag carried by an operator, connected to the controller and allowing the operator to operate the cleaning robot. [0153] it is possible to display the number of times cleaning is repeated, the area which has been cleaned by the cleaning robot and the area which is not cleaned. [0160] An automatic cleaning unit receiving location information from the cleaning robot and controlling the location of the cleaning robot	**Hong -** teaches in [0031] a portable electronic device or a console set in a bag carried by an operator AND in [0153] Hong depicts movement of the vehicle on the display or, in other words, displays the number of times cleaning is repeated, the area which has been cleaned by the cleaning robot and the area which is not cleaned. AND further, in [0160] Hong teaches receiving location information from the cleaning robot and controlling the location of the cleaning robot thereby depicting movement of the vehicle on display.
7. The system of claim 1, wherein the controller generates second control signals steering the vehicle based on a coverage algorithm independent of signals from the camera and wherein the control signals based on the captured coverage steer the vehicle to clean	[0152] the manual cleaning mode and the automatic cleaning mode can be selected according to a degree of contamination of the water stored in the water tank 10 in the mode setting step S140. Specifically, the manual cleaning mode can be selected (S140) when the internal state of the water tank 10 can be recognized with the camera 168 attached to the cleaning robot 100 due to a low degree of contamination. On the contrary, the automatic cleaning mode can be selected (S150) when the	Hong teaches in [0152] a choice between two coverage algorithms. The first - is an automatic steering of the vehicle that is independent of signals from the camera. This is relevant when there is a low degree of contamination or when the contamination is so high that the camera is practically inoperative due to low vision. The second coverage program is the manual cleaning mode that can be manually selected. It would have been obvious to a person skilled in the art to propose a relatively easy integration of the clean or dirty surfaces identification signals by the

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portions of the water containing surfaces missed by the vehicle while being steered according to the second control signals.	internal state of the water tank 10 is difficult to recognize with the camera 168 attached to the cleaning robot 100 due to a high degree of contamination. [0030] The controller may further comprise a camera unit controlling an image captured by a camera included in the cleaning robot...AND The camera unit, the light unit, the sensor unit and the automatic cleaning unit may be connected to the central processing unit, and the central processing unit may process control commands generated from the camera unit, the light unit, the sensor unit and the automatic cleaning unit.	camera into the automatic algorithm so that the second control signals steering the vehicle can adapt itself to new captured coverage [processed photos] and reroute to surfaces missed by the vehicle. Hong bases himself on [0030] that includes a central processing unit that is connected to the camera.

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8. The system of claim 1, wherein the portable electronic device is configured to output an alert based on signals from the camera indicating presence of a person at pool satisfying a predefined characteristic.	[0031] The underwater sediment cleaning apparatus may further comprise an operation console set in a bag carried by an operator, connected to the controller and allowing the operator to operate the cleaning robot. AND [0134] The output plugs 365 provide power to a terminal, a portable device, etc. other than the operation console 400 using the power supplied to the controller 300. The LAN port 365 allows the terminal, portable device, etc. and the controller 300 to exchange data. The image output port 367 transmits an image signal corresponding to an image photographed by the camera 168 to the operation console 400 such that a display 414 provided to the operation console 400 displays the image. [0135] The warning buzzer 372 generates alarm sound when a wrong operation occurs during operator's absence to inform the operator to know the wrong operation.	**Hong -** teaches in [0031] a portable electronic device or console that may be carried by the operator. Whereby the output alert is configured based on signals from camera or [0134] the image output port transmits an image signal corresponding to an image photographed by the camera to the operation console such that a display provided to the operation console displays the image. Hong further teaches in [0135] a warning buzzer or a device configured to output an alert on a portable electronic device or console; In other words, [0135] says that an alarm sound is generated when a wrong operation occurs to inform the operator to know the wrong operation. It would have been obvious to a person skilled in the art to include an indication of a presence of a person at pool as satisfying a predetermined requirement or a predefined characteristic.
9. The system of claim 1 further comprising: a portable electronic device having a display; and sensors carried by the	[0031] The underwater sediment cleaning apparatus may further comprise an operation console set in a bag carried by an operator, connected to the controller and allowing the operator to operate the cleaning robot. **[0134]** The output plugs 365 provide power to a	**Hong** teaches in [0031] a portable electronic device or a portable device having a display or a console that operates as per [0134] on which- as per [0030] - an information emanating from Sensors carried by the vehicle or included in the cleaning robot- may well also be Optical Sensors or Cameras - or a sensing

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vehicle, wherein the display presents information based on characteristics of the water containing surfaces of the pool sensed by the sensors.	terminal, a portable device, etc. other than the operation console 400 using the power supplied to the controller 300. The LAN port 365 allows the terminal, portable device, etc. and the controller 300 to exchange data. The image output port 367 transmits an image signal corresponding to an image photographed by the camera 168 to the operation console 400 such that a display 414 provided to the operation console 400 displays the image. [0030] The controller may further comprise a camera unit controlling an image captured by a camera included in the cleaning robot, a light unit controlling the brightness of a light included in the cleaning robot, sensing signal generated from sensors included in the cleaning robot, and an automatic cleaning unit receiving location information from the cleaning robot and controlling the location of the cleaning robot. The camera unit, the light unit, the sensor unit and the automatic cleaning unit may be connected to the central processing unit, and the central processing unit may process control commands generated from the camera unit, the light unit, the sensor unit and the automatic cleaning unit. [0153] it is possible to display the number of times cleaning is repeated, the area which has been cleaned by the cleaning robot and the area which is not cleaned.	signal generated from sensors included in the cleaning robot presents information based on characteristics of the water containing surfaces of the pool. Or, in other words, the camera unit, the light unit, the sensor unit and the automatic cleaning unit may be connected to the central processing unit, and the central processing unit may process control commands generated from the camera unit, the light unit, the sensor unit and the automatic cleaning unit - all may be displayed including the characteristics of the water containing surfaces of the pool sensed by the sensors or specifically, as per [0153], the number of times cleaning is repeated, the area which has been cleaned by the cleaning robot and the area which is not cleaned.
11. The system of claim 1 further comprising sensors carried by the vehicle to sense the water containing surfaces of the pool after	[0030] The controller may further comprise a camera unit controlling an image captured by a camera included in the cleaning robot, a light unit controlling the brightness of a light included in the cleaning robot, a sensor unit controlling a sensing	**Hong** in [0030] describes a wide range of sensors carried or included in the vehicle or the cleaning robot that are able to sense the water containing surfaces of the pool. Sensors Carried by The Vehicle may include - within such an array - speed sensors, optical

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the water containing surfaces of the pool have been cleaned by the vehicle during a pass of the vehicle under control of a pool coverage algorithm, wherein the control signals steer the vehicle so as to reclean the water containing surfaces having a cleanliness characteristic sensed by the sensors failing to satisfy a predefined threshold.	signal generated from sensors included in the cleaning robot, and an automatic cleaning unit receiving location information from the cleaning robot and controlling the location of the cleaning robot. [0153] it is possible to display the number of times cleaning is repeated, the area which has been cleaned by the cleaning robot 100 and the area which is not cleaned. [0175] If the cleaning robot 100 can move according to the forward movement command (S1672), the cleaning robot 100 moves forward. Here, although the cleaning robot 100 moves toward the target point at a speed lower than an input speed value since the cleaning robot 100 is moving forward on the route having a large amount of works, the cleaning robot 100 cannot arrive at the target point. A command of returning to the original position toward the target point is inputted to the cleaning robot 100 moving toward the target point according to the forward movement command, and the cleaning robot 100 moves backward to the original position (S1676). The forward movement command and the command of returning to the original position are repeated for a predetermined operating time. Accordingly, the cleaning robot 100 can repeat forward movement and backward movement toward the target point on the route having a large amount of works to handle the works.	sensors AND **Hong** in [0153] further describes the possibility to identify areas that have been cleaned by the vehicle or the cleaning robot. The cleaning may therefore be performed during a pass of the vehicle under control of a pool coverage algorithm wherein the control signals steer the vehicle so as to reclean the water containing surfaces having a cleanliness characteristic sensed by the sensors failing to satisfy a predefined threshold. In other words, **Hong** describes in [0175] a pool cleaner that comprises an algorithmic capacity to govern a travel forward at a sensed lower speed than an input or a threshold speed. The lower speed indicates a large amount of works that is the equivalent to an unclean surface so a new steering command is given to drive backward to the original position. As long as the cleanliness characteristic sensed by the sensors fails to satisfy a predefined threshold then according to **Hong** in [0175], a reclean command is issued in the form of a forward movement command and the reversing command of returning to the original position are repeated for a predetermined operating time or until the sensors send a signal that the cleanliness characteristic sensed are not failing to satisfy a predefined threshold.

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12. An apparatus comprising: a non-transient computer-readable medium comprising code configured to cause a processor to: obtain signals from a camera representing water containing surfaces of a pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool; identify portions of the water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle to satisfy a predefined threshold; present a graphical depiction of the identified portions.	[0002] The present invention relates to a cleaning robot and an underwater sediment cleaning apparatus [0175] If the cleaning robot 100 can move according to the forward movement command (S1672), the cleaning robot 100 moves forward. Here, although the cleaning robot 100 moves toward the target point at a speed lower than an input speed value since the cleaning robot 100 is moving forward on the route having a large amount of works, the cleaning robot 100 cannot arrive at the target point. A command of returning to the original position toward the target point is inputted to the cleaning robot 100 moving toward the target point according to the forward movement command, and the cleaning robot 100 moves backward to the original position (S1676). The forward movement command and the command of returning to the original position are repeated for a predetermined operating time. Accordingly, the cleaning robot 100 can repeat forward movement and backward movement toward the target point on the route having a large amount of works to handle the works. [0067] FIG. 17 is a view for explaining an algorithm of generating the detour of the cleaning robot in the cleaning method according to the automatic cleaning mode, shown in FIG. 14; and [0030] The controller may further comprise a camera unit controlling an image captured by a camera included in the cleaning robot, a light unit controlling the brightness of a light included in the cleaning robot, a sensor unit controlling a sensing signal generated from sensors included in the cleaning robot, and an automatic cleaning unit	**Hong** in [0002] states the invention relates to a cleaning robot and an underwater sediment cleaning apparatus. **Hong** describes in [0175] a pool cleaner that comprises an algorithmic capacity to govern a travel forward at a sensed lower speed than an input or a threshold speed. The lower speed indicates a large amount of works that is the equivalent to an unclean surface so a new steering command is given to drive backward to the original position. Such a description is equivalent to a Non Transient CRM comprising code. [0067] describes and explains the algorithm. **Hong's** [0030] cameras are able to obtain signals representing water containing surfaces of a pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool; or in other words, to obtain location information from the cleaning robot and controlling the location of the cleaning robot in the pool. Hong's camera in [0134] presents a graphical depiction of the identified portion or in other words, it transmits an image signal corresponding to an image photographed by the camera 168 to the operation console. AND As per Hong in [0153] and [175] it is possible identify portions of the water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle to satisfy a predefined threshold that was discussed above in claim 11. Namely, Hong says that a reclean command is issued in the form of a forward movement command and the reversing command of returning to the original position are repeated for a predetermined operating time or until the sensors send a signal that the cleanliness characteristic

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	receiving location information from the cleaning robot and controlling the location of the cleaning robot. The camera unit, the light unit, the sensor unit and the automatic cleaning unit may be connected to the central processing unit, and the central processing unit may process control commands generated from the camera unit, the light unit, the sensor unit and the automatic cleaning unit. AND [0134] The output plugs 365 provide power to a terminal, a portable device, etc. other than the operation console 400 using the power supplied to the controller 300. The LAN port 365 allows the terminal, portable device, etc. and the controller 300 to exchange data. The image output port 367 transmits an image signal corresponding to an image photographed by the camera 168 to the operation console 400 such that a display 414 provided to the operation console 400 displays the image. AND [0153] …. it is possible to display the number of times cleaning is repeated, the area which has been cleaned by the cleaning robot 100 and the area which is not cleaned.	sensed are not failing to satisfy a predefined threshold.
14. The apparatus of claim 12 further comprising a portable electronic device comprising: a processing unit; a display to present the graphical depiction; and the non-transient computer readable medium.	[0002] The present invention relates to a cleaning robot and an underwater sediment cleaning apparatus [0031] The underwater sediment cleaning apparatus may further comprise an operation console set in a bag carried by an operator, connected to the controller and allowing the operator to operate the cleaning robot.	**Hong** describes in [0002] an apparatus and in [0031] a portable electronic device. Comprising: In [0134] a processing unit or controller 300 to exchange data; and a display to present the graphical depiction or in other words: the image output port 367 transmits an image signal corresponding to an image photographed by the camera; whereby in [0029] [a] central processing unit may process control commands; and a non-transient computer readable

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	[0134] The output plugs 365 provide power to a terminal, a portable device, etc. other than the operation console 400 using the power supplied to the controller 300. The LAN port 365 allows the terminal, portable device, etc. and the controller 300 to exchange data. The image output port 367 transmits an image signal corresponding to an image photographed by the camera 168 to the operation console 400 such that a display 414 provided to the operation console 400 displays the image. [0029] The controller may further comprise a wheel driver controlling the moving operation of the cleaning robot, a screw driver controlling the rotation speed and rotation direction of a screw included in the cleaning robot, a tilt driver controlling the tilting angle of a tilting part included in the cleaning robot, and a pump driver controlling the operation of a suction pump included in the cleaning robot. The wheel driver, the screw driver, the tilt driver and the pump driver may be connected to the central processing unit, and the central processing unit may process control commands generated from wheel driver, the screw driver, the tilt driver and the pump driver. [0028] The controller may comprise a power supply connected to the cleaning robot through a power cable to provide power supplied from an external supply source to the cleaning robot, a communication unit connected to the cleaning robot through a communication cable to transmit/receive data to/from the cleaning robot, and a central processing unit controlling the power supplied to the cleaning robot and processing the data transmitted/received to/from the cleaning	medium or in other words per Hong [0028] A controller may comprise a […] communication unit connected to the cleaning robot through a communication cable to transmit/receive data to/from the cleaning robot, and a central processing unit controlling the power supplied to the cleaning robot and processing the data transmitted/received to/from the cleaning robot. Any person skilled in the art would include a non transient CRM as part of the data packages transmitted to and from the apparatus or cleaning robot.

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	robot.	
15. A method comprising: capturing images of a pool being cleaned with a robotic pool cleaning vehicle operating according to a steering algorithm; obtaining signals from a camera representing water containing surfaces of the pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool; identifying portions of the water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle to satisfy a predefined threshold; presenting a graphical depiction of the identified portions.	[0002] The present invention relates to a cleaning robot and an underwater sediment cleaning apparatus and method and, more particularly, to a cleaning robot and an underwater sediment cleaning apparatus and method for cleaning sediment accumulated in a water tank. [0030] The controller may further comprise a camera unit controlling an image captured by a camera included in the cleaning robot, a light unit controlling the brightness of a light included in the cleaning robot, a sensor unit controlling a sensing signal generated from sensors included in the cleaning robot, and an automatic cleaning unit receiving location information from the cleaning robot and controlling the location of the cleaning robot. The camera unit, the light unit, the sensor unit and the automatic cleaning unit may be connected to the central processing unit, and the central processing unit may process control commands generated from the camera unit, the light unit, the sensor unit and the automatic cleaning unit. AND [0067] FIG. 17 is a view for explaining an algorithm of generating the detour of the cleaning robot in the cleaning method according to the automatic cleaning mode, shown in FIG. 14; [0153] In the preparation step S100, it is possible to display the number of times cleaning is	**Hong** in [0002] teaches a method comprising: a pool being cleaned with a robotic pool cleaning vehicle or, in Hong's words: usage of a cleaning robot and an underwater sediment cleaning apparatus for cleaning sediment accumulated in a water tank. **In Hong** - describes in [0030] the capturing of images or that signals may be obtained from a camera representing water containing surfaces of the pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool; Hong further describes in [0067] the operating according to a steering algorithm or an algorithm of generating the detour of the cleaning robot in the cleaning method. Hong further describes in [0153] identifying portions of the water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle **In Hong** - describes in [0175] means to satisfy a predefined threshold by registering a slow steering movement as a threshold signal that the pool cleaner has encountered a large amount of works to handle or in other words a large quantity of dirt or detritus. **In Hong's** apparatus of presenting a graphical depiction of the identified portions or, in other words: The image output port transmits an image signal corresponding to an image photographed by the camera to the operation console such that a display provided to the operation console displays the image.

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	repeated, the area which has been cleaned by the cleaning robot 100 and the area which is not cleaned. [0175] If the cleaning robot 100 can move according to the forward movement command (S1672), the cleaning robot 100 moves forward. Here, although the cleaning robot 100 moves toward the target point at a speed lower than an input speed value since the cleaning robot 100 is moving forward on the route having a large amount of works, the cleaning robot 100 cannot arrive at the target point. A command of returning to the original position toward the target point is inputted to the cleaning robot 100 moving toward the target point according to the forward movement command, and the cleaning robot 100 moves backward to the original position (S1676). The forward movement command and the command of returning to the original position are repeated for a predetermined operating time. Accordingly, the cleaning robot 100 can repeat forward movement and backward movement toward the target point on the route having a large amount of works to handle the works. [0134] The output plugs 365 provide power to a terminal, a portable device, etc. other than the operation console 400 using the power supplied to the controller 300. The LAN port 365 allows the terminal, portable device, etc. and the controller 300 to exchange data. The image output port 367 transmits an image signal corresponding to an image photographed by the camera 168 to the operation console 400 such that a display 414 provided to the operation console 400 displays the image.	

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16. The method of claim 15 further comprising steering the robotic pool cleaning vehicle based upon signals from the camera to reclean the identified portions.	**[**0030] The controller may further comprise a camera unit controlling an image captured by a camera included in the cleaning robot, a light unit controlling the brightness of a light included in the cleaning robot, a sensor unit controlling a sensing signal generated from sensors included in the cleaning robot, and an automatic cleaning unit receiving location information from the cleaning robot and controlling the location of the cleaning robot. The camera unit, the light unit, the sensor unit and the automatic cleaning unit may be connected to the central processing unit, and the central processing unit may process control commands generated from the camera unit, the light unit, the sensor unit and the automatic cleaning unit. AND [0153] In the preparation step S100, it is possible to display the number of times cleaning is repeated, the area which has been cleaned by the cleaning robot 100 and the area which is not cleaned. AND [0175] If the cleaning robot 100 can move according to the forward movement command (S1672), the cleaning robot 100 moves forward. Here, although the cleaning robot 100 moves toward the target point at a speed lower than an input speed value since the cleaning robot 100 is moving forward on the route having a large amount of works, the cleaning robot 100 cannot arrive at the target point. A command of returning to the original position toward the target point is inputted to the cleaning robot 100 moving toward the target point according to the forward movement command, and the cleaning robot 100 moves	**Hong** in [0030], [0153], [0175] and in [0176] describes a method comprising steering the robotic pool cleaning vehicle based upon signals from the camera to move back and forth on an unclean stretch of surface to reclean the identified portions. Hong's method may therefore be able to generate and memorize in the controller any steering commands based on signals from the camera. Hong further teaches [0036] that an Automatic steering mode differs from a Manual steering. Nevertheless, since Hong's method does anyway comprise of an automatic cleaning operation, it would have been obvious to Hong or to a person skilled in the art to either use the memorized generated camera signals to steer the vehicle in an Automatic mode and not solely in the Manual mode. It would have been equally obvious to keep the camera online in the Automatic mode and to combine camera signals with steering commands to steer the vehicle.

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	backward to the original position (S1676). [0176] The forward movement command and the command of returning to the original position are repeated for a predetermined operating time. Accordingly, the cleaning robot 100 can repeat forward movement and backward movement toward the target point on the route having a large amount of works to handle the works.	
17. A pool cleaning system comprising: a powered robotic pool cleaning vehicle to travel adjacent to water containing surfaces of a pool while submerged within the pool; a dry station remote from the pool and in communication with the vehicle; a server in communication with the dry station across a wide area network; and a portable electronic device in communication with the server.	[0002] The present invention relates to a cleaning robot and an underwater sediment cleaning apparatus and method and, more particularly, to a cleaning robot and an underwater sediment cleaning apparatus and method for cleaning sediment accumulated in a water tank. [0126] Referring to FIG. 9, the controller 300 includes a power supply 310, a communication unit 320 and a central processing unit 330. The power supply 310 and the communication unit 320 are connected to the cleaning robot 100 and the central processing unit 330 through the power cable and the communication cable. The power supply 310 can supply power generated from the generator 502 shown in FIG. 7. Otherwise, the power supply 310 may use power provided by an external power supply source. [0068] FIG. 18 is a flowchart showing an operation of securing a moving route of the cleaning robot when the cleaning robot is moved according to the automatic cleaning mode in the underwater sediment cleaning method according to the present	**Hong** describes in [0002] the Pool Cleaning System that comprises a robotic pool cleaning vehicle. **Hong's** [0126] describes the power supplied to the cleaning system to make it a a powered robotic pool cleaning vehicle. Hong's [0068] describes the travel adjacent to water containing surfaces of a pool while submerged within the poo or, in other words: a moving route of the cleaning robot when the cleaning robot is moved according to the automatic cleaning mode in the underwater sediment cleaning method according to the present invention. **Hong** in [0027] further describes a Dry Station that is located remote from the pool. The said Station may be located in a dry operating room outside and away from the wet swimming pool environment. Hong in [0028] describes the said station may be in communication with the vehicle through a power cable to provide power supplied from an external supply source to the cleaning robot, a communication unit connected to the cleaning robot through a communication cable to transmit/receive data to/from

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	invention. [0027] The controller may be installed in an operating room which is located outside the water tank and movable. AND [0028] The controller may comprise a power supply connected to the cleaning robot through a power cable to provide power supplied from an external supply source to the cleaning robot, a communication unit connected to the cleaning robot through a communication cable to transmit/receive data to/from the cleaning robot, and a central processing unit controlling the power supplied to the cleaning robot and processing the data transmitted/received to/from the cleaning robot. [0031] The underwater sediment cleaning apparatus may further comprise an operation console set in a bag carried by an operator, connected to the controller and allowing the operator to operate the cleaning robot. AND [0134] The output plugs 365 provide power to a terminal, a portable device, etc. other than the operation console 400 using the power supplied to the controller 300. The LAN port 365 allows the terminal, portable device, etc. and the controller 300 to exchange data. The image output port 367 transmits an image signal corresponding to an image photographed by the camera 168 to the operation console 400 such that a display 414 provided to the operation console 400 displays the image.	the cleaning robot, and a central processing unit controlling the power supplied to the cleaning robot and processing the data transmitted/received to/from the cleaning robot. **Hong** in [0031] teaches a portable electronic device in communication with the server or in other words, Hong in [0134] describes the LAN port allows the terminal, portable device, etc. and the controller to exchange data. The controller will include, inter alia, signals from the camera, sensors of the vehicle.

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18. The system of claim 17, further comprising: one or more processing units; at least one non-transient computer-readable medium comprising code configured to direct the one or more processing units to cause the portable electronic device to display coverage of the water containing surfaces of the pool by the vehicle.	[0002] The present invention relates to a cleaning robot and an underwater sediment cleaning apparatus and method and, more particularly, to a cleaning robot and an underwater sediment cleaning apparatus and method for cleaning sediment accumulated in a water tank. [0031] The underwater sediment cleaning apparatus may further comprise an operation console set in a bag carried by an operator, connected to the controller and allowing the operator to operate the cleaning robot. AND [0134] The output plugs 365 provide power to a terminal, a portable device, etc. other than the operation console 400 using the power supplied to the controller 300. The LAN port 365 allows the terminal, portable device, etc. and the controller 300 to exchange data. The image output port 367 transmits an image signal corresponding to an image photographed by the camera 168 to the operation console 400 such that a display 414 provided to the operation console 400 displays the image. [0029] The controller may further comprise a wheel driver controlling the moving operation of the cleaning robot, a screw driver controlling the rotation speed and rotation direction of a screw included in the cleaning robot, a tilt driver controlling the tilting angle of a tilting part included in the cleaning robot, and a pump driver controlling the operation of a suction pump included in the cleaning robot. The wheel driver, the screw driver, the tilt driver and the pump driver may be connected to the central processing unit, and the central processing unit may process control	**Hong** describes in [0002] the Pool Cleaning System that comprises a robotic pool cleaning vehicle. **Hong** in [0031] describes a portable electronic device set in a bag carried by an operator, connected to the controller and allowing the operator to operate the cleaning robot. AND **Hong** in [0134] also describes a system that is able to exchange data whereby an image is transmitted by means of an image signal corresponding to an image photographed by a camera to an operation console that may be a portable device and thereby be able to cause to display coverage of the water containing surfaces of the pool by the vehicle. **Hong** in [0029] describes [a] central processing unit may process control commands; and a non-transient computer readable medium or in other words per Hong [0028]: A controller may comprise a […] communication unit connected to the cleaning robot through a communication cable to transmit/receive data to/from the cleaning robot, and a central processing unit controlling the power supplied to the cleaning robot and processing the data transmitted/received to/from the cleaning robot. Within the context of the claimed system Any person skilled in the art would include a non transient CRM as part of the data packages transmitted to and from the apparatus or cleaning robot.

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	commands generated from wheel driver, the screw driver, the tilt driver and the pump driver. [0028] The controller may comprise a power supply connected to the cleaning robot through a power cable to provide power supplied from an external supply source to the cleaning robot, a communication unit connected to the cleaning robot through a communication cable to transmit/receive data to/from the cleaning robot, and a central processing unit controlling the power supplied to the cleaning robot and processing the data transmitted/received to/from the cleaning robot.	
19. The system of claim 18 further comprising a camera to capture movement of the vehicle while the vehicle is submerged within the pool.	[0030] The controller may further comprise a camera unit controlling an image captured by a camera included in the cleaning robot, a light unit controlling the brightness of a light included in the cleaning robot, a sensor unit controlling a sensing signal generated from sensors included in the cleaning robot, and an automatic cleaning unit receiving location information from the cleaning robot and controlling the location of the cleaning robot. The camera unit, the light unit, the sensor unit and the automatic cleaning unit may be connected to the central processing unit, and the central processing unit may process control commands generated from the camera unit, the light unit, the sensor unit and the automatic cleaning unit. Independent Claim 15.: An underwater sediment cleaning apparatus comprising:	**Hong** in [0030] teaches a system further comprising a camera to capture movement of the vehicle . Hong's camera is positioned on-board the pool cleaner and is able to capture movement of the vehicle or in other words: receiving location information from the cleaning robot and controlling the location of the cleaning robot. Hong's Independent Claim 15 submerges the vehicle within the pool or a water tank.

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	a cleaning robot put into a water tank to suck contaminated water containing sediment in the water tank;	

Second reference – US patent 5886630 of Menoud

20140015959 CLAIMS	**US patent 5886630 of Menoud**	**Remarks**
1. A pool cleaning system comprising:		
a powered robotic surface cleaning vehicle to travel adjacent water containing surfaces of a pool while submerged within the pool;	18	**Menoud** (abstract) teaches of a device for monitoring the absence of motionless bodies in a swimming pool. Two cameras (1) provide for the permanent imaging of the bottom of the swimming pool. These images are first digitized and then processed by a computer. The superimposition of the two information permits analysis of substantially the entire the surface of the swimming pool in order to determine if a portion is masked by an obstacle. When such obstacle is detected, the duration of the presence of each masked pixel is analyzed. After a certain time delay, and for a minimum number of neighboring pixels, an alarm is generated.

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a camera adapted to be mounted external the pool to capture movement of the vehicle while submerged within the pool; and a controller to generate control signals steering the vehicle based on the signals from the camera.	Column 5, Line 54-55: one or several cameras can be placed above water level. Column 6, Line 18-20: The images of each camera are then delivered via the output of this camera control module 30 to the computer that processes the images-marks for visualization and setting off of an alarm when needed. Column 6, Line 63-66: [camera] provide[s] for the permanent imaging of the bottom of the swimming pool. These images are first digitized and then processed by a computer.	**Menoud** teaches in Column 5, Line 54-55, Column 6, Line 18-20, Column 6, Line 63-66 at least one camera adapted to be mounted external to the pool for observing and/or monitoring the absence of motionless bodies in a swimming pool. When monitoring an absence of motion one may be or should also be able logically to capture movement of a body - any body, apparatus, or vehicle - in the pool. The data collected is sent to a controller or a computer for processing. The result of said processing is a command to activate an alarm. Any person skilled in the art may propose a different resulting command, for example: commands to steer the underwater vehicle. This is in combination with Hong US20130151061
8. The system of claim 1, wherein the portable electronic device is configured to output an alert based on signals from the camera indicating presence of a person at pool satisfying a predefined characteristic.	Column 4, Line 66-72: The sequence of the maximum values of these histograms from the detection algorithm is then compared to a reference which is kept up to date for each camera. For each point, where a difference exceeding a threshold value is detected, the program takes note of a presence which is materialized by an image-mark which is transmitted to a central image-processing unit. Column 6, Line 18-21: The images of each camera are then delivered via the output of this camera control module 30 to the computer that processes the images-marks for visualization and setting off of an alarm when needed. Column 2, Line 18-21: The invention relates to a swimming pool monitoring system comprising at least one device	**Menoud** in Column 4, Line 66-72 refers to transmittance of an image-mark to a central image-processing unit. Any person skilled in the art may propose to transmit said images to a hand held device. **Menoud** in Column 6, Line 18-21 teaches a configuration to output an alert based on signals from the camera. **Menoud** teaches a system that raises an alarm based on signals from the camera indicating presence of a person at pool satisfying a predefined characteristic. In other words, Menoud describes a system geared to monitor absence of bodies in danger in a swimming pool where danger fulfills a predefined characteristic of presence of a person at pool. **Menoud** in Column 2, Line 18-21describes a predefined characteristic as constituted of a means for observing critical zones, said observing means being connected to a computer processing the data obtained and able to distinguish the absence of

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	for monitoring the absence of bodies in danger in a swimming pool, constituted of a means for observing critical zones, said observing means being connected to a computer processing the data obtained and able to distinguish the absence of submerged immobile bodies from other bodies and to signal danger when the duration of immobility of an observed body in a critical zone has exceeded a given threshold.	submerged immobile bodies from other bodies and to signal danger when the duration of immobility of an observed body in a critical zone has exceeded (or satisfied) a given (or predefined) threshold.
19. The system of claim 18 further comprising a camera to capture movement of the vehicle while the vehicle is submerged within the pool.	Column 5, Line 54-56: one or several cameras can be placed above water level. Column 6, Line 18-20: The images of each camera are then delivered via the output of this camera control module 30 to the computer that processes the images-marks for visualization and setting off of an alarm when needed. Column 2, Line 18-21: The invention relates to a swimming pool monitoring system comprising at least one device for monitoring the absence of bodies in danger in a swimming pool, constituted of a means for observing critical zones, said observing means being connected to a computer processing the data obtained and able to distinguish the absence of submerged immobile bodies from other bodies and to signal danger when the duration of immobility of an observed body in a critical zone has exceeded a given threshold.	**Menoud** in Column 5, Line 54-56, Column 6, Line 18-20 and Column 2, Line 18-21 further teaches capturing movement of the vehicle while the vehicle is submerged within the pool monitoring the absence of bodies in danger in a swimming pool. Namely, submerged immobile bodies in the pool. Any body or apparatus or vehicle - in the pool.

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Third reference – US patent 7362351 of Meniere

20140015959 CLAIMS	**US patent 7362351 of Meniere**	**Remarks**
1. A pool cleaning system comprising:		Meniere teaches (abstract) of a method and system for detecting an object in a zone located proximate to an interface between two liquid and/or gaseous media having different refractive indices, for example of the air/water type. The method and system produce at least a video image of the interface and the zone and produces electric signals representing each video image. Then, the electric signals are digitized and the data is processed by discriminating the data corresponding to the video image of the real object from those corresponding to the apparent video image generated by the interface.
a powered robotic surface cleaning vehicle to travel adjacent water containing surfaces of a pool while submerged within the pool;		

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a camera adapted to be mounted external the pool to capture movement of the vehicle while submerged within the pool; and a controller to generate control signals steering the vehicle based on the signals from the camera.	Column 6, Line 21-30: The invention also relates to a system and to devices for detecting an object in a zone situated in the proximity of an interface between two liquid and/or gaseous media having different refractive indices, especially an interface of the water/air type. Within the meaning of the present invention; "in the proximity of" also denotes "at the interface". The said system comprises means, especially a video camera, for creating at least one video image of the said interface and of the said zone from at least one observation point.	**Meniere** in Column 6, Line 21-30 teaches a camera positioned externally, above a swimming pool to capture movements or detecting an object either in a zone between two liquid surfaces i.e.: submersed in the pool or an object floating on the water in a zone between a liquid and the air.
8. The system of claim 1, wherein the portable electronic device is configured to output an alert based on signals from the camera indicating presence of a person at pool satisfying a predefined characteristic.	Column 6, Line 21-30: The invention also relates to a system and to devices for detecting an object in a zone situated in the proximity of an interface between two liquid and/or gaseous media having different refractive indices, especially an interface of the water/air type. Within the meaning of the present invention; "in the proximity of" also denotes "at the interface". The said system comprises means, especially a video camera, for creating at least one video image of the said interface and of the said zone from at least one observation point. Also see FIG_6. in sheet 5 Column 1, Line 24-27: More particularly, in the case of this application, the object of the invention is to trip an alarm in the case in which the body of a swimmer has remained immersed in the water for	**Meniere** in Column 6, Line 21-30 and FIG_6 in sheet 5 describes the present invention that relates to a method, to a system and to devices. **Meniere** in Column 1, Line 24-27 describes the external cameras that are depicted in FIGS 1 to 4 of the presently opposed to application number US2014015959 to Kameshwar Durvasula (Aqua Products, Inc.) **Meniere** in Column 2, Line 18-23 describes a method and system that comprises the production of electrical signals and digitizing them to produce data corresponding to video images. Any person skilled in the art may have proposed a similar system by adding a configuration feature of a portable electronic device or a remote control.

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	time that is deemed to be too long. Column 2, Line 18-23: The method according to the invention also comprises the stage of producing electrical signals representative of each video image. The method according to the invention also comprises the stage of digitizing the electrical signals in such a way as to produce data corresponding to each video image.	
19. The system of claim 18 further comprising a camera to capture movement of the vehicle while the vehicle is submerged within the pool.	Column 6, Line 21-26: The invention also relates to a system and to devices for detecting an object in a zone situated in the proximity of an interface between two liquid and/or gaseous media having different refractive indices, especially an interface of the water/air type. Within the meaning of the present invention; "in the proximity of" also denotes "at the interface". Column 6, Line 27-30: The said system comprises means, especially a video camera, for creating at least one video image of the said interface and of the said zone from at least one observation point. Column 1, Line 63-67 and Column 2, Line 1-4: The present invention solves the problem of […] discriminating moving objects from stationary objects, of generating warnings, of processing statistics, of determining elements of trajectory plotting and of permitting detection of when objects enter and	**Meniere** in Column 6, Line 21-26 and Column 6, Line 27-30 teaches a capturing of movement of the vehicle while the vehicle is submerged within the pool. One or several cameras can be placed above water level for detecting an object in a zone situated in the proximity of an interface between two liquid and/or gaseous media having different refractive indices. **Meniere** in Column 1, Line 63-67 and Column 2, Line 1-4 teaches a solution of capturing and discerning between images of objects - that includes vehicles or pool cleaning apparatuses - that are in movement from those that are stationary while submersed within a pool.

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	leave the monitored zone.	

Fourth reference – US patent application 20140009748 of Leonessa

20140015959 CLAIMS	**20140009748 of Leonessa**	**Remarks**
:		
1. A pool cleaning system comprising:		
a powered robotic surface cleaning vehicle to travel adjacent water containing surfaces of a pool while submerged within the pool;	**Leonessa** who actually teaches an interaction between a laser beam range finder and a camera both of which are positioned on board the vehicle while submerged within the pool.	**Leonessa** (abstract) teaches of a pool cleaner control system including a laser range finder with a first laser line generator, a second laser line generator, and a camera. The first laser line generator and the second laser line generator are positioned to emit parallel laser lines and the camera is positioned to capture an image of the laser lines projected on an object. The control system also includes a controller in communication with the laser range finder and configured to control operation of the laser line generators to emit the laser lines and to control the camera to capture the image. The controller is also configured to receive the image from the camera, calculate a pixel distance between the laser lines in the image, and calculate the physical distance between the camera and the object based on the pixel distance.
a camera adapted to be mounted external the pool to capture movement of the vehicle while submerged within the pool; and a controller to generate control signals steering the vehicle based on	[0057] For example, when corners or obstacles that are not flat and perpendicular to the camera's viewing axis are encountered, the control system 10 can be capable of obtaining shape data from a single image. AND	**Leonessa** who actually teaches in [0005], [0057], [0058], [0089], [0089] and [0037] an interaction between a laser beam range finder and a camera both of which are positioned on board the vehicle while submerged within the pool. The said interaction captures movement of the vehicle and generates signals to an on-board

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the signals from the camera.	[0005] …the controller is also configured to receive the image from the camera AND [0058] In some embodiments, the control system 10 can be configured to use the laser range finder 16 as an obstacle or feature finder, thereby controlling turning movement of the pool cleaner 12 when a detected obstacle or feature is a certain distance directly in front of the pool cleaner 12. AND [0089]...based on the mapping and localization, the control system 10 can track and control the movement of the pool cleaner 12 to optimize cleaning routes of the pool cleaner 12 throughout the environment. This can include determining and storing a cleaning route and controlling the pool cleaner 12 to following the cleaning route or tracking movement routes of the pool cleaner 12 and periodically adjusting movements of the pool cleaner 12 to ensure all areas of the environment are traversed within a certain time period. AND [0037] For example, as shown in FIG. 1, the controller 14 can include a processor 98 and a storage medium 100 on which is stored program code. This program code can be executed by the processor 98 to perform various operations.	Controller in order to steer the vehicle based on signals from the Camera.

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12. An apparatus comprising: a non-transient computer-readable medium comprising code configured to cause a processor to: obtain signals from a camera representing water containing surfaces of a pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool; identify portions of the water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle to satisfy a predefined threshold; present a graphical depiction of the identified portions.	[0037] […] For example, as shown in FIG. 1, the controller 14 can include a processor 98 and a storage medium 100 on which is stored program code. This program code can be executed by the processor 98 to perform various operations [0057] For example, when corners or obstacles that are not flat and perpendicular to the camera's viewing axis are encountered, the control system 10 can be capable of obtaining shape data from a single image. AND [0058] In some embodiments, the control system 10 can be configured to use the laser range finder 16 as an obstacle or feature finder, thereby controlling turning movement of the pool cleaner 12 when a detected obstacle or feature is a certain distance directly in front of the pool cleaner 12. AND [0087] […] Following the line identification step, intersections between lines can be found and, if the minimum angle between those lines is greater than a predefined threshold, the intersection can be characterized as a corner. [0027] […] the control system 10 can optimize cleaning routes and identify specific locations of debris within the environment. Generally, the controller 14 can operate and receive inputs from	The apparatus is not described in the description and this makes one think about the unity of invention of this application. It may be a Vehicle or another name for the System. **Leonessa** in [0037] describes the code configured to cause a processor to perform various operations. **Leonessa** in [0057] and [0058] describes how to obtain shape data signals. A person skilled in the art may have proposed obtaining signals from a camera representing water containing surfaces of a pool; and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool; Leonessa is quite specific about that the laser cum camera configuration is also able to detect obstacles along the water containing surfaces of the pool. Said obstacles may be pool corners. Dirt or detritus may also be defined as an obstacle. **Leonessa** in [0087] describes the ability to calculate if a predefined threshold has been satisfied or not in order to characterize the said element. **Leonessa** in [0027] and [0036] describes presenting a graphical depiction of the identified portions of the pool. The camera can be arranged to face downward and/or forward in order to provide visual data of features or surfaces in front or underneath of the pool cleaner thereby presenting a graphical depiction of the identified portions of the pool.

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	the laser range finder 16 and/or the second sensor assembly 24 and can operate the directional control mechanism 26 to move the pool cleaner 12 along a desired route within the underwater environment based on these inputs, as further described below. [0036] In some embodiments, the second sensor assembly 24 can be housed within the electronics box 38. For example, in one embodiment, the second sensor assembly 24 can include a camera. […] can be arranged to face downward to capture images of the pool floor (i.e., ground surface).[…] More specifically, the sensor box 40 can be positioned adjacent to the nose 102 of the skimmer assembly 30 and the camera 22 can be arranged to face forward in order to provide visual data of features or surfaces in front of the pool cleaner 12.	
13. The apparatus of claim 12, wherein the code is further configured to direct the processing unit to generate control signals steering the robotic pool cleaning vehicle so as to clean the identified portions.	[0037] For example, as shown in FIG. 1, the controller 14 can include a processor 98 and a storage medium 100 on which is stored program code. This program code can be executed by the processor 98 to perform various operations AND [0089] the control system 10 can continuously or periodically measure object distances in front of the pool cleaner 12, map the surrounding environment, identify objects within the	**Leonessa** describes in [0037] and [0089] a basic and well known feature of Pool Cleaners that comprise a cleaning program to cover surfaces of the pool. Namely, to direct the processing unit to generate control signals steering the robotic pool cleaning vehicle so as to clean the identified portions. In other words in conjunction of Sensors, Optical Sensors and/or Cameras: the control system 10 can continuously or periodically measure object distances in front of the pool cleaner 12, map the surrounding environment, identify objects within the environment, locate the pool cleaner's position within the environment, and/or navigate the pool cleaner 12

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	environment, locate the pool cleaner's position within the environment, and/or navigate the pool cleaner 12 throughout the environment. [0027] FIG. 1 illustrates a control system 10, according to one embodiment of the invention, for an autonomous robotic pool cleaner, such as the pool cleaner 12 illustrated in FIGS. 2-4. The control system 10 can include a controller […] and a directional control mechanism 26. [..] can optimize operation of the pool cleaner 12 by mapping a swimming pool or spa environment and accurately positioning the pool cleaner 12 throughout the environment. […] can optimize cleaning routes and identify specific locations of debris within the environment.	throughout the environment. Leonessa in [0027] describes a mechanism that specifically can direct the processing unit to generate control signals steering the robotic pool cleaning vehicle according identification of specific locations of debris within the environment with the object so as to clean the said identified portions.

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15. A method comprising: capturing images of a pool being cleaned with a robotic pool cleaning vehicle operating according to a steering algorithm; obtaining signals from a camera representing water containing surfaces of the pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool; identifying portions of the water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle to satisfy a predefined threshold; presenting a graphical depiction of the identified portions.	[0005] The controller is also configured to receive the image from the camera, calculate a pixel distance between the laser lines in the image, and calculate the physical distance between the camera and the object based on the pixel distance. AND [0057] […] For example, when corners or obstacles that are not flat and perpendicular to the camera's viewing axis are encountered, the control system 10 can be capable of obtaining shape data from a single image. AND [0058] In some embodiments, the control system 10 can be configured to use the laser range finder 16 as an obstacle or feature finder, thereby controlling turning movement of the pool cleaner 12 when a detected obstacle or feature is a certain distance directly in front of the pool cleaner 12. AND [0089] [0089] In some embodiments, using the above methods and techniques, the control system 10 can continuously or periodically measure object distances in front of the pool cleaner 12, map the surrounding environment, identify objects within the environment, locate the pool cleaner's position within the environment, and/or navigate the pool cleaner 12 throughout the environment. For example, based on	**Leonessa** - describes a system method in [0005], [0037] [0057], [0058], [0089] capturing or receiving images of a pool being cleaned with a robotic pool cleaning vehicle operating according to a steering algorithm or in other words: control turning of the pool cleaner, determining and storing a cleaning route... and periodically adjusting movements or navigate the pool cleaner through the environment. Such actions are characteristics of a steering algorithm. Leonessa in [0027] describes a method that specifically can direct the processing unit to generate control signals steering the robotic pool cleaning vehicle according identification of specific locations of debris within the environment with the object so as to clean the said identified portions of the water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle to satisfy a predefined threshold; **Leonessa** in [0027] and [0036] describes presenting a graphical depiction of the identified portions of the pool. The camera can be arranged to face downward and/or forward in order to provide visual data of features or surfaces in front or underneath of the pool cleaner and thereby presenting a graphical depiction of the identified portions.

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	the mapping and localization, the control system 10 can track and control the movement of the pool cleaner 12 to optimize cleaning routes of the pool cleaner 12 throughout the environment. This can include determining and storing a cleaning route and controlling the pool cleaner 12 to following the cleaning route or tracking movement routes of the pool cleaner 12 and periodically adjusting movements of the pool cleaner 12 to ensure all areas of the environment are traversed within a certain time period. AND [0037] For example, as shown in FIG. 1, the controller 14 can include a processor 98 and a storage medium 100 on which is stored program code. This program code can be executed by the processor 98 to perform various operations AND [0027] FIG. 1 illustrates a control system 10, according to one embodiment of the invention, for an autonomous robotic pool cleaner, such as the pool cleaner 12 illustrated in FIGS. 2-4. The control system 10 can include a controller [...] and a directional control mechanism 26. [..] can optimize operation of the pool cleaner 12 by mapping a swimming pool or spa environment and accurately positioning the pool cleaner 12 throughout the environment. [...] can	

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	optimize cleaning routes and identify specific locations of debris within the environment. [0036] In some embodiments, the second sensor assembly 24 can be housed within the electronics box 38. For example, in one embodiment, the second sensor assembly 24 can include a camera. […] can be arranged to face downward to capture images of the pool floor (i.e., ground surface).[…] More specifically, the sensor box 40 can be positioned adjacent to the nose 102 of the skimmer assembly 30 and the camera 22 can be arranged to face forward in order to provide visual data of features or surfaces in front of the pool cleaner 12.	
18. The system of claim 17, further comprising: one or more processing units; at least one non-transient computer-readable medium comprising code configured to direct the one or more processing units to cause the portable electronic device to display coverage of the water containing surfaces of the pool by the vehicle.	[0037] For example, as shown in FIG. 1, the controller 14 can include a processor 98 and a storage medium 100 on which is stored program code. This program code can be executed by the processor 98 to perform various operations. [0036] In some embodiments, the second sensor assembly 24 can be housed within the electronics box 38. For example, in one embodiment, the second sensor assembly 24 can include a camera. An underside of the electronics box 38 can include a clear window 105 positioned relative to a through-hole 107 in the chassis 28, as shown in FIG. 4. The camera of the	**Leonessa** in [0037] describes the at least one non-transient computer-readable medium comprising code. This program code can be executed by the processor 98 to perform various operations. **Leonessa** does not teach a portable electronic device but it does describe the ability to provide visual odometry data to the controller that is the process of determining the position and orientation of a robot by analyzing the associated camera images. Any person skilled in the art may have been easily able to propose to transmit said images also to a hand held device whether directly or indirectly via the controller.

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	second sensor assembly 24 can be arranged to face downward to capture images of the pool floor (i.e., ground surface) through the window and the chassis through-hole in order to provide visual odometry data to the controller 14, as further described below. In addition, in some embodiments, the laser range finder 16 can be housed within the sensor box 40. A clear lid 106 can be coupled to the sensor box 40 to enclose the laser range finder 16 within the sensor box 40. In some embodiments, the clear lid 106 and the sensor box 40 can be substantially sealed to waterproof the laser range finder 16. In other embodiments, the components of the laser range finder 16 can be substantially waterproof. As shown in FIGS. 2-3, the sensor box 40 can be coupled to and supported by the skimmer assembly 30. More specifically, the sensor box 40 can be positioned adjacent to the nose 102 of the skimmer assembly 30 and the camera 22 can be arranged to face forward in order to provide visual data of features or surfaces in front of the pool cleaner 12.	

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Fifth reference – US patent application 20040040581 of Azoteq

20140015959 CLAIMS	**20040040581 Azoteq**	**remarks**
15. A method comprising: capturing images of a pool being cleaned with a robotic pool cleaning vehicle operating according to a steering algorithm; obtaining signals from a camera representing water containing surfaces of the pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool; identifying portions of the water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle to satisfy a predefined threshold; presenting a graphical depiction of the identified portions.	[0027] The control means may be used for causing the pool cleaner to follow a defined route through the pool or to detect dirt in order to move away from surfaces in the pool which are already clean. This may be achieved by fitting sensors of any appropriate type to the cleaner and by causing operation of the control means which is responsive to the sensors. The sensors may be light sensitive, or detect contrasting colors which are indicative of areas to be cleaned or avoided. [0009] As used herein "operating characteristics" and "sensed input" include decision making functions, control parameters and input data of, or associated with, the cleaner. Such characteristics and inputs may for example include one or more of: water flow rate through the cleaner; its direction of movement; its speed of movement; its travel path through the water, the condition of the pool floor (submerged surface); the presence of dirt; leaves or other debris; and, the physical structure of the pool, e.g. the presence of steps, corners and other formations, and the like. [0025] The storage means may include	**Azoteq** (abstract) teaches of an apparatus for controlling a suction-type pool cleaner, which is not connected to an external power supply by electrical conductors, employs an electrical generator powered by water flow through the cleaner. The output of the generator is used, under the control of a computer, optionally in response to sensors, to actuate a motor or a valve to influence the movement path of the cleaner through the water. **Azoteq** in [0027] describes causing the pool cleaner to follow a defined route through the pool or to detect dirt in order to move away from surfaces in the pool which are already clean. The sensors may be light sensitive and therefore may comply with signals from a camera or any other optical sensing device. **Azoteq** in [0009] describes signals water containing surfaces of the pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool. Said signals are for the purpose of identifying portions of the water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle or, in other words: "operating characteristics" and "sensed input" include decision making functions, control parameters and input data of, or associated with, the cleaner. Such characteristics and inputs may for example include one or more of:[…] the presence of dirt; leaves or other debris. **Azoteq** in [0025] describes storage means for operating per algorithm whereby the cleaner

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	memory means for storing a plurality of parameters relating to pool cleaner movement and such parameters may be employed, in response to the operating conditions of the pool cleaner or on any other predetermined basis, to influence the movement or operating characteristics of the cleaner.	responds to predefined thresholds or, in other words: the cleaner responds to a plurality of parameters relating to pool cleaner movement and such parameters may be employed, in response to the operating conditions of the pool cleaner or on any other predetermined basis, to influence the movement or operating characteristics of the cleaner.
16. The method of claim 15 further comprising steering the robotic pool cleaning vehicle based upon signals from the camera to reclean the identified portions.	[0027] The control means may be used for causing the pool cleaner to follow a defined route through the pool or to detect dirt in order to move away from surfaces in the pool which are already clean. This may be achieved by fitting sensors of any appropriate type to the cleaner and by causing operation of the control means which is responsive to the sensors. The sensors may be light sensitive, or detect contrasting colors which are indicative of areas to be cleaned or avoided. [0024] To vary the direction of movement of the cleaner […] to change its direction of movement […] [0027] It is also possible to […] change direction or proceed in a chosen direction, or take any other appropriate action.	**Azoteq** describes in [0027] steering the robotic pool cleaning vehicle based upon signals from sensors that may also be optical sensors. The sensors may be light sensitive, or detect contrasting colors which are indicative of areas to be cleaned or avoided. **Azoteq** describes in [0024] and [0027] the ability to steer the pool cleaner, based upon signals from optical sensors or camera to reclean identified portions or, in other words to vary the direction of movement of the cleaner.

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Sixth reference – US patent application 20130269097 of Alammari

20140015959 CLAIMS	**20130269097 of Alammari**	**remarks**
8. The system of claim 1, wherein the portable electronic device is configured to output an alert based on signals from the camera indicating presence of a person at pool satisfying a predefined characteristic.	[0040] If detection data is being generated (i.e., the detection of a human-sized object with the swimming pool 103) by one or more of the underwater sensor units 200, the underwater detection array 20 sends detection data to the underwater sensor interface 300 within the preservation controller 30 as presented in FIG. 7. The underwater sensor interface 300 converts the detection data, which may be in one or more formats based on the type of underwater sensor unit 200 that made the detection. In the present example, the sensor provides latitudinal and longitudinal angles for the detected object. Such types of underwater detection arrays 200 could include acoustic, laser, motion, optical sensing devices or any combination thereof […] [0056] [...] the preservation controller 30 according to exemplary embodiments is described […]. The process data and instructions may be stored in memory 502. These processes and instructions may also be stored on a storage medium disk 504 such as a hard drive (HDD) or portable storage medium or may be stored remotely. [0042] An example of a first scenario may include a toddler that reaches a certain depth within the swimming pool	**Alammari** in [0040] describes the configuration to output an alert based on signals from the camera indicating presence of a person at pool satisfying a predefined characteristic. The camera may be in the form of an optical sensing device. **Alammari** in [0056] describes the ability to use a portable electronic device in conjunction of the preservation controller. **Alammari** in [0042] describes by means of examples the scenario of indicating presence of a person at pool satisfying a predefined characteristic, the configuration of the portable device to output an alert based on signals or in other words: the triggered alarm may also be in the form of a cellular phone text that meet the required term of portable electronic device.

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	[…] This scenario will then be stored within the user defined scenario memory 303 of the preservation controller 30 [that may] trigger an audible alarm. The triggered alarm may also be in the form of a cellular phone text or the contact of an emergency number.	
15. A method comprising: capturing images of a pool being cleaned with a robotic pool cleaning vehicle operating according to a steering algorithm; obtaining signals from a camera representing water containing surfaces of the pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool; identifying portions of the water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle to satisfy a predefined threshold; presenting a graphical depiction of the identified portions.	[0060] The preservation controller 30 further includes a display controller 508, such as a NVIDIA GeForce GTX or Quadro graphics adaptor from NVIDIA Corporation of America for interfacing with display 510, such as a Hewlett Packard HPL2445w LCD monitor. A general purpose I/O interface 512 interfaces with a keyboard and/or mouse 514 as well as a touch screen panel 516 on or separate from display 510. General purpose I/O interface also connects to a variety of peripherals 518 including printers and scanners, such as an OfficeJet or DeskJet from Hewlett Packard.	**Alammari** (abstract) teaches of a swimming pool safety system, and method, uses a preservation mechanism that lifts a human-sized object from within a swimming pool to a top surface of the swimming pool. An underwater detection array detects the human-sized object within the swimming pool and generates a detection data. A preservation controller actuates the preservation mechanism in response to an automatic actuation signal that was generated based on the detection data so as to actuate the preservation mechanism to lift the human-sized object above the top surface of the swimming pool. **Alammari** in [0060] describes a controller that further includes ability to present a graphic on the displaying a graphical depiction of the identified portions.

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17. A pool cleaning system comprising: a powered robotic pool cleaning vehicle to travel adjacent to water containing surfaces of a pool while submerged within the pool; a dry station remote from the pool and in communication with the vehicle; a server in communication with the dry station across a wide area network; and a portable electronic device in communication with the server.	[0056] […] For example, the instructions may be stored on CDs, DVDs, in FLASH memory, RAM, ROM, PROM, EPROM, EEPROM, hard disk or any other information processing device with which the computer aided design station communicates, such as a server or computer. AND [0059] The preservation controller 30 in FIG. 15 also includes a network controller 506, such as an Intel Ethernet PRO network interface card from Intel Corporation of America, for interfacing with a wireless network 507. As can be appreciated, the wireless network 507 can be a public network, such as the Internet, or a private network such as an LAN or WAN network,	**Alammari** in [0056] and [0059] describes a Swimming Pool lifesaving system which concerns a similar swimming pool/a body or object within a swimming pool that may be in communication with a server in communication with the dry station across a wide area network; or in other words, a network communication controller such as an Intel Ethernet PRO network interface card from Intel Corporation of America, for interfacing with a wireless network. As can be appreciated, the wireless network 507 can be a public network, such as the Internet, or a private network such as an LAN or WAN network. Alammari teaches a portable electronic device in communication with the server or in other words, the LAN port allows the terminal, portable device, etc. and the controller to exchange data. The controller will include, inter alia, signals from the camera, sensors of the vehicle.

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18. The system of claim 17, further comprising: one or more processing units; at least one non-transient computer-readable medium comprising code configured to direct the one or more processing units to cause the portable electronic device to display coverage of the water containing surfaces of the pool by the vehicle.	[0058] […] Further, CPU 500 may be implemented as multiple processors cooperatively working in parallel to perform the instructions of the inventive processes described above. [0010] […] a preservation controller configured to actuate the preservation mechanism in response to an actuation signal that was generated based on the detection data so as to actuate the preservation mechanism. [0060] The preservation controller 30 further includes a display controller 508, such as a NVIDIA GeForce GTX or Quadro graphics adaptor from NVIDIA Corporation of America for interfacing with display 510, such as a Hewlett Packard HPL2445w LCD monitor.	**Alammari** in [0058] describes a Swimming Pool lifesaving system which concerns a similar swimming pool/a body or object within a swimming pool that may be in communication with a server in communication with the dry station across a wide area network; or in other words, a network communication controller such as an Intel Ethernet PRO network interface card from Intel Corporation of America, for interfacing with a wireless network. As can be appreciated, the wireless network 507 can be a public network, such as the Internet, or a private network such as an LAN or WAN network. Alammari's system may also consist of one or more processing units or in other words: multiple processors cooperatively working in parallel to perform the instructions of the inventive processes described above. **Alammari** in [0010] further describes a computer controlled swimming pool system that is configured to direct the one or more processing units or to actuate the preservation mechanism or, in our case - any type of actuated mechanism - in response to an actuation signal automatically generated based on the detection data so as to actuate the preservation mechanism. **US20130151061 of Hong** in [0031] describes a portable electronic device set in a bag carried by an operator, connected to the controller and allowing the operator to operate the cleaning robot. **Alammari** in [0060] teaches that the portable display controller may present a graphical display of camera photographs or video by means of a graphics adaptor.

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Seventh reference – US patent US7123746 of Poseidon

20140015959 CLAIMS	US patent 7123746 of Poseidon	Remarks
The system of claim 1 further comprising a station remote from the vehicle and in communication with the vehicle, wherein the station includes the controller.	[0121] [in FIG.7] Cables 33, 43 which cross boxes 32, 42 containing cameras 31, 41, are coax cables, connected to a micro computer 72, for example of the "IBM compatible" type constructed around a PENTIUM microprocessor, by means of a multiplex system 71. A continuous power supply is established on each cable 33, 43 intended to supply the corresponding camera 31, 41. The said camera 31, 41 sends a modulation, which constitutes the signal to be processed through the cable 33, 43. Before input into the multiplex system 71, the separation of the continuous component must be assured thanks to the demodulation means which supply the signal emitted by the camera of the "CCD" type, solely by means of a multiplex system. The microcomputer 72 includes a central processing unit 73, means for temporary storage, or RAM (Random Access Memory), means for permanent storage, or hard disk 75, and a remote control card 76 which is able to control the alarm systems 77. In addition, the microcomputer 72 is connected to a control screen E, said screen is a touch screen which allows control of operation. The microcomputer 72 is configured as "multimedia" and is equipped with a video capture card 78, which converts	Poseidon teaches (abstract) for a system and method for detecting an object (**1**) in relation to a surface (**2**). This can be used for surveying a swimming pool. **Poseidon** teaches in this lengthy passage of [0121] - a station remote from the pool that would contain the swimmer.

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	these into digital images.	
3. The system of claim 1 further comprising a station remote from the vehicle and in communication with the vehicle, wherein the controller is located remote from the vehicle and the station.	[0021] One or numerous control screens are positioned by the lifeguards' chairs or in the offices of the persons responsible for surveillance of the swimming pool, screens on which the images are shown of a zone considered suspect.	**Poseidon** in [0021] teaches a system comprising control screens that form a control "station" that are located by the lifeguard's chairs that by definition are both remote and external to the pool=swimmer=vehicle=pool cleaner.
4. The system of claim 1 further comprising a portable electronic device in communication with the camera, with the portable electronic device includes a controller.	[0121] The microcomputer 72 includes a central processing unit 73, means for temporary storage, or RAM (Random Access Memory), means for permanent storage, or hard disk 75, and a remote control card 76 which is able to control the alarm systems 77.	Poseidon in [0121] teaches a system comprising a remote control that is able to control the alarm system which by definition may also be a portable electronic device in communication with the camera or any sub component of the "system"
8. The system of claim 1, wherein the portable electronic device is configured to output an alert based on signals from the camera indicating presence of a person at pool satisfying a predefined characteristic.	[0001] The present invention relates to a process and a system for detecting an object in relation to a surface, said surface is not necessarily flat. In accordance with the present invention an object is defined as: a material element devoid of life and/or a person or animal. The object in accordance with the invention may be static and/or in movement. AND [0017] [...] means for making decisions appropriate for setting off an alarm in the event of a suspicious trajectory or movement of the body being observed. AND [0121] The microcomputer 72 includes a central processing unit 73, means for temporary storage, or RAM (Random Access Memory), means for permanent storage, or hard disk 75, and a remote control card 76 which is able to control the alarm systems 77.	**Poseidon** in [0001], [0017] and [0121] describes a Remote Control card able to control the alarm systems. It would have been obvious to a person skilled in the art to name a Remote Control Card as a Portable Electronic Device or as a Console Set In a Bag Carried by an Operator. Said Alarm or Alert is a function of a camera indicating or detecting presence of a person or detecting an object in relation to a surface, said surface is not necessarily flat. In accordance with the present invention an object is defined as: a material element devoid of life and/or a person or animal.

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10. The system of claim 1 further comprising a server remote from the camera and the vehicle, the server comprising the controller, wherein the controller generates control signals for steering a plurality of vehicles across a plurality of pools based on signals from a plurality of cameras associated with the plurality of pools.	[0122] Thanks to the multiplex system it is possible to process cameras 31 and 41 with the same video capture card 78. It should be noted that the number of cameras processed by the same card may be greater than two. AND The microcomputer 72 includes a central processing unit 73, means for temporary storage, or RAM (Random Access Memory), means for permanent storage, or hard disk 75, and a remote control card 76 which is able to control the alarm systems 77.	**US7123746 Poseidon** in [0122] describes a Multiplex system that by definition makes it possible to generate signals for steering or observing a plurality of vehicle or pool cleaners that are associated with a plurality of swimming pools which are common in large nautical recreation establishments. Or- that the number of cameras processed by the same card may be greater than two. Any person skilled in the art may have proposed to interconnect by Multiplex various Swimming Pools which would have made significant economic savings.
12. An apparatus comprising: a non-transient computer-readable medium comprising code configured to cause a processor to: obtain signals from a camera representing water containing surfaces of a pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool; identify portions of the water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle to satisfy a predefined threshold; present a graphical depiction of the identified portions.	[0124] [...] The central processing unit 73 combined with appropriate software [...]. In addition the central unit 73 and the software are provided to constitute the means for making decisions appropriate for setting off an alarm. AND The fact that the matrix of the initial image is known (empty swimming pool), makes it possible to count and follow the different forms moving in the swimming pool captured by the cameras individually. [0026] The process according to the invention includes a step for realising a computer-generated image associated to the viewpoint being considered for each viewpoint by means of a geometric conversion at least including a projection in perspective of said object on said surface from at least two distinct viewpoints. [0027] Further in the description the computer-generated image associated to the viewpoint considered is defined as the image obtained by	**Poseidon** in [0124] describes a CPU combined with a software configured to cause a processor, for example, to ignite an alarm. **Poseidon's** cameras are able to obtain signals representing water containing surfaces of a pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool; AND Since the matrix of the initial image of Poseidon's pool is known then: **Poseidon** in the sections [0026] to [0028] describes the configuration to cause a processor to obtain signals from a camera representing water containing surfaces of a pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool; this enables to identify portions of the water containing surfaces of the pool […] to satisfy a predefined threshold. **Poseidon** in [0121] describes how to present a graphical depiction of the identified portions or in other words, Poseidon places screens, for example,

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	the application of the geometric conversion at the scene being observed from said viewpoint whether or not there is an object. [0028] In addition said process includes a stage for distinguishing between the computer-generated images for detecting a presence and determining the position of said object in relation to said surface. [0021] One or numerous control screens are positioned by the lifeguards' chairs or in the offices of the persons responsible for surveillance of the swimming pool, screens on which the images are shown of a zone considered suspect. The alarm may be given through a sound and/or visual warning, in particular with an indication of the zone of the swimming pool in which a suspicious event is taking place.	in an office. The screens depict images of a zone that is being observed by the camera and in which an event is taking place.
14. The apparatus of claim 12 further comprising a portable electronic device comprising: a processing unit; a display to present the graphical depiction; and the non-transient computer readable medium.	[0121] […] The microcomputer 72 includes a central processing unit 73, means for temporary storage, or RAM (Random Access Memory), means for permanent storage, or hard disk 75, and a remote control card 76 which is able to control the alarm systems 77. In addition, the microcomputer 72 is connected to a control screen E, said screen is a touch screen which allows control of operation. The microcomputer 72 is configured as “multimedia” and is equipped with a video capture card 78, which converts these into digital images.	**Poseidon** in [0121] describes a processing unit that includes a portable electronic device in the form of a remote control card. The processing unit is with a display or a control screen that may be a touch screen which is able to allow control of operation and a display to present the graphical depiction or a “multimedia” and is equipped with a video capture card 78, which converts these into digital images; and the non-transient computer readable medium or in other words a means for temporary storage, or RAM (Random Access Memory).

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17. A pool cleaning system comprising: a powered robotic pool cleaning vehicle to travel adjacent to water containing surfaces of a pool while submerged within the pool; a dry station remote from the pool and in communication with the vehicle; a server in communication with the dry station across a wide area network; and a portable electronic device in communication with the server.	[0121] […] connected to a micro computer 72, for example of the "IBM compatible" type constructed around a PENTIUM microprocessor, by means of a multiplex system 71. A continuous power supply is established on each cable 33, 43 intended to supply the corresponding camera 31, 41. AND [0021] one or numerous control screens are positioned by the lifeguards' chairs or in the offices of the persons responsible for surveillance of the swimming pool, screens on which the images are shown of a zone considered suspect.	**Poseidon** in [0121] describes a camera as the communicative medium in contact with the swimming pool and any element such a human, animal within it. A person skilled in the art would have thought about identification and communication with a travelling Pool Cleaner. In addition, included in the processing unit is a portable electronic device in the form of a remote control card Both Hong and Alammari **Poseidon** in [0021] describes a server in communication with the dry station across a wide area network that includes screens in, for example, the offices of the persons responsible for surveillance of the swimming pool
18. The system of claim 17, further comprising: one or more processing units; at least one non-transient computer-readable medium comprising code configured to direct the one or more processing units to cause the portable electronic device to display coverage of the water containing surfaces of the pool by the vehicle.	[0124] […] The central processing unit 73 combined with appropriate software [...]. In addition the central unit 73 and the software are provided to constitute the means for making decisions appropriate for setting off an alarm.	**Poseidon** in [0124] describes the at least one non-transient computer-readable medium comprising code. This program code can be executed by the processor 98 to perform various operations.

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20. The system of claim 19, wherein the camera comprises a pool security camera and wherein the at least one non-transient computer-readable medium causes the portable electronic device to output an alert based on signals from the camera indicating presence of a person at pool satisfying a predefined characteristic.	[0024] The process and the system according to the invention were originally conceived for surveillance in swimming pools and the prevention of incidents of drowning. In any event, it quickly became apparent that the image processing techniques consisting of analyzing the image of a dense object in a general way in relation to a surface could be applied to surfaces including virtual surfaces and objects located before or behind such surfaces. Due to this fact they are appropriate for application in fields other than the surveillance of swimming pools. AND [0121] […] The microcomputer 72 includes a central processing unit 73, means for temporary storage, or RAM (Random Access Memory), means for permanent storage, or hard disk 75, and a remote control card 76 which is able to control the alarm systems 77. AND [0118] wherein an alarm signal is emitted if the body has a suspicious trajectory for an abnormally long period of time. AND [0020] The means for making decisions are appropriate for setting off an alarm if the slow nature of a movement or the almost-immobility of a body in the swimming pool continues over a defined period, in particular over 15 seconds.	**Poseidon** in [0024] teaches a system wherein the camera comprises a pool security camera for surveillance in swimming pools and the prevention of incidents of drowning. AND **in [0121]** wherein the at least one non-transient computer-readable medium or a microcomputer that includes a central processing unit and/or means for temporary storage, or RAM (Random Access Memory), means for permanent storage, or hard disk and a remote control card. AND **in [0118]** causes the portable electronic device to output an alert based on signals from the camera indicating presence of a person at pool or in other words, able to control the alarm systems that are the essence of the Poseidon registered patent. AND **in [0020]** said alert will be outputted when satisfying a predefined characteristic or, in other words, an alarm signal is emitted if the body has a suspicious trajectory for an abnormally long period of time or means for making decisions are appropriate for setting off an alarm if the slow nature of a movement or the almost-immobility of a body in the swimming pool continues over a defined period - thereby, again, satisfying a predefined characteristic

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Electronic Patent Application Fee Transmittal	
Application Number:	13545918
Filing Date:	
Title of Invention:	
First Named Inventor/Applicant Name:	
Filer:	Oren Reches
Attorney Docket Number:	
Filed as Small Entity	

Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
DOCUMENT FEE FOR THIRD-PARTY SUBMISSIONS	2818	1	90	90
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

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Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
		Total in USD ($)		**90**

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Electronic Acknowledgement Receipt	
EFS ID:	20306511
Application Number:	13545918
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First Named Inventor/Applicant Name:	
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Filer:	Oren Reches
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Attorney Docket Number:	
Receipt Date:	02-OCT-2014
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Payment was successfully received in RAM	$90

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RAM confirmation Number	7373
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Concise Description of Relevance	Concise-description-generated.pdf	32695 336ec14d0a142a8c4addd14f8bbd6b88279cda96	no	2
Warnings:					
Information:					
2	Third-Party Submission Under 37 CFR 1.290	Third-party-preissuance-submission.pdf	49495 38c113e122340d4b00a6a4f5dc890daa3b0bbe20	no	3
Warnings:					
Information:					
3	Request for Notification of Non-compliant Third-Party Submission	Third-party-notification-request.pdf	19502 55e28c8017ebfdba93a1c4214fca4284a7780a7b	no	1
Warnings:					
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4	Concise Description of Relevance	8606-Third-Party.pdf	283505 002db1a7f48edcaa163cc51f794e0f99b8f23cba	no	44
Warnings:					
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5	Fee Worksheet (SB06)	fee-info.pdf	28947 c6e9b175f9c0f9d015bb5f183e8d14fc7dfb1e9b	no	2
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		Total Files Size (in bytes):	414144		

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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.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/545,918	07/10/2012	Kameshwar Durvasula	A150-102	9590

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EXAMINER	
WONG, ALLEN C	
ART UNIT	PAPER NUMBER
2488	

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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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13/545,918	10 July, 2012	DURVASULA ET AL.	A150-102

Rathe Lindenbaum LLP
700 W. Virginia Street
Suite 302
Milwaukee, WI 53204

EXAMINER	
JUSTIN RIDER	
ART UNIT	PAPER
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Commissioner for Patents

A third-party submission under 37 CFR 1.290 was filed on October 2nd 2014, and is being entered in the above-identified application. Please allow a few days for the submission to be visible in the Patent Application Information Retrieval (PAIR) system. Note that the submission will be identified using the "Information Disclosure Statement Filed" Document Description. This Document Description is being used for the internal purposes only. The Office does not consider the submission to be an Information Disclosure Statement under 37 CFR 1.97 and 1.98.

Any questions regarding this communication should be directed to Justin W. Rider at (571) 270-1068. A secondary contact is Christopher Grant (571) 272-7294

/JUSTIN RIDER/
Supervisory Patent Examiner, Art Unit 2400

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PTO/SB/81 (01-09)
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POWER OF ATTORNEY OR REVOCATION OF POWER OF ATTORNEY WITH A NEW POWER OF ATTORNEY AND CHANGE OF CORRESPONDENCE ADDRESS

Application Number	13/545,918
Filing Date	July 10, 2012
First Named Inventor	DURVASULA, Kameshwar
Title	POOL CLEANING SYSTEM AND METHOD
Art Unit	2488
Examiner Name	WONG, Allen C
Attorney Docket Number	316,091

I hereby revoke all previous powers of attorney given in the above-identified application.

☐ A Power of Attorney is submitted herewith.

OR

☒ I hereby appoint Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith: 38,137

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OR

☒ Assignee of record of the entire interest. See 37 CFR 3.71.
Statement under 37 CFR 3.73(b) (Form PTO/SB/96) submitted herewith or filed on _____

SIGNATURE of Applicant or Assignee of Record

Signature		Date	3/18/15
Name	Ethan Hanan	Telephone	
Title and Company	Vice President R&D Aqua Products, Inc.		

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

☒ *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.**

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PTO/SB/96 (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
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STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: Aqua Products, Inc.

Application No./Patent No.: 13/545,918 Filed/Issue Date: July 10, 2012

Titled: POOL CLEANING SYSTEM AND METHOD

Aqua Products, Inc. , a Company

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.

states that it is:

1. [X] the assignee of the entire right, title, and interest in;

2. [ ] an assignee of less than the entire right, title, and interest in (The extent (by percentage) of its ownership interest is _____ %); or

3. [ ] the assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made)

the patent application/patent identified above, by virtue of either:

A. [X] An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel 028542, Frame 0620, or for which a copy therefore is attached.

OR

B. [ ] A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

2. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

3. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

[ ] Additional documents in the chain of title are listed on a supplemental sheet(s).

[ ] As required by 37 CFR 3.73(b)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (*i.e.*, a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Steven M. Hertzberg/ March 20, 2015

Signature Date

Steven M. Hertzberg Attorney

Printed or Typed Name Title

This collection of information is required by 37 CFR 3.73(b). 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 12 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.

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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.

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Electronic Acknowledgement Receipt	
EFS ID:	21830690
Application Number:	13545918
International Application Number:	
Confirmation Number:	9590
Title of Invention:	POOL CLEANING SYSTEM AND METHOD
First Named Inventor/Applicant Name:	Kameshwar Durvasula
Customer Number:	112708
Filer:	Steven M. Hertzberg/Steven Ortiz
Filer Authorized By:	Steven M. Hertzberg
Attorney Docket Number:	A150-102
Receipt Date:	20-MAR-2015
Filing Date:	10-JUL-2012
Time Stamp:	11:45:55
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	316091_Revocation.pdf	80364 c23f927e8f3ec13e096e6d6951f16cc8a86dd51c	no	1

Warnings:
Information:

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2	Assignee showing of ownership per 37 CFR 3.73.	316091_Stmt.pdf	422668 9dd4aa0feda0ba2aae4742eeca9acd312b0bdc5e	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	503032	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a 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.

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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/545,918	07/10/2012	Kameshwar Durvasula	A150-102

CONFIRMATION NO. 9590

112708
Rathe Lindenbaum LLP
700 W. Virginia Street
Suite 302
Milwaukee, WI 53204

POWER OF ATTORNEY NOTICE

OC000000074235372

Date Mailed: 03/26/2015

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 03/20/2015.

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

/atesfai/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/545,918	07/10/2012	Kameshwar Durvasula	316.091

CONFIRMATION NO. 9590

38137
ABELMAN, FRAYNE & SCHWAB
666 THIRD AVENUE, 10TH FLOOR
NEW YORK, NY 10017

POA ACCEPTANCE LETTER

OC000000074235384

Date Mailed: 03/26/2015

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 03/20/2015.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/atesfai/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/545,918	07/10/2012	Kameshwar Durvasula	316.091	9590

38137 7590 06/26/2015

ABELMAN, FRAYNE & SCHWAB
666 THIRD AVENUE, 10TH FLOOR
NEW YORK, NY 10017

EXAMINER	
WONG, ALLEN C	

ART UNIT	PAPER NUMBER
2488	

MAIL DATE	DELIVERY MODE
06/26/2015	PAPER

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.

PTOL-90A (Rev. 04/07)

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Office Action Summary	Application No. 13/545,918	Applicant(s) DURVASULA ET AL.	
	Examiner ALLEN WONG	Art Unit 2488	AIA (First Inventor to File) Status No

-- 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 _____.

☐ 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 7/10/12 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

The present application is being examined under the pre-AIA first to invent provisions.

Information Disclosure Statement

The information disclosure statement (IDS) submitted on 7/10/12 is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement has been considered by the Examiner.

Also, the information disclosure statement filed 10/2/14 via third party submission under 37 CFR 1.290 has been considered by the Examiner.

Claim Rejections - 35 USC § 101

35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

35 U.S.C. 101 requires that a claimed invention must fall within one of the four eligible categories of invention (i.e. process, machine, manufacture, or composition of matter) *and* must not be directed to subject matter encompassing a judicially recognized exception as interpreted by the courts. MPEP 2106. The four eligible categories of invention include: (1) process which is an act, or a series of acts or steps, (2) machine which is an concrete thing, consisting of parts, or of certain devices and combination of devices, (3) manufacture which is an article produced from raw or prepared materials by giving to these materials new forms, qualities, properties, or combinations, whether by hand labor or by machinery, and (4) composition of matter which is all compositions of two or more substances and all composite articles, whether they be the results of chemical union, or of mechanical mixture, or whether they be gases, fluids, powders or solids. MPEP 2106(I).

Claims **12-14 and 18-20** are rejected under 35 U.S.C. 101 as not falling within one of the four statutory categories of invention because the broadest reasonable interpretation of the instant claims in light of the specification encompasses transitory signals. But, transitory signals are not within one of the

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four statutory categories (i.e. non-statutory subject matter). *See* MPEP 2106(I). However, claims directed toward a non-transitory computer readable medium may qualify as a manufacture and make the claim patent-eligible subject matter. MPEP 2106(I). Therefore, amending the claims to recite a "*non-transitory computer-readable medium*" would resolve this issue.

Claim 12, line 2, "a non-transient computer-readable medium" should be changed to "a **non-transitory** computer-readable medium".

Claim 14, line 5, "non-transient computer readable medium" should be changed to "**non-transitory** computer readable medium".

Claim 18, line 3, "non-transient computer-readable medium" should be changed to "**non-transitory** computer readable medium".

Claim 20, line 2, "non-transient computer-readable medium" should be changed to "**non-transitory** computer readable medium".

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of pre-AIA 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) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.

Claims 12 and 14-16 are rejected under pre-AIA 35 U.S.C. 102(a) as being anticipated by Hong (WO 2012/023676 A1).

Regarding claim 12, Hong discloses an apparatus comprising: a non-transient computer-readable medium comprising code configured to cause a processor to:

obtain signals from a camera representing water containing surfaces of a pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool (paragraph [1], Hong discloses a cleaning robot and an underwater sediment cleaning apparatus; paragraph [137], Hong discloses a camera 168, in that paragraph [178-179], Hong discloses a pool cleaner that comprises an algorithmic capacity to govern a travel forward at a sensed lower speed than an input or a threshold

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speed, wherein the lower speed indicates a large amount of works that is the equivalent to an unclean surface so a new steering command is given to drive backward to the original position);

identify portions of the water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle to satisfy a predefined threshold (paragraph [31], Hong discloses cameras are aisle to obtain signals representing water containing surfaces of a pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool, or in other words, to obtain location information from the cleaning robot and controlling the location of the cleaning robot in the pool, paragraph [137], Hong discloses a graphical depiction of the identified portion or in other words, it transmits an image signal corresponding to an image photographed by the camera 168 to the operation console, thus, identifying the portions of water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle);

present a graphical depiction of the identified portions (paragraph [137], Hong's camera presents a graphical depiction of the identified portion or in other words, it transmits an image signal corresponding to an image photographed by the camera 168 to the operation console).

Regarding claim 14, Hong discloses further comprising a portable electronic device comprising: a processing unit (paragraph [137], Hong discloses a processor or controller 300 to exchange data); a display to present the graphical depiction (paragraph [137], Hong discloses a display 414); and the non-transient computer readable medium (paragraph [29], Hong discloses a central processing unit with a processor and memory or a computer for operating the pool cleaning system).

Regarding claim 15, Hong discloses a method comprising:

capturing images of a pool being cleaned with a robotic pool cleaning vehicle operating according to a steering algorithm (paragraph [137], Hong discloses a camera for capturing images of a pool, and paragraph [31], Hong discloses capturing of images or that signals are obtained from a camera representing water containing surfaces of the pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool; Hong further describes in [68] the operating according to a steering algorithm or an algorithm of generating the detour of the cleaning robot in the cleaning method);

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obtaining signals from a camera representing water containing surfaces of the pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool (paragraph [1], Hong discloses a cleaning robot and an underwater sediment cleaning apparatus; paragraph [137], Hong discloses a camera 168, in that paragraph [178-179], Hong discloses a pool cleaner that comprises an algorithmic capacity to govern a travel forward at a sensed lower speed than an input or a threshold speed, wherein the lower speed indicates a large amount of works that is the equivalent to an unclean surface so a new steering command is given to drive backward to the original position);

identifying portions of the water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle to satisfy a predefined threshold (paragraph [31], Hong discloses cameras are aisle to obtain signals representing water containing surfaces of a pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool, or in other words, to obtain location information from the cleaning robot and controlling the location of the cleaning robot in the pool, paragraph [137], Hong discloses a graphical depiction of the identified portion or in other words, it transmits an image signal corresponding to an image photographed by the camera 168 to the operation console, thus, identifying the portions of water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle);

presenting a graphical depiction of the identified portions (paragraph [137], Hong's camera presents a graphical depiction of the identified portion or in other words, it transmits an image signal corresponding to an image photographed by the camera 168 to the operation console).

Regarding claim 16, Hong discloses further comprising steering the robotic pool cleaning vehicle based upon signals from the camera to reclean the identified portions (paragraph [31,156,178,179], Hong discloses steering the robotic pool cleaning vehicle based upon signals from the camera to move back and forth on an unclean stretch of surface to reclean the identified portions; paragraph [154-155], Hong discloses the possibility to identify areas that have been cleaned by the vehicle or the cleaning robot, paragraph [178-179], Hong discloses a reclean command is issued in the form of a forward movement command and the reversing command of returning to the original position are repeated for a

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predetermined operating time or until the sensors send a signal that the cleanliness characteristic sensed are not failing to satisfy a predefined threshold).

Claim Rejections - 35 USC § 103

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

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1, 5-9 and 11 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Hong (WO 2012/023676 A1) in view of Meniere (US 7,362,351).

Regarding claim 1, Hong discloses a pool cleaning system comprising:

a powered robotic surface cleaning vehicle to travel adjacent water containing surfaces of a pool while submerged within the pool (abstract and paragraph [1], Hong discloses a powered robotic surface cleaning vehicle to travel adjacent water containing surfaces of a pool while submerged within the pool);

a camera adapted to be mounted to the vehicle (paragraph [111], note camera 168 is mounted on vehicle); and

a controller to generate control signals steering the vehicle based on the signals from the camera (paragraph [31], Hong discloses the controller to generate control signals steering the vehicle based on signals ascertained by the camera, and paragraph [36], Hong discloses the automatic cleaning mode for controlling the vehicle movements for moving the cleaning robot to clean a certain targeted location, and a determination process is done to determine if the cleaning robot reaches the final destination).

Hong does not disclose a camera adapted to be mounted external the pool to capture movement of the vehicle while submerged within the pool. However, Meniere ('351) teaches a camera adapted to be mounted external the pool to capture movement of the vehicle while submerged within the pool (col.6, ln.21-30, Meniere ('351) discloses the cameras are externally placed above the pool for capturing

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movement of the vehicle within the pool). Therefore, it would have been obvious to one of ordinary skill in the art to combine the teachings of Hong and Meniere ('351) as a whole at the time of the invention was made for permitting accurate surveillance of the pool with cameras to detect objects within the pool (Meniere col.2, ln.8-10).

Regarding claim 5, Hong discloses further comprising a portable electronic device having a display (paragraph [32], Hong discloses there is a user interface where the operator resides to view the imaged data, wherein paragraph [137], Hong discloses the display), wherein the portable electronic device is configured to present a graphic on the display (paragraph [32 and 137], Hong discloses the display is present for permitting the operator to view the images obtained by camera), the graphic depicting water containing surfaces of the pool and those portions of the water containing surfaces that remain uncleaned as a vehicle traverses the water containing surfaces (paragraph [156], the area which has been cleaned by the cleaning robot and the area which is not cleaned as the vehicle or pool cleaner traverses the water surfaces, or in other words, as paragraph [31] the system receives signals as to the location information and controlling the said location of the cleaning robot or "vehicle" as it traverses the water containing surfaces).

Regarding claim 6, Hong discloses wherein the portable electronic device depicts movement of the vehicle on the display (paragraph [156], Hong depicts movement of the vehicle on the display or, in other words, displays the number of times cleaning is repeated, the area which has been cleaned by the cleaning robot and the area which is not cleaned, and paragraph [136], Hong teaches receiving location information from the cleaning robot and controlling the location of the cleaning robot thereby depicting movement of the vehicle on display).

Regarding claim 7, Hong discloses wherein the controller generates second control signals steering the vehicle based on a coverage algorithm independent of signals from the camera and wherein the control signals based on the captured coverage steer the vehicle to clean portions of the water containing surfaces missed by the vehicle while being steered according to the second control signals (paragraph [155], Hong discloses a choice between two coverage algorithms, wherein the first is an automatic steering of the vehicle that is independent of signals from the camera, thus relevant when

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there is a low degree of contamination or when the contamination is so high that the camera is practically inoperative due to low vision, and the second coverage program is the manual cleaning mode that can be manually selected, and thus the automatic algorithm so that the second control signals steering the vehicle can adapt itself to new captured coverage, via processed photos, and reroute to surfaces missed by the vehicle, thus permitting the controlling of the cleaning vehicle to clean portions of the water containing surfaces missed by the vehicle while being steered according to the second control signals).

Regarding claim 8, Hong discloses wherein the portable electronic device is configured to output an alert based on signals from the camera indicating presence of a person at pool satisfying a predefined characteristic (paragraph [137], Hong discloses the image output port transmits an image signal corresponding to an image photographed by the camera to the operation console such that a display provided to the operation console displays the image, and paragraph [138], Hong discloses a warning buzzer or a device configured to output an alert on a portable electronic device or console, in that an alarm sound is generated when a wrong operation occurs to inform the operator to know the wrong operation, thus indicating presence of a person at pool satisfying a predefined characteristic).

Regarding claim 9, Hong discloses further comprising: a portable electronic device having a display (paragraph [32], Hong discloses there is a station where the operator resides to view the imaged data, wherein paragraph [137], Hong discloses the display); and sensors carried by the vehicle (paragraph [31], Hong discloses an information emanating from Sensors carried by the vehicle or included in the cleaning robot- may well also be Optical Sensors or Cameras - or a sensing signal generated from sensors included in the cleaning robot presents information based on characteristics of the water containing surfaces of the pool), wherein the display presents information based on characteristics of the water containing surfaces of the pool sensed by the sensors (paragraph [156], the area which has been cleaned by the cleaning robot and the area which is not cleaned as the vehicle or pool cleaner traverses the water surfaces, or in other words, as paragraph [31] the system receives signals as to the location information and controlling the said location of the cleaning robot or "vehicle" as it traverses the water containing surfaces).

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Regarding claim 11, Hong discloses further comprising sensors carried by the vehicle to sense the water containing surfaces of the pool after the water containing surfaces of the pool have been cleaned by the vehicle during a pass of the vehicle under control of a pool coverage algorithm (paragraph [31], Hong discloses an information emanating from Sensors carried by the vehicle or included in the cleaning robot- may well also be Optical Sensors or Cameras - or a sensing signal generated from sensors included in the cleaning robot presents information based on characteristics of the water containing surfaces of the pool), wherein the control signals steer the vehicle so as to reclean the water containing surfaces having a cleanliness characteristic sensed by the sensors failing to satisfy a predefined threshold (paragraph [154-155], Hong discloses the possibility to identify areas that have been cleaned by the vehicle or the cleaning robot, paragraph [178-179], Hong discloses a reclean command is issued in the form of a forward movement command and the reversing command of returning to the original position are repeated for a predetermined operating time or until the sensors send a signal that the cleanliness characteristic sensed are not failing to satisfy a predefined threshold).

Claims 2-4 and 10 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Hong (WO 2012/023676 A1) and Meniere (US 7,362,351) in view of Meniere (US 7,123,746).

Regarding claim 2, Hong and Meniere ('351) do not disclose further comprising a station remote from the vehicle and in communication with the vehicle, wherein the station includes the controller. However, Meniere ('746) discloses a station remote from the vehicle and in communication with the vehicle (col.11, ln.1-22, Meniere discloses a remote station from the vehicle, and a processor or microcomputer in communication with vehicle), wherein the station includes the controller (col.11, ln.1-22, Meniere discloses a remote station in communication with vehicle, wherein there is a processor or controller). Therefore, it would have been obvious to one of ordinary skill in the art to combine the teachings of Hong, Meniere ('351) and Meniere ('746) as a whole at the time of the invention was made for permitting the user to be informed of the conditions of the pool with accurate surveillance of the pool to detect aberrations in order to survey the pool.

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Regarding claim 3, Hong and Meniere ('351) do not disclose further comprising a station remote from the vehicle and in communication with the vehicle, wherein the controller is located remote from the vehicle and the station. However, Meniere ('746) discloses a station remote from the vehicle and in communication with the vehicle (col.11, ln.1-22, Meniere discloses a remote station from the vehicle, and a processor or microcomputer in communication with vehicle), wherein the controller is located remote from the vehicle and the station (col.11, ln.1-22, Meniere discloses a remote station in communication with vehicle, wherein there is a processor or controller that is placed remote from the vehicle and the station). Therefore, it would have been obvious to one of ordinary skill in the art to combine the teachings of Hong, Meniere ('351) and Meniere ('746) as a whole at the time of the invention was made for permitting the user to be informed of the conditions of the pool with accurate surveillance of the pool to detect aberrations in order to survey the pool.

Regarding claim 4, Hong and Meniere ('351) do not disclose further comprising a portable electronic device in communication with the camera, with the portable electronic device includes a controller. However, Meniere ('746) discloses a portable electronic device in communication with the camera (col.11, ln.1-22, Meniere discloses a remote station from the vehicle, and a processor or microcomputer in communication with vehicle), with the portable electronic device includes a controller (col.11, ln.1-22, Meniere discloses a system comprising a remote control that is able to control the alarm system, in that a portable electronic device in communication with the camera or any sub component of the "system"). Therefore, it would have been obvious to one of ordinary skill in the art to combine the teachings of Hong, Meniere ('351) and Meniere ('746) as a whole at the time of the invention was made for permitting the user to be informed of the conditions of the pool with accurate surveillance of the pool to detect aberrations in order to survey the pool.

Regarding claim 10, Hong and Meniere ('351) do not disclose further comprising a server remote from the camera and the vehicle, the server comprising the controller, wherein the controller generates control signals for steering a plurality of vehicles across a plurality of pools based on signals from a plurality of cameras associated with the plurality of pools. However, Meniere ('746) discloses a server remote from the camera and the vehicle (col.11, ln.1-22), the server comprising the controller, wherein

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the controller generates control signals for steering a plurality of vehicles across a plurality of pools based on signals from a plurality of cameras associated with the plurality of pools (col.11, ln.1-22, Meniere discloses there are multiple cameras are placed with the pools, in that Meniere discloses a system comprising a remote control that is able to control the alarm system, in that a portable electronic device in communication with the camera or any sub component of the "system"). Therefore, it would have been obvious to one of ordinary skill in the art to combine the teachings of Hong, Meniere ('351) and Meniere ('746) as a whole at the time of the invention was made for permitting the user to be informed of the conditions of the pool with accurate surveillance of the pool to detect aberrations in order to survey the pool.

Claim 13 is rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Hong (WO 2012/023676 A1) in view of Leonessa (US 2014/0009748).

Regarding claim 13, Hong does not disclose wherein the code is further configured to direct the processing unit to generate control signals steering the robotic pool cleaning vehicle so as to clean the identified portions. However, Leonessa teaches wherein the code is further configured to direct the processing unit to generate control signals steering the robotic pool cleaning vehicle so as to clean the identified portions (paragraph [37 and 89], Leonessa discloses a basic and well known feature of Pool Cleaners that comprise a cleaning program to cover surfaces of the pool, in that directing the processing unit to generate control signals steering the robotic pool cleaning vehicle so as to clean the identified portions, in other words in conjunction of sensors, optical sensors and/or cameras, the control system 10 can continuously or periodically measure object distances in front of the pool cleaner 12, map the surrounding environment, identify objects within the environment, locate the pool cleaner's position within the environment, and/or navigate the pool cleaner 12 throughout the environment; paragraph [0027], Leonessa discloses a mechanism that specifically can direct the processing unit to generate control signals steering the robotic pool cleaning vehicle according identification of specific locations of debris within the environment with the object so as to clean the said identified portions). Therefore, it would have been obvious to one of ordinary skill in the art to combine the teachings of Hong and

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Leonessa as a whole at the time of the invention was made for permitting accurate cleaning of the pool in an efficient manner.

Claim 17-19 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Hong (WO 2012/023676 A1) in view of Monroe (US 2002/0097322).

Regarding claim 17, Hong discloses a pool cleaning system comprising:

a powered robotic pool cleaning vehicle to travel adjacent to water containing surfaces of a pool while submerged within the pool (paragraph [129], Hong discloses the power supplied to the cleaning system to make it a powered robotic pool cleaning vehicle);

a dry station remote from the pool and in communication with the vehicle (paragraph [28-29], Hong discloses a dry Station that is located remote from the pool, in that station is located in a dry operating room outside and away from the wet swimming pool environment, and the station is in communication with the vehicle through a power cable to provide power supplied from an external supply source to the cleaning robot, a communication unit connected to the cleaning robot through a communication cable to transmit/receive data to/from the cleaning robot, and a central processing unit controlling the power supplied to the cleaning robot and processing the data transmitted/received to/from the cleaning robot);

a server in communication with the dry station across a local area network (paragraph [32], Hong in [32] teaches a portable electronic device in communication with the server or in other words, paragraph [137], Hong discloses the LAN port allows the terminal, portable device, etc. and the controller to exchange data, wherein LAN is connected to an outer wider network for distributing and receiving data); and

a portable electronic device in communication with the server (paragraph [137], Hong discloses the portable electronic device is in communication with the server via LAN).

Hong does not disclose wide area network, however, wide area networks (WAN) are well known in the art and Monroe teaches the implementation of wide area network for communication of data (paragraph [61], Monroe disclose using WAN with surveillance and cameras). Therefore, it would have

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been obvious to one of ordinary skill in the art to combine the teachings of Hong and Monroe as a whole at the time of the invention was made for permitting the user to be informed of the conditions of the pool with accurate surveillance of the pool to detect aberrations in order to survey the pool.

Regarding claim 18, Hong discloses further comprising: one or more processing units (); at least one non-transient computer-readable medium comprising code configured to direct the one or more processing units to cause the portable electronic device to display coverage of the water containing surfaces of the pool by the vehicle (paragraph [31], Hong discloses the controller to generate control signals steering the vehicle based on signals ascertained by the camera, and paragraph [36], Hong discloses the automatic cleaning mode for controlling the vehicle movements for moving the cleaning robot to clean a certain targeted location, and a determination process is done to determine if the cleaning robot reaches the final destination; paragraph [32], Hong discloses there is a user interface where the operator resides to view the imaged data, wherein paragraph [137], Hong discloses the display 414).

Regarding claim 19, Hong discloses further comprising a camera to capture movement of the vehicle while the vehicle is submerged within the pool (paragraph [1], Hong discloses a cleaning robot and an underwater sediment cleaning apparatus; paragraph [137], Hong discloses a camera 168, in that paragraph [178-179], Hong discloses a pool cleaner that comprises an algorithmic capacity to govern a travel forward at a sensed lower speed than an input or a threshold speed, wherein the lower speed indicates a large amount of works that is the equivalent to an unclean surface so a new steering command is given to drive backward to the original position).

Claim 20 is rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Hong (WO 2012/023676 A1) and Monroe (US 2002/0097322) in view of Meniere (US 7,123,746).

Regarding claim 20, Hong does not disclose wherein the camera comprises a pool security camera and wherein the at least one non-transient computer-readable medium causes the portable electronic device to output an alert based on signals from the camera indicating presence of a person at

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pool satisfying a predefined characteristic. However, Meniere ('746) discloses wherein the camera comprises a pool security camera and wherein the at least one non-transient computer-readable medium causes the portable electronic device to output an alert based on signals from the camera indicating presence of a person at pool satisfying a predefined characteristic (col.11, ln.1-22, Hong discloses wherein the at least one non-transient computer-readable medium or a microcomputer that includes a central processing unit and/or means for temporary storage, or RAM (Random Access Memory), means for permanent storage, or hard disk and a remote control card; col.10, ln.36-52, Meniere discloses the portable electronic device to output an alert based on signals from the camera indicating presence of a person at pool, and col.11, ln.58 to col.12, ln.3, Meniere discloses an alarm signal is emitted if the body has a suspicious trajectory for an abnormally long period of time or means for making decisions are appropriate for setting off an alarm if the slow nature of a movement or the almost-immobility of a body in the swimming pool continues over a defined period, thus disclosing satisfying a predefined characteristic). Therefore, it would have been obvious to one of ordinary skill in the art to combine the teachings of Hong, Monroe and Meniere ('746) as a whole at the time of the invention was made for permitting the user to be informed of the conditions of the pool with accurate surveillance of the pool to detect aberrations in order to survey the pool.

Contact Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to ALLEN WONG whose telephone number is (571)272-7341. The examiner can normally be reached on Flex Monday to Thursday 8am-6pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, SATH PERUNGAVOOR can be reached on (571) 272-7455. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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/ALLEN WONG/
Primary Examiner, Art Unit 2488

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Notice of References Cited	Application/Control No. 13/545,918	Applicant(s)/Patent Under Reexamination DURVASULA ET AL.	
	Examiner ALLEN WONG	Art Unit 2488	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-7,362,351	04-2008	Meniere et al.	348/143
*	B	US-7,123,746	10-2006	Meniere et al.	382/103
*	C	US-2014/0009748	01-2014	Leonessa et al.	356/4.03
*	D	US-2002/0097322	07-2002	Monroe et al.	348/159
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N	WO-2012/023676 A1	02-2012	WO	Hong	E04H 4/16
	O					
	P					
	Q					
	R					
	S					
	T					

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*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
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Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13545918	DURVASULA ET AL.
	Examiner	**Art Unit**
	ALLEN WONG	2488

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

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	06/25/2015								
	1	✓								
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	First Named Inventor	Ethan Hanan
	Art Unit	
	Examiner Name	
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	1	5435031	A	1995-07-25	Minami et al.	Entire Document
	2	5507058	A	1996-04-16	Minami et al.	Entire Document
	3	7398138	B2	2008-07-08	Emery et al.	Entire Document
	4	7993600	B2	2011-08-09	Doyle et al.	Entire Document
	5	8007653	B2	2011-08-30	Porat	Entire Document
	6	8043070	B2	2011-10-25	Stiles Jr et al.	Entire Document
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	First Named Inventor	Ethan Hanan
	Art Unit	
	Examiner Name	
	Attorney Docket Number	A150-102

	1	20070094817	A	2007-05-03	Stoltz et al.	Entire Document
	2	20110091329	A	2011-04-21	Stiles Jr et al.	Entire Document
	3	20110301752	A	2011-12-08	Finezilber	Entire Document

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Receipt date: 07/10/2012	Application Number	13545918 - GAU: 2488
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	First Named Inventor	Ethan Hanan
	Art Unit	
	Examiner Name	
	Attorney Docket Number	A150-102

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	1	(underwater or (under adj water)) with clean$4 with pool with (specif$4 or identif$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 14:29
S1	52	pool with clean$3 with robot$4 with (camera$1 or sensor$1)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 10:39
S2	2	pool with clean$3 with robot$4 with (camera$1 or sensor$1) with submerg$4 with (controller or processor)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 10:40
S3	191	348/114.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 10:40
S4	2	S1 and S3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 10:40
S5	558	pool with clean$3 with robot$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 10:41
S6	598	pool with clean$3 same robot$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 10:41
S7	846	pool with clean$3 and robot$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 10:41
S8	64	S5 and (station)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 10:41
S9	69	S6 and (station)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 10:41

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S10	137	S7 and (station)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 10:41
S11	195	(portable or miniature) near4 display$1 with water	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 10:42
S12	14	(portable or miniature) near4 display$1 with pool	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 10:42
S13	2486	E04H4/1654.CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:01
S14	4698	H04N5/23203.CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:01
S15	11531	H04N7/18.CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:01
S16	4656	H04N2005/2255.CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:02
S17	314	S5 and S13	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:03
S18	4	S5 and S14	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:03
S19	4	S5 and S15	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:03
S20	4	S5 and S16	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:03
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S22	4	S6 and S14	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:03
S23	4	S6 and S15	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:03
S24	4	S6 and S16	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:03
S25	348	S7 and S13	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:03
S26	4	S7 and S14	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:03
S27	4	S7 and S15	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:03
S28	4	S7 and S16	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:03
S29	2	S10 and S3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:03
S30	18	S10 and S13	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:03
S31	4	S10 and S14	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:04
S32	4	S10 and S15	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:04
S33	4	S10 and S16	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:04

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S34	1	S11 and S3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:04
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S36	1	S11 and S14	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:04
S37	1	S11 and S15	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:04
S38	1	S11 and S16	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:04
S39	1	S1 and WAN	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:04
S40	1	S1 and wide adj area adj network	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:05
S41	7	S5 and ((wide adj area adj network) or WAN)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:05
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S64	7	S56 and (display or monitor)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:07
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S66	1	13/545918.app.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:30
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S68	407	(underwater or (under adj water)) with clean$4 with pool	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:48
S69	23	(underwater or (under adj water)) with clean$4 with pool with (robot$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:49

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S70	30	(underwater or (under adj water)) same clean$4 with pool with (robot$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:52
S71	30	("20070094817" | "20110091329" | "20110301752" | "5435031" | "5507058" | "7398138" | "7993600" | "8007653" | "8043070").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/06/25 11:54

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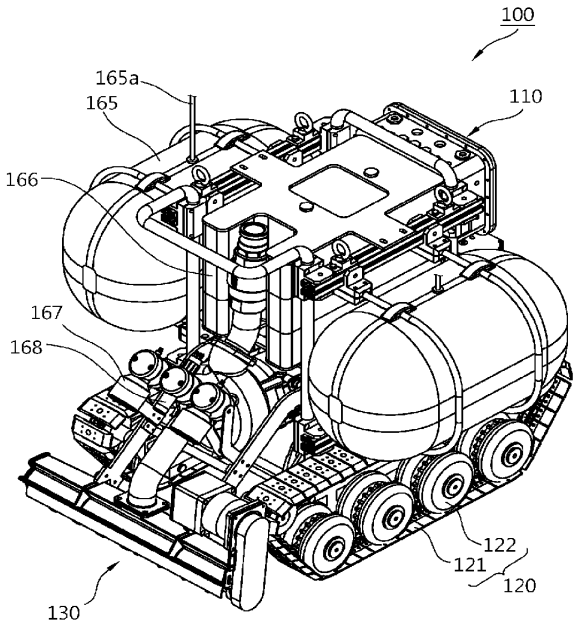
[Continued on next page]

(54) Title: CLEANING ROBOT AND UNDERWATER SEDIMENT CLEANING APPARATUS AND METHOD

[Fig. 1]



(57) Abstract: A cleaning robot capable of cleaning a water tank in an unmanned manner and an underwater sediment cleaning apparatus and method are provided. The cleaning robot includes a body put into a water tank, a driver supporting the body and moving the body, a suction part arranged in front of the body and sucking contaminated water containing sediment in the water tank, and a tilting part supported by the body to support the suction part and rotating the suction part on an axis corresponding to the direction across the moving direction of the body.

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Description

Title of Invention: CLEANING ROBOT AND UNDERWATER SEDIMENT CLEANING APPARATUS AND METHOD

Technical Field

[0001] The present invention relates to a cleaning robot and an underwater sediment cleaning apparatus and method and, more particularly, to a cleaning robot and an underwater sediment cleaning apparatus and method for cleaning sediment accumulated in a water tank.

[0002]

Background Art

[0003] Water is used for various industrial facilities and production facilities, and thus there are a water tank reserving water and facilities for administrating the water tank. Since sediment is accumulated in the water tank, the water tank requires to be periodically cleaned in order to manage water quality and prevent equipment using water from being damaged.

[0004] A conventional water tank cleaning method includes an operation of discharging water reserved in the water tank, an operation of removing sediment from the water tank and an operation of storing water in the water tank.

[0005] The removal operation in the conventional water tank cleaning method is manually performed by operators. Specifically, the removal operation is carried out in such a manner that the operators enter the drained water tank, accumulate sediment using a push rod, a bulldozer, etc., suck the accumulated sediment and discharge the sediment to the outside of the water tank.

[0006]

Summary of Invention

Technical Problem

[0007] This manually performed water tank cleaning method requires a long time for cleaning. Furthermore, it has to stop the operations of facilities using the water of the water tank while the water tank is cleaned. These problems deteriorate production efficiency of industrial facilities or production facilities using the water tank.

[0008] Moreover, since the sediment accumulated in the water tank used for the industrial facilities or production facilities contains toxic materials in many cases, the conventional cleaning method may cause safety accidents when the operators entering the water tank are exposed to the toxic materials.

[0009] Furthermore, the conventional cleaning method does not recycle drained water to result in waste of water resources.

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[0010]

Solution to Problem

[0011] A cleaning robot according to an aspect of the present invention comprises a body put into a water tank, a driver supporting the body and moving the body, a suction part arranged in front of the body and sucking contaminated water containing sediment in the water tank, and a tilting part supported by the body to support the suction part and rotating the suction part on an axis corresponding to the direction across the moving direction of the body.

[0012] The suction part may comprise a suction tube opened to the front of the body, a screw arranged in a direction to the suction tube, located at the front of the suction tube and having screw threads tilted to the suction tube, and a rotary motor connected to the shaft of the screw to rotate the screw.

[0013] The cleaning robot may further comprise a contaminated water discharge pipe connected with the suction tube to form a path for discharging the contaminated water sucked through the suction tube and a swivel joint provided between the contaminated water discharge pipe and the suction tube.

[0014] The cleaning robot may further comprise a suction pump arranged between the suction tube and the swivel joint and a pump hanger set in the body to elastically support the suction pump.

[0015] The tilting part may comprise a support supporting the suction part with its front end, being rotatably combined with the body and rotating from the body on a first supporting pin provided in a direction across the moving direction of the body, a first link joint having a first end connected to the support through a first link pin, a second link joint having a first end connected to a second end of the first link joint through a second link pin and a second end connected to the body through a second supporting pin, being rotatably combined with the body and rotating on the second supporting pin, and a tilt cylinder having an output terminal connected to the second link pin.

[0016] The cleaning robot may further comprise a tilt limit sensing part arranged behind the support to sense the lower limit point and the upper limit point of the support.

[0017] The cleaning robot may further comprise a location information sensing part supported by the body and exposed from the surface of water in the water tank.

[0018] The location information sensing part may comprise a GPS sensor controller supported by the body and a GPS antenna connected to the GPS sensor controller and located above the GPS sensor controller.

[0019] The cleaning robot may further comprise a buoy provided between the body and the GPS sensor controller and floating on the surface of the water in the water tank, and retractable support supporting the GPS sensor controller and the GPS antenna from the

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body and combined with the buoy, the retractable support having a length increasing or decreasing according to the distance between the body and the buoy.

[0020] The cleaning robot may further comprise a balloon connected with the body and a supply pipe connected to the balloon to supply a gas to the balloon.

[0021] The cleaning robot may further comprise a neutral buoy provided to the body to maintain neutral buoyancy.

[0022] The cleaning robot may further comprise a bumper part installed in front of the suction part.

[0023] The bumper part may comprise bumper wheels arranged to roll on an obstruction appearing in front of the body and a supporting frame supporting the bumper wheels.

[0024] The supporting frame may be rotatably combined with the body and rotating on an axis corresponding to the direction across the moving direction of the body, and the cleaning robot may further comprise a rotation angle sensing part arranged behind the supporting frame to sense the rotation angle of the supporting frame.

[0025] An underwater sediment cleaning apparatus according to another aspect of the present invention comprises a cleaning robot put into a water tank to suck contaminated water containing sediment in the water tank, a sediment separator located outside the water tank, receiving the contaminated water from the cleaning robot, filtering the sediment from the contaminated water and discharging clean water obtained by filtering the sediment from the contaminated water to the water tank, and a controller located outside the water tank and connected to the cleaning robot to control the operation of the cleaning robot.

[0026] The sediment separator may comprise a tank having a first side connected with a contaminated water discharge pipe extended from the cleaning robot, an intake pipe having a first end connected to a second side of the tank and a second end opened to the water tank to allow the clean water to flow into the water tank, and a filter set inside the tank to filter the sediment from the contaminated water flowing to the intake pipe.

[0027] The underwater sediment cleaning apparatus may further comprise a sediment discharge pipe having a first end connected to the first side of the tank and a second end opened to the outside of the tank.

[0028] The controller may be installed in an operating room which is located outside the water tank and movable.

[0029] The controller may comprise a power supply connected to the cleaning robot through a power cable to provide power supplied from an external supply source to the cleaning robot, a communication unit connected to the cleaning robot through a communication cable to transmit/receive data to/from the cleaning robot, and a central processing unit controlling the power supplied to the cleaning robot and processing the

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data transmitted/received to/from the cleaning robot.

[0030] The controller may further comprise a wheel driver controlling the moving operation of the cleaning robot, a screw driver controlling the rotation speed and rotation direction of a screw included in the cleaning robot, a tilt driver controlling the tilting angle of a tilting part included in the cleaning robot, and a pump driver controlling the operation of a suction pump included in the cleaning robot. The wheel driver, the screw driver, the tilt driver and the pump driver may be connected to the central processing unit, and the central processing unit may process control commands generated from wheel driver, the screw driver, the tilt driver and the pump driver.

[0031] The controller may further comprise a camera unit controlling an image captured by a camera included in the cleaning robot, a light unit controlling the brightness of a light included in the cleaning robot, a sensor unit controlling a sensing signal generated from sensors included in the cleaning robot, and an automatic cleaning unit receiving location information from the cleaning robot and controlling the location of the cleaning robot. The camera unit, the light unit, the sensor unit and the automatic cleaning unit may be connected to the central processing unit, and the central processing unit may process control commands generated from the camera unit, the light unit, the sensor unit and the automatic cleaning unit.

[0032] The underwater sediment cleaning apparatus may further comprise an operation console set in a bag carried by an operator, connected to the controller and allowing the operator to operate the cleaning robot.

[0033] The operation console may comprise a camera switch turning on/off the camera included in the cleaning robot, a brightness controller controlling the brightness of the light include in the cleaning robot, a status lamp indicating statuses of the sensors included in the cleaning robot, a display displaying the image captured by the camera, the route of the cleaning robot and the location of the cleaning robot, a mode selection switch for selecting one of a manual cleaning mode and an automatic cleaning mode of the cleaning robot, a screw switch for controlling the rotation speed and rotation direction of the screw included in the cleaning robot, a screw tilt joystick controlling the tilting angle of the screw, a pump switch turning on/off the suction pump included in the cleaning robot, a driving joystick steering the cleaning robot, a speed control switch for controlling the moving speed of the cleaning robot, and an emergency stop switch for stopping the cleaning unit.

[0034] The underwater sediment cleaning apparatus may further comprise a generator generating the power supplied to the controller and a compressor connected to a balloon included in the cleaning robot to inject a gas into the balloon.

[0035] An underwater sediment cleaning method according to another aspect of the present invention comprises a preparation step of putting a cleaning robot into a water tank and

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preparing cleaning the water tank, a suction step of sucking contaminated water containing sediment in the water tank by means of the cleaning robot moving in the water tank, a discharging step of discharging the contaminated water to a tank arranged outside the water tank, and filtering step of discharging the sediment contained in the contaminated water to the outside of the tank and making clean water obtained by filtering the sediment from the contaminated water flow into the water tank.

[0036] The preparation step may comprise the steps ofsetting the whole area of the water tank, setting a moving route of the cleaning robot in the whole area of the water tank, controlling the space between neighboring route parts of the moving route of the cleaning robot to set a degree of precision of cleaning the water tank, and selecting one of the automatic cleaning mode and the manual cleaning mode.

[0037] An automatic cleaning operation according to selection of the automatic cleaning mode may comprise a control step of receiving location information from the cleaning robot and controlling the location of the cleaning robot, a moving step of moving the cleaning robot along the route, a target point arrival determination unit of determining whether the cleaning robot arrives at a target point, and a cleaning completion determination step of determining whether the cleaning robot reaches a final target point.

[0038] The control step may comprise the steps of receiving first location information from a GPS sensor included in the cleaning robot and acquiring second location information from a encoder included in the cleaning robot, applying the first location information and the second location information to extended Kalman filter to correct the current location of the cleaning robot, calculating a target point which has to be tracked by the cleaning robot from the current location of the cleaning robot, calculating a difference between the current location of the cleaning robot and the target point, and calculating speed values of left and right wheels of the cleaning robot based on the calculated difference.

[0039] When the cleaning robot does not reach the target point in the target point arrival determination step, the cleaning method may further comprise calculating the current load of the cleaning robot and comparing the current load of the cleaning robot with an optimal load of the cleaning robot to detect the load of the cleaning robot.

[0040] The optimal load of the cleaning robot may be calculated based on the current consumed by the cleaning robot, the speed of the wheels revolving when the cleaning robot is driven and a variation in the location of the cleaning robot.

[0041] A detour of the cleaning robot is generated when the current load of the cleaning robot exceeds the optimal load.

[0042] The operation of generating the detour of the cleaning robot may comprise the steps of detecting a target point at which the cleaning robot cannot arrive from the current location, removing the detected target point from the route of the cleaning robot,

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generating new target point candidates at which the cleaning robot can arrive from the current location, and selecting a new target point from the generated new target point candidates.

[0043] A moving route of the cleaning robot may be secured when the current load of the cleaning robot is less than the optimal load.

[0044] The operation of securing the moving route of the cleaning robot may comprise the steps of moving the cleaning robot forward and moving the cleaning robot backward to return the cleaning robot to the position before being moved forward, and the step of moving the cleaning robot forward and the step of returning the cleaning robot may be repeated for a predetermined operating time.

[0045] When the cleaning robot cannot be moved forward, the cleaning method may further comprise the steps of moving the cleaning robot forward while turning the cleaning robot left or right and moving the cleaning robot backward to return the cleaning robot to the position before being moved forward, and the step of moving the cleaning robot forward and the step of returning the cleaning robot may be repeated for a predetermined operating time.

[0046] When the cleaning robot cannot be turned left or right or moved forward, the cleaning method may further comprise the step of moving the cleaning robot backward to a position behind the position before being moved forward, and the step of moving the cleaning robot forward and the step of moving the cleaning robot backward may be repeated for the predetermined operating time.

[0047]

Advantageous Effects of Invention

[0048] The cleaning robot and underwater sediment cleaning apparatus and method according to the present invention can protect operators from exposure to toxic materials contained in sediment accumulated in the water tank so as to prevent accidents from happening.

[0049] Furthermore, the cleaning robot and underwater sediment cleaning apparatus and method according to the present invention can allow the water tank to be used even when the water tank is being cleaned, and thus water tank utilization efficiency can be improved.

[0050] Moreover, the cleaning robot and underwater sediment cleaning apparatus and method according to the present invention can filter contaminated water to generate clean water to thereby save water resources.

Brief Description of Drawings

[0051] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, il-

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lustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention. In the drawings:

[0052] FIG. 1 is a perspective view of a cleaning robot according to an embodiment of the present invention;

[0053] FIG. 2 is a perspective view of part of the cleaning robot shown in FIG. 1;

[0054] FIG. 3 is a bottom view of part of a suction part of the cleaning robot shown in FIG. 1;

[0055] FIG. 4 is a perspective view of the cleaning robot with a bumper part according to an embodiment of the present invention;

[0056] FIG. 5 is a side view roughly showing a rotation angle sensing part of the cleaning robot shown in FIG. 1;

[0057] FIG. 6 is a perspective view of the cleaning robot including a location information sensing part and a retractable support according to an embodiment of the present invention;

[0058] FIG. 7 is a block diagram of an underwater sediment cleaning apparatus according to an embodiment of the present invention;

[0059] FIG. 8 is a perspective view of a sediment separator of the underwater sediment cleaning apparatus shown in FIG. 7;

[0060] FIG. 9 is a block diagram showing connections among the cleaning robot, a controller and an operation console of the cleaning apparatus according to an embodiment of the present invention;

[0061] FIG. 10 is a front view showing the exterior of the controller of the underwater sediment cleaning apparatus according to an embodiment of the present invention;

[0062] FIG. 11 illustrates the exterior of the operation console of the underwater sediment cleaning apparatus according to an embodiment of the present invention;

[0063] FIG. 12 is a flowchart showing an underwater sediment cleaning method;

[0064] FIG. 13a is a flowchart showing a preparation step in the underwater sediment cleaning method shown in FIG. 12;

[0065] FIGS. 13b, 13c, 13d and 13e are plan views showing coordinates, routes and the space between neighboring route parts, which are set based on the shape of the bottom of a water tank in the underwater sediment cleaning method shown in FIG. 12;

[0066] FIG. 14 is a flowchart showing a cleaning method according to an automatic cleaning mode according to an embodiment of the present invention;

[0067] FIG. 15 is a flowchart showing a control step in the cleaning method according to the automatic cleaning mode, shown in FIG. 14;

[0068] FIG. 16 is a flowchart showing an operation of generating a detour of the cleaning robot in the cleaning method according to the automatic cleaning mode, shown in FIG. 14;

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[0069] FIG. 17 is a view for explaining an algorithm of generating the detour of the cleaning robot in the cleaning method according to the automatic cleaning mode, shown in FIG. 14; and

[0070] FIG. 18 is a flowchart showing an operation of securing a moving route of the cleaning robot when the cleaning robot is moved according to the automatic cleaning mode in the underwater sediment cleaning method according to the present invention.

[0071]

Best Mode for Carrying out the Invention

[0072] Hereinafter, an embodiment of the present invention will be described below with reference to the accompanying drawings.

[0073] FIG. 1 is a perspective view of a cleaning robot 100 according to an embodiment of the present invention.

[0074] Referring to FIG. 1, the cleaning robot 100 includes a body 110, a driver 120, a suction part 130, and a tilting part 140.

[0075] The driver 120 supports and drives the body 110 and includes a caterpillar 121 and a plurality of wheels 122.

[0076] The caterpillar 121 allows the body 110 to show excellent running performance even in a poor operating environment such as the bottom of a water tank, which has an uneven surface or is covered with mud. The shoes of the caterpillar 121 may be made of one of reinforced plastic, urethane and stainless steel and a component such as spikes can be additionally attached to the caterpillar 121.

[0077] The caterpillar 121 generally uses shoes made of reinforced plastics. If the bottom of the water tank is formed of synthetic resin such as a tarpaulin or rubber, the caterpillar 121 can use urethane shoes in order to minimize damage of the bottom of the water tank. When the bottom of the water tank is covered with mud, the caterpillar 121 can use stainless steel shoes to secure the running performance of the body 110 and additionally use spikes attached to the shoes.

[0078] The plurality of wheels 122 support the caterpillar 121. The wheels 122 maintain the grip of the caterpillar 121 even when the caterpillar 121 runs on the uneven surface of the bottom of the water tank. The wheels 122 are configured to absorb shock transferred from the uneven surface of the bottom of the water tank and buffer the load of the body 110. That is, suspensions (not shown) are respectively provided to shafts of the wheels 122 and urethane having adjusted hardness can be molded and used for the shafts.

[0079] The suction part 130 is arranged in front of the body 110 to suck contaminated water containing sediment in the water tank.

[0080] FIG. 2 is a perspective view of part of the cleaning robot shown in FIG. 1 and FIG. 3

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is a bottom view of part of the suction part 130 of the cleaning robot 100 shown in FIG. 1.

[0081] Referring to FIGS. 2 and 3, the suction part 130 includes a suction tube 131, a screw 132 and a rotary motor 133. The suction tube 131 may be configured such that one end thereof is opened to the front of the body 110 and the other end is formed in a shape that comes into closely contact with the bottom of the water tank and is extended to a direction to the moving direction of the body 110 to scrape sediment accumulated on the bottom of the water tank as the body 110 moves. In an alternative embodiment, one end of the suction tube 131 may be combined with a separate scraper opened to a direction across the moving direction of the body 110.

[0082] The screw 132 is arranged in a direction to the suction tube 131 at the front of the body 110. The screw 132 has screw threads 132a arranged at both sides of the suction tube 131 and tilted to the suction tube 131. The screw threads 132a crush the sediment accumulated on the bottom of the water tank such that the sediment can be smoothly sucked through the suction tube 131.

[0083] The screw 132 can be made of stainless steel when the sediment is not easily scraped off the bottom of the water tank due to its high viscosity and a brush made of nylon or urethane can be used to remove the sediment when the sediment is easily scraped off the bottom of the water tank due to its low viscosity.

[0084] The rotary motor 133 is connected to the screw 132 through a power transmission means such as a chain, a timing belt or the like. The rotary motor 133 rotates the screw 132 forward such that sediment dispersed to both sides of the suction tube 131 can be accumulated before the suction tube 131. On the contrary, the rotary motor 133 rotates the screw 132 reversely such that particles which are located in front of the suction tube 131 and obstructed suction of the sediment can be moved to the outside of the screw 132.

[0085] The tilting part 140 supports the suction part 130 against the body 110 and rotates the suction part 130 on an axis corresponding to a direction across the moving direction of the body 110. The tilting part 140 includes a support 141, a first link joint 142, a second link joint 143, and a tilt cylinder 144.

[0086] The support 141 supports the suction part 130 with its front end. The support 141 is rotatably combined with the body 110 and rotates on a first supporting pin 141a provided in a direction across the moving direction of the body 110.

[0087] One end of the first link joint 142 is connected to the support 141 by means of a first link pin 142a and one end of the second link joint 143 is connected to the other end of the first link joint 142 by means of a second link pin 142b. The other end of the second link joint 143 is connected to the body 110 through a second supporting pin 143a. The second link joint 143 is rotatably combined with the body 110 and rotates on the

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second supporting pin 143a. The tilt cylinder 144 has an output terminal connected to the second link pin 142b. The tilt cylinder 144 moves the second link pin 142b forward and backward such that the suction part 130 supported by the support 141 can rotate on the first supporting pin 141a.

[0088] The tilting part 140 controls a sediment suction rate. That is, the tilting part 140 can increase the suction rate by narrowing the distance between the bottom of the water tank and the suction part 130 and decrease the suction rate by widening the distance between the bottom of the water tank and the suction part 130.

[0089] Here, a tilt limit sensing part 150 that senses the upper limit and lower limit of the support 141 is arranged behind the support 141 to prevent the suction part 130 from excessively tilting. The tilt limit sensing part 150 includes a tilt loader 151 combined with the back end of the support 141 and tilted with the support 141, a lower limit sensor 152 located above the tilt loader 151, and an upper limit sensor 153 arranged under the tilt loader 151.

[0090] The tilt limit sensing part 150 can sense the lower limit point and the upper limit point of the support 141 to prevent the suction part 130 from excessively tilting.

[0091] Meanwhile, the cleaning robot 100 includes a suction pump 161, a pump hanger 162, a contaminated water discharge pipe 163, and a swivel joint 164.

[0092] The suction pump 161 is placed on the body 110 and connected to the other end of the suction tube 131. The suction pump 161 sucks the sediment accumulated before the suction tube 131 through the suction tube 131.

[0093] The pump hanger 162 hangs the suction pump 161 on the body 110 such that the suction pump 161 is supported by the body 110. An elastic member such as rubber, coil spring or the like may be provided to the connecting portion of the pump hanger 162 and the body 110. The elastic member prevents shock caused by vibrations generated from the operation of the suction pump 161 and moving of the body 110 from being transferred to the body 110 and the suction pump 161.

[0094] The contaminated water discharge pipe 163 has a first end connected with the suction tube 131 and a second end extended to the outside of the water tank. The contaminated water discharge pipe 163 forms a contaminated water discharge route through which contaminated water sucked through the suction tube 131 can be discharged to the outside of the water tank.

[0095] The swivel joint 164 is provided between the suction tube 131 and the contaminated water discharge pipe 163. The swivel joint 164 prevents the contaminated water discharge pipe 163 from turning along the suction tube 131 when the body 110 moves, particularly, when the body 110 turns, and thus the contaminated water discharge pipe 163 is not twisted.

[0096] As described above, the suction pump 161 is hung on the pump hanger 162 and

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combined with the body 110. In an alternative embodiment, the suction pump 161 may be located outside the water tank and connected to the contaminated water discharge pipe 163, which is not shown.

[0097] The cleaning robot 100 includes a balloon 165 and a supply pipe 165a, shown in FIG. 1, as means for floating the body 110 located inside the water tank on the surface of the water in the water tank.

[0098] Referring back to FIG. 1, the balloon 165 is connected with the body 110. The supply pipe 165a has a first end connected to the balloon 165 and a second end connected to a compressor 501 located outside the water tank, shown in FIG. 7, which will be explained later, to form a passage for supplying a gas to the balloon 165. The balloon 165 makes the cleaning robot 100 float on the surface of the water in the water tank when the cleaning robot 100 is difficult to move in the water or wrongly operates.

[0099] Here, the number and volume of balloons can be adjusted based on the weight of the cleaning robot 100. Furthermore, a neutral buoy 166 that maintains neutral buoyancy in the cleaning robot 100 when the cleaning robot 100 cannot float may be additionally provided to the body 110.

[0100] In addition, the supply pipe 165a may be placed with a power cable and a communication cable, which will be described later, in a single cable and connected to the cleaning robot 100. The supply pipe 165a may be come out of the cable in the body 110 and connected to the balloon 165.

[0101] The cleaning robot 100 may include a bumper part 170 provided in front of the body 110.

[0102] FIG. 4 is a perspective view of the cleaning robot with the bumper part 170 according to an embodiment of the present invention.

[0103] Referring to FIG. 4, the bumper part 170 includes a supporting frame 171 and bumper wheels 172. The supporting frame 171 supports the bumper wheels 172 and a elevating wheel 181 which will be explained later. The supporting frame 171 rotates on an axis corresponding to a direction across the moving direction of the body 110.

[0104] The bumper wheels 172 are provided to be supported by the supporting frame 171 to roll in contact with obstructions appearing in front of the body 110. The bumper wheels 172 are arranged in a direction across the moving direction of the body 110. The bumper wheels 172 are provided such that the outermost bumper wheels are located outside the front corners of the body 110.

[0105] The bumper wheels 172 absorb shock generated when the cleaning robot 100 moving in the water tank collides with obstructions such as the inner walls of the water tank and a structure installed in the water tank and prevent the inner walls of the water tank, the structure in the water tank and the cleaning robot 100 from being damaged. To complement the shock-absorbing force of the bumper wheels 172, an elastic member

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such as a coil spring or rubber may be provided to shafts of the bumper wheels 172.

[0106] The cleaning robot 100 can detect the height of the sediment on the bottom of the water tank based on the rotation angle of the supporting frame 171 to estimate the quantity of the sediment. Specifically, the cleaning robot 100 can estimate that there is a small quantity of sediment when the rotation angle of the supporting frame 171 is narrow and estimate that there is a large quantity of sediment when the rotation angle of the supporting frame 171 is wide. Accordingly, the cleaning robot 100 may include a rotation angle sensing part 180 for sensing the rotation angle of the supporting frame 171.

[0107] FIG. 5 is a side view roughly showing the rotation angle sensing part of the cleaning robot 100.

[0108] Referring to FIG. 5, the rotation angle sensing part 180 includes an elevating wheel 181, a rotary loader 182 and a plurality of rotation angle sensors 183.

[0109] The elevating wheel 181 is supported by the supporting frame 171 to roll in contact with the bottom of the water tank. As described above, the supporting frame 171 is installed such that it can rotate on the axis corresponding to the direction across the moving direction of the body 110, and thus the elevating wheel 181 rolls on the bottom of the water tank and moves up and down according to the height of the sediment in the water tank. The rotary loader 182 is combined with the back end of the supporting frame 171 and rotates with the supporting frame 171. The rotation angle sensors 183are arranged behind the rotary loader 182and sense the rotation angle of the supporting frame 171.

[0110] The rotation angle sensing part 180 can estimate the quantity of the sediment in the water tank based on the height of the sediment by sensing the rotation angle of the supporting frame 171. The estimated quantity is used to control the tilting angle of the suction part 130 according to the tilting part 140, the power of the suction pump 161, the moving direction of the body 110 and whether the water tank cleaning operation continues.

[0111] Referring back to FIG. 1, the cleaning robot 100 includes a camera 168 and a light 167 installed in front of the body 110.

[0112] The camera 168 photographs the cleaning operation of the cleaning robot 100, the environment where the cleaning robot 100 operates, the overall operating state of the cleaning robot 100, etc. The camera 168 may be constructed in such a manner that a pan/tilt camera is set in a globular waterproof case.

[0113] The light 167 may use one of a high intensity discharge (HID) lamp, tungsten halogen lamp and a light emitting diode (LED).

[0114] The cleaning robot 100 is configured such that it can be aware of the location thereof.

[0115] FIG. 6 is a perspective view of the cleaning robot with a location information sensing

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part 190, a buoy 193 and a retractable support 194 according to an embodiment of the present invention.

[0116] Referring to FIG. 6, the cleaning robot 100 includes the location information sensing part 190, the buoy 193 and the retractable support 194.

[0117] The location information sensing part 190 senses the location of the body 110 in the water tank and includes a global positioning system (GPS) sensor 191 and a GPS antenna 192. The GPS sensor 191 is supported by the retractable support 194 and the GPS antenna 192 is pulled out of the GPS sensor 191 and set up on the GPS sensor 191. Here, the GPS sensor 191 can use a deep GPS (DGPS) sensor having an error range of several dozen meters although it can use a general GPS sensor having an error range of several meters.

[0118] The buoy 193 is located under the GPS sensor 191 and combined with the retractable support 194. The buoy 193 makes the GPS sensor 191 float on the surface of the water in the water tank all the time.

[0119] The retractable support 194 includes a combining rod 194a, elevating rods 194b and rollers 194c. The combining rod 194a is combined with the body 110. The elevating rods 194b are connected with the combining rod 194a and combined with the buoy 193 and the GPS sensor 191 to be elevated from the combining rod 194a according to the level of the water in the water tank. The number of the elevating rods 194b may be increased or decreased. The rollers 194c are provided between the combining rod 194a and the elevating rods 194b and between the elevating rods 194b and roll to support the elevating rods 194b.

[0120] Furthermore, the cleaning robot 100 can estimate its moving range based on the number of revolutions, transmitted from an encoder mounted on a wheel motor 122a (refer to FIG. 6) for driving the wheels 122.

[0121] An underwater sediment cleaning apparatus using the aforementioned cleaning robot according to embodiments of the present invention will now be explained with reference to the attached drawings.

[0122] FIG. 7 is a block diagram of the underwater sediment cleaning apparatus 500 according to the present embodiment and FIG. 8 is a perspective view of a sediment separator 200 of the underwater sediment cleaning apparatus 500 shown in FIG. 7.

[0123] Referring to FIGS. 7 and 8, the underwater sediment cleaning apparatus 500 includes the cleaning robot 100, the sediment separator 200, a controller 300 and an operation console 400.

[0124] The contaminated water discharge pipe 163 connected to the cleaning robot 100 is extended to the sediment separator 200.

[0125] The sediment separator 200 separates sediment from the contaminated water sucked from the cleaning robot 100 and includes a tank 210, a sediment discharge pipe 220, an

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intake pipe 230 and a filter 240. The tank 210 is located outside the water tank and the contaminated discharge pipe 163 is connected to an upper portion of one side of the tank 210. The sediment discharge pipe 220 is connected to a lower portion of one side of the tank 210. The sediment discharge pipe 220 is connected to a vacuum car located outside the tank 210 to form a route for discharging sediment filtered by the filter 240 and left in the tank 210. The intake pipe 230 is connected to the other side of the tank 210 and extended to the water tank 10. The intake pipe 230 has a valve 231 which controls the flow rate of clean water obtained by filtering the sediment of the contaminated water using the filter 240.

[0126] The filter 240 is provided between one side and the other side of the tank 210 and filters the sediment from contaminated water.

[0127] An operating room 20 is arranged outside the water tank 10. The operating room 20 may use a container box such to be movable. The controller 300 for controlling the cleaning robot 100 is installed in the operating room 20. The operating room 20 may have the controller 300, a generator 502 for providing power to the cleaning robot 100 and a compressor 501, which are installed therein.

[0128] FIG. 9 is a block diagram showing connections of the cleaning robot 100, the controller 300 and the operation console 400 of the underwater sediment cleaning apparatus according to the present embodiment.

[0129] Referring to FIG. 9, the controller 300 includes a power supply 310, a communication unit 320 and a central processing unit 330. The power supply 310 and the communication unit 320 are connected to the cleaning robot 100 and the central processing unit 330 through the power cable and the communication cable. The power supply 310 can supply power generated from the generator 502 shown in FIG. 7. Otherwise, the power supply 310 may use power provided by an external power supply source.

[0130] Furthermore, the controller 300 includes a wheel driver 341, a screw driver 342, a pump driver 343, and a tilt driver 344. The wheel driver 341 is connected to the driver 120 of the cleaning robot 100 through the central processing unit 330 and controls the operation of the cleaning robot 100. The screw driver 342 is connected to the motor 133 of the cleaning robot 100 through the central processing unit 330 and controls the rotation speed and rotation direction of the screw 132. The tilt driver 344 is connected to the tilt cylinder 144 of the cleaning robot 100 through the central processing unit 300 and controls the tilting angle of the suction part 130. The pump driver 343 is connected to the suction pump 161 of the cleaning robot 100 through the central processing unit 330 and controls the operation of the suction pump 161 through the central processing unit 330.

[0131] In addition, the controller 300 includes a camera unit 351, a lighting unit 352, a

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sensor unit 353 and an automatic cleaning unit 354. The camera unit 351 is connected to the camera 168 of the cleaning robot 100 through the central processing unit 330, processes images captured by the camera 168 and displays the processed images. The lighting unit 352 is connected to the light 167 of the cleaning robot 100 through the central processing unit 330 and controls the brightness of the light 167. The sensor unit 353 is connected to the tilt limit sensing part 150 and the rotation angle sensing part 180 of the cleaning robot 100 through the central processing unit 330 and processes sensing signals generated from sensors included in the tilt limit sensing part 150 and the rotation angle sensing part 190.

[0132] The automatic cleaning unit 354 is connected to the cleaning robot 100 through the central processing unit 330 analyzes the location of the cleaning robot 100 and controls the cleaning robot 100 to move along a predetermined route. The automatic cleaning unit 354 may use an industrial computer. The automatic cleaning unit 354 has a touch screen which displays the location of the cleaning robot 100 and a cleaning area.

[0133] As described above, the central processing unit 330 is connected to the drivers 341,342,343 and 344 and the units 351, 352, 353 and 354 and linked to the cleaning robot 100 through the power supply 310 and the communication unit 320. The central processing unit 330 controls the power supplied to the cleaning robot 100 and processes data transmitted between the cleaning robot 100 and other components of the cleaning apparatus. Furthermore, the central processing unit 330 processes control commands of the drivers 341, 342, 343 and 344 and the units 351, 352, 353 and 354.

[0134] FIG. 10 is a front view of the exterior of the controller of the underwater sediment cleaning apparatus according to the present embodiment.

[0135] Referring to FIG. 10, the controller 300 includes an input connector 361, an output connector 362, a control connector 363 and a pneumatic connector 364. The input connector 361 is connected to an input cable extended to be provided with power supplied from the generator 502 or the external power supply source. The output connector 362 is connected to an output cable coupled to the cleaning robot 100. The control connector 363 is connected to the cleaning robot 100 to be coupled to a communication cable through which data is transmitted/received between the cleaning robot 100 and other components of the cleaning apparatus. The pneumatic connector 364 is connected to the balloon 165 and the supply pipe 165a supplying a gas to the balloon 165.

[0136] Moreover, the controller 300 includes an operation console connector 400a, a plurality of output plugs 365, a LAN port 366, and an image output port 367. The operation console connector 400a connects the operation console 400and the controller 300. The operation console connector 400a allows the power supplied to the controller 300 to be provided to the operation console 400 and permits the controller 300 and the

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operation console 400 to transmit/receive data to/from each other. There may be a plurality of operation console connectors 400a to connect a plurality of operation consoles to the controller 300.

[0137] The output plugs 365 provide power to a terminal, a portable device, etc. other than the operation console 400 using the power supplied to the controller 300. The LAN port 365 allows the terminal, portable device, etc. and the controller 300 to exchange data. The image output port 367 transmits an image signal corresponding to an image photographed by the camera 168 to the operation console 400 such that a display 414 provided to the operation console 400 displays the image.

[0138] In addition, the controller 300 includes an input power switch 368, an input power state lamp 369, an output power state lamp 370, an operation stand-by state lamp 371, a warning buzzer 372, a first emergency stop switch 373, a reset button 374, an automatic cleaning unit power switch 375, and a first brightness control switch 376.

[0139] The input power switch 368 allows input power applied to a power connector to be supplied to the controller 300 and the cleaning robot 100. The input power state lamp 369 indicates whether or not the input power supplied to the controller 300 is normal. If the cleaning apparatus performs an underwater cleaning work outdoors, the input power may have input current lower than the current used by the controller 300. On the contrary, the input power may have input current higher than the current used by the controller 300. That is, when the input power becomes abnormal, the input power state lamp 369 blinks to warn that the input power is abnormal. The output power state lamp 370 indicates whether or not the power supplied to the cleaning robot 100 is normal. The power cable connected to the cleaning robot 100 may be down due to its abnormal state or excessive current cause by electric leakage or overload may flows. When the output power becomes abnormal, as described, the output power state lamp 370 blinks to warn that the output power state is abnormal. The operation stand-by state lamp 371 indicates that power is supplied to the controller 300 and all of components are ready to operate so that the cleaning robot 100 can be operated. The warning buzzer 372 generates alarm sound when a wrong operation occurs during operator's absence to inform the operator to know the wrong operation. The first emergency stop switch 373 is used to stop the operation of the controller 300 and make the controller 300 to cut power. The reset button 374 is used to reset the cleaning apparatus when the cleaning apparatus cannot normally operate due to overload applied to the controller 300 or the cleaning robot 100 or other unknown causes. The reset button 374 blinks a warning light when the cleaning apparatus cannot normally operate. The automatic cleaning unit power switch 375 is used to select an automatic cleaning mode or a manual cleaning mode. The user can select the manual cleaning mode by turning the automatic cleaning unit power switch 375 to 'manual cleaning mode' and select the automatic

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cleaning mode by turning the automatic cleaning unit power switch 375 to 'automatic cleaning mode'. When the automatic cleaning mode is selected, the automatic cleaning unit 354 starts to operate (for example, activate GPS unit and activates related software).

[0140] The first brightness control switch 376 is configured in the form of a rotary switch and controls the brightness of the light 167 included in the cleaning robot 100.

[0141] Referring back to FIG. 7, the operation console 400 is connected to the controller 300 and used for the operator to manually operate the cleaning robot 100. The operation console 400 may be provided in the form of a bag such that the operator can easily carry the operation console 400.

[0142] FIG. 11 illustrates the exterior of the operation console of the underwater sediment cleaning apparatus according to the present embodiment.

[0143] Referring to FIGS. 9 and 11, the operation console 400 includes a camera switch 411, a second brightness control switch 412, a status lamp 413 and the display 414. The camera switch 411 is connected to the camera unit 351. The camera switch 411 is used to turn on/off the camera 168 included in the cleaning robot 100. The second brightness control switch 412 is connected to the lighting unit 352 and controls the brightness of underwater light. The status lamp 413 is connected to the sensor unit 353 and indicates statuses of the sensors included in the tilt limit sensing part 150 and the rotation angle sensing part 180 of the cleaning robot 100. The display 414 is connected to the camera unit 351, the sensor unit 353 and the automatic cleaning unit 354 and displays an image photographed by the camera 168, signals sensed by the sensors include in the tilt limit sensing part 150 and the rotation angle sensing part 180, the route of the cleaning robot 100, and the current location of the cleaning robot 100.

[0144] In addition, the operation console 400 includes a mode selection switch 415, a screw switch 416, a pump switch 417, a driving joystick 419, a screw tilt joystick 418, a speed control switch 420, and a second emergency stop switch 421 The mode selection switch 415, the screw switch 416, the pump switch 417, the driving joystick 419, the screw tilt joystick 418, the speed control switch 420 and the second emergency stop switch 421 are connected to the central processing unit 330.

[0145] The mode selection switch 415 is used to select one of the manual cleaning mode and the automatic cleaning mode of the cleaning robot 100. The screw switch 416 is used to control the rotation direction and rotation speed of the screw 132. The pump switch 417 used to turn on/off the suction pump 161. The driving joystick 419 is used to steer the cleaning robot 100. The speed control switch 420 is used to control the moving speed of the cleaning robot 100. The second emergency stop switch 421 is used to stop the operation of the cleaning robot 100 when the cleaning robot 100 performs a wrong operation.

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[0146] An underwater sediment cleaning method according to an embodiment of the present invention will now be explained.

[0147] FIG. 12 is a flowchart showing the underwater sediment cleaning method according to an embodiment of the present invention.

[0148] Referring to FIG. 12, the underwater sediment cleaning method includes a preparation step S100, a suction step S200, a discharging step S300 and a filtering step S400.

[0149] The cleaning robot 100 is put into the water tank to prepare an underwater cleaning operation in the preparation step S100. The cleaning robot 100 sucks contaminated water containing sediment while moving in the water tank in the suction step S200. The contaminated water sucked by the cleaning robot 100 is discharged to the outside of the water tank in the discharging step S300. The sediment in the contaminated water is filtered and clean water flows into the water tank in the filtering step S400.

[0150] FIG. 13a is a flowchart showing the preparation step S100 in the underwater sediment cleaning method shown in FIG. 1 and FIGS. 13b, 13c, 13d and 13e are plan views showing coordinates, routes and the space between neighboring route parts which are set based on the shape of the bottom of the water tank and used for the underwater sediment cleaning method shown in FIG. 12.

[0151] Referring to FIGS. 13a though 13e, the preparation step S100 includes an area setting step S110, a route setting step S120, a precision setting step S130 and a mode selection step S140.

[0152] An area which will be cleaned by the cleaning robot 100 is set in the area setting step S110. In the area setting step S110, coordinates P1, P2, P3, …, Pn based on the shape of the bottom of the water tank 10 are set. If the bottom of the water tank 10 has a polygonal shape, for example, coordinates P1, P2, P3, …., Pn corresponding to corners of the bottom of the water tank 10 can be set. If the bottom of the water tank 10 has a circular shape, coordinates P1, P2, P3, …., Pn corresponding to the edge of the bottom of the water tank 10 can be set.

[0153] The moving route of the cleaning robot 100 is set in the route setting step S120. In this step, the route of the cleaning robot 100 may be set based on the shape of the bottom of the water tank 10. If the bottom of the water tank 10 has a polygonal shape, for example, a zigzag route can be set. If the bottom of the water tank 10 has a circular shape, a spiral route can be set.

[0154] The space between neighboring route parts is controlled in the precision setting step S130. A degree of precision of cleaning increases as the space between neighboring route parts becomes closer to each other and decreases as the space between neighboring route parts becomes apart from each other. The space between neighboring route parts is set to a narrow level when the cleaning robot 100 cleans a

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severely contaminated water tank or intensively cleans part of the route, which is severely contaminated. The space between neighboring route parts is set to a wide level when the cleaning robot 100 cleans a water tank that is not seriously contaminated or performs rough cleaning before thorough cleaning.

[0155] One of the manual cleaning mode and the automatic cleaning mode can be selected according to a degree of contamination of the water stored in the water tank 10 in the mode setting step S140. Specifically, the manual cleaning mode can be selected (S140) when the internal state of the water tank 10 can be recognized with the camera 168 attached to the cleaning robot 100 due to a low degree of contamination. On the contrary, the automatic cleaning mode can be selected (S150) when the internal state of the water tank 10 is difficult to recognize with the camera 168 attached to the cleaning robot 100 due to a high degree of contamination.

[0156] In the preparation step S100, it is possible to display the number of times cleaning is repeated, the area which has been cleaned by the cleaning robot 100 and the area which is not cleaned.

[0157] An underwater sediment cleaning method according to the automatic cleaning mode will now be explained.

[0158] FIG. 14 is a flowchart showing the underwater sediment cleaning method according to the automatic cleaning mode according to an embodiment of the present invention.

[0159] Referring to FIG. 14, the underwater sediment cleaning method according to the automatic cleaning mode includes a control step S161, a moving step S162, a target point arrival determination step S163 and a cleaning completion determination step S168.

[0160] Location information is received from the cleaning robot 100 and the location of the cleaning robot 100 is controlled based on the received location information in the control step S161.

[0161] FIG. 15 is a flowchart showing the control step in the underwater sediment cleaning method according to the automatic cleaning mode, shown in FIG. 14.

[0162] Referring to FIG. 15, the control step S161 includes a location information acquisition step S1611, a correction step S1612, a target point calculating step S1613, a location error calculating step S1614, and a control input calculating step S1615.

[0163] The automatic cleaning unit 354 can acquire first location information and second location information from the cleaning robot 100. The first location information is sensed by the GPS sensor 191 included in the cleaning robot 100 and the second location information is estimated based on the number of revolutions of the wheels 122, transmitted from the encoder set in the wheel motor 122a of the cleaning robot 100.

[0164] The first location information and the second location information are acquired in the

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location information acquisition step S1611. The current location of the cleaning robot 100 is precisely calculated using extended Kalman filter based on the first location information and the second location information in the correction step S1612. In the target point calculating step S1613, a target point on the route generated in the preparation step S100, which has to be tracked in the current location, is calculated and found based on the current location of the cleaning robot 100, calculated in the correction step S1612. A difference between the target point and the current location is calculated in the location error calculating step S1614. In the control input calculating step S1615, speed values of the left and right wheels 122 of the cleaning robot 100 are calculated based on the difference between the target point and the current location, calculated in the location error calculating step S1614.

[0165] Referring back to FIG. 14, in the moving step S162, the cleaning robot 100 moves toward the target point according to a rotation speed of the encoder of the wheel motor 122a based on the speed values of the left and right wheels 122, calculated in the control input calculating step S1615.

[0166] It is determined whether the cleaning robot 100 arrives at the target point in the target point arrival determination step S163. Here, the cleaning robot 100 moving toward the target point may not reach the target point. Specifically, the cleaning robot 100 cannot move due to an obstruction on the moving route or the moving speed of the cleaning robot 100 is reduced since there are large amount of works on the moving route.

[0167] When the cleaning robot 100 cannot arrive at the target point, a predetermined optimal load of the cleaning robot 100 is compared with the current load of the cleaning robot 100 (S165) to detect the load of the cleaning robot 100 (S165). The load of the cleaning robot 100 can be calculated based on the current consumed by the cleaning robot 100 and the rotation speed of the wheels.

[0168] When the cleaning robot 100 cannot reach the target point since the load of the cleaning robot 100 exceeds the optimal load, it can be determined that an obstruction appears on the moving route of the cleaning robot 100.

[0169] FIG. 16 is a flowchart showing an operation of generating a detour of the cleaning robot 100 in the underwater sediment cleaning method according to the automatic cleaning mode, shown in FIG. 14, and FIG. 17 is a view for explaining an algorithm of generating the detour of the cleaning robot 100 in the underwater sediment cleaning method according to the automatic cleaning mode, shown in FIG. 14.

[0170] Referring to FIGS. 16 and 17, when the load of the cleaning robot 100 exceeds the optimal load, the detour of the cleaning robot 100 is generated (S166). The operation of generating the detour includes an unattainable target point search step S1661, an unattainable target point removal step S1662, a new target point candidate generating step S1663, and a new target point selecting step S1664.

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[0171] Specifically, the cleaning robot 100 cannot move toward the target point ($X_{wpt(i)}$, $Y_{wpt(i)}$) in the current location ($X_{robot(i)}$, $Y_{robot(i)}$). Accordingly, it is required to generate a new target point of the cleaning robot 100.

[0172] New target point candidates are generated based on the target point ($X_{wpt(i-1)}$, $Y_{wpt(i-1)}$) through which the cleaning robot 100 passed on the basis of the current location ($X_{robot(i)}$, $Y_{robot(i)}$) of the cleaning robot 100 and a target point ($X_{wpt(i+1)}$, $Y_{wpt(i+1)}$) after the initial target point ($X_{wpt(i)}$, $Y_{wpt(i)}$).

[0173] Here, a circle having a diameter r_1 corresponding to the straight line that connects the two target points ($X_{wpt(i-1)}$, $Y_{wpt(i-1)}$) and ($X_{wpt(i+1)}$, $Y_{wpt(i+1)}$) can be obtained. A normal which intersects the line that passes the center point of the circle and connects the two target points ($X_{wpt(i-1)}$, $Y_{wpt(i-1)}$) and ($X_{wpt(i+1)}$, $Y_{wpt(i+1)}$) is generated and two intersection points of the circle and the normal are generated as new target point candidates ($X_{wpt(i)}^{cadi1}$, $Y_{wpt(i)}^{cadi1}$) and ($X_{wpt(i)}^{cadi2}$, $Y_{wpt(i)}^{cadi2}$).

[0174] In consideration of whether the cleaning robot 100 collides with the working environment and distances between the two target point candidates ($X_{wpt(i)}^{cadi1}$, $Y_{wpt(i)}^{cadi1}$) and ($X_{wpt(i)}^{cadi2}$, $Y_{wpt(i)}^{cadi2}$) and the following target point ($X_{wpt(i+2)}$, $Y_{wpt(i+2)}$), the final target point is selected from the two new target point candidates ($X_{wpt(i)}^{cadi1}$, $Y_{wpt(i)}^{cadi1}$) and ($X_{wpt(i)}^{cadi2}$, $Y_{wpt(i)}^{cadi2}$). The final target point becomes a new target point and a route to the new target point becomes a detour around the initial target point at which the cleaning robot 100 cannot arrive.

[0175] When the cleaning robot 100 cannot reach the target point even though the load of the cleaning robot 100 is less than the optimal load, it can be determined that there is a large amount of works.

[0176] FIG. 18 is a flowchart showing an operation of securing a moving route of the cleaning robot when the cleaning robot moves in the automatic cleaning mode in the underwater sediment cleaning method shown in FIG. 14.

[0177] Referring to FIG. 18, when the load of the cleaning robot 100 is less than the optimal load, the operation of securing the moving route of the cleaning robot 100 is performed (S167). That is, when the load of the cleaning robot 100 is determined to be less than the optimal load and the moving speed of the cleaning robot 100 is reduced, a forward movement command is inputted to the cleaning robot 100 (S1671).

[0178] If the cleaning robot 100 can move according to the forward movement command (S1672), the cleaning robot 100 moves forward. Here, although the cleaning robot 100 moves toward the target point at a speed lower than an input speed value since the cleaning robot 100 is moving forward on the route having a large amount of works, the cleaning robot 100 cannot arrive at the target point. A command of returning to the original position toward the target point is inputted to the cleaning robot 100 moving toward the target point according to the forward movement command, and the cleaning

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robot 100 moves backward to the original position (S1676).

[0179] The forward movement command and the command of returning to the original position are repeated for a predetermined operating time. Accordingly, the cleaning robot 100 can repeat forward movement and backward movement toward the target point on the route having a large amount of works to handle the works.

[0180] When the cleaning robot 100 cannot move even though the forward movement command is inputted to the cleaning robot 100 (S1672), a left-turn command or a right-turn command based on the direction to the target point is inputted. The cleaning robot 100 moves to a left or right direction at 30° from the direction to the target point according to the left-turn or right-turn command (S1673).

[0181] If the cleaning robot 100 can move according to the left-turn or right-turn command (S1674), the cleaning robot 100 turns left or right according to the left-turn or right-turn command. The command of returning to the original position toward the target point is inputted to the cleaning robot 100 turning left or right, and thus the cleaning robot 100 moves backward to the original position before the forward movement command is inputted thereto.

[0182] In this manner, the left-turn or right-turn command and the command of returning to the original position toward the target point are inputted to the cleaning robot 100 that cannot move toward the target point, and thus the large amount of works around the route to the target point is gradually reduced and the cleaning robot 100 becomes a state that the cleaning robot 100 can move toward the target point when the works are handled to some degree by the cleaning robot 100.

[0183] When the cleaning robot 100 cannot move even though the left-turn or right-turn command is inputted to the cleaning robot 100 (S1674), the cleaning robot 100 is moved backward from the current location of the cleaning robot 100. Then, the cleaning robot 100 moves backward to a position behind the position where the forward movement command is inputted to the cleaning robot 100 (S1675). When the left-turn or right-turn command is inputted to the cleaning robot 100 moved backward, the cleaning robot 100 turns left or right according to the left-turn or right-turn command (S1673).

[0184] In this manner, the backward movement command is inputted to the cleaning robot 100 that cannot move toward the target point and turn left or right to gradually reduce the large amount works around the route to the target point and make the cleaning robot 100 be in a state that the cleaning robot 100 can move toward the target point when the works are handled to some extent by the cleaning robot 100.

[0185] The forward movement command (S1671) and the command of returning to the original position toward the target point (S1676) are repeated for a predetermined operating time (S1677). Accordingly, the cleaning robot 100 can repeat forward

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movement and backward movement on the route having the large amount of works to handle the works.

[0186] That is, the cleaning robot 100 having a load determined to be less than the optimal load can repeatedly secure the moving route for the predetermined operating time to handle a large amount of works.

[0187] After the lapse of the predetermined operating time (S1677), the cleaning robot 100 returns to the control step S161 and moves to find the target point.

[0188] Referring back to FIG. 14, when the cleaning robot 100 reaches the target point in the target point arrival determination step S163, speed values of the left and right wheels for the next target point are inputted to the cleaning robot 100. The cleaning robot 100 moves toward the next target point according to the speed values of the left and right wheels.

[0189] When the control step S161 and the moving step S162 are repeated, the cleaning robot 100 can arrive at the final target point (S163). Then, the operation of discharging the contaminated water from the water tank 10 is finished.

[0190] Referring back to FIG. 13a, when the manual cleaning mode is selected in the mode selection step S140 (S150), the user can operate the operation console 400 while observing the image photographed by the camera 167 to control the cleaning robot 100.

[0191] The contaminated water sucked by the cleaning robot 100 is discharged to the tank 210 of the sediment separator 200. The contaminated water discharged to the tank 210 passes through the filter 240. Here, the sediment contained in the contaminated water is left at one side of the tank 210 and clean water flows to the other side of the tank 210. The sediment left in the tank 210 is discharged to the outside of the tank 210 through the sediment discharge pipe 220 and the clean water flows into the water tank.

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Claims

[Claim 1] A cleaning robot comprising:
a body put into a water tank;
a driver supporting the body and moving the body;
a suction part arranged in front of the body and sucking contaminated water containing sediment in the water tank; and
a tilting part supported by the body to support the suction part and rotating the suction part on an axis corresponding to the direction across the moving direction of the body.

[Claim 2] The cleaning robot of claim 1, wherein the suction part comprises:
a suction tube opened to the front of the body;
a screw arranged in a direction across the suction tube, located at the front of the suction tube and having screw threads tilted to the suction tube; and
a rotary motor connected to the shaft of the screw to rotate the screw.

[Claim 3] The cleaning robot of claim 2, further comprising:
a contaminated water discharge pipe connected with the suction tube to form a path for discharging the contaminated water sucked through the suction tube; and
a swivel joint provided between the contaminated water discharge pipe and the suction tube.

[Claim 4] The cleaning robot of claim 3, further comprising:
a suction pump arranged between the suction tube and the swivel joint; and
a pump hanger set in the body to elastically support the suction pump.

[Claim 5] The cleaning robot of claim 1, wherein the tilting part comprises:
a support supporting the suction part with its front end, being rotatably combined with the body and rotating from the body on a first supporting pin provided in a direction across the moving direction of the body;
a first link joint having a first end connected to the support through a first link pin;
a second link joint having a first end connected to a second end of the first link joint through a second link pin and a second end connected to the body through a second supporting pin, being rotatably combined with the body and rotating on the second supporting pin; and
a tilt cylinder having an output terminal connected to the second link

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pin.

[Claim 6] The cleaning robot of claim 5, further comprising a tilt limit sensing part arranged behind the support to sense the lower limit point and the upper limit point of the support.

[Claim 7] The cleaning robot of claim 1, further comprising a location information sensing part supported by the body and exposed from the surface of water in the water tank.

[Claim 8] The cleaning robot of claim 7, wherein the location information sensing part comprises:
a GPS sensor controller supported by the body; and
a GPS antenna connected to the GPS sensor controller and located above the GPS sensor controller.

[Claim 9] The cleaning robot of claim 8, further comprising:
a buoy provided between the body and the GPS sensor controller and floating on the surface of the water in the water tank; and
retractable support supporting the GPS sensor controller and the GPS antenna from the body and combined with the buoy, the retractable support having a length increasing or decreasing according to the distance between the body and the buoy.

[Claim 10] The cleaning robot of claim 1, further comprising:
a balloon connected with the body; and
a supply pipe connected to the balloon to supply a gas to the balloon.

[Claim 11] The cleaning robot of claim 1, further comprising a neutral buoy provided to the body to maintain neutral buoyancy.

[Claim 12] The cleaning robot of claim 1, further comprising a bumper part installed in front of the suction part.

[Claim 13] The cleaning robot of claim 12, wherein the bumper part comprises:
bumper wheels arranged to roll on an obstruction appearing in front of the body; and
a supporting frame supporting the bumper wheels.

[Claim 14] The cleaning robot of claim 13, wherein the supporting frame is rotatably combined with the body and rotating on an axis corresponding to the direction across the moving direction of the body, further comprising a rotation angle sensing part arranged behind the supporting frame to sense the rotation angle of the supporting frame.

[Claim 15] An underwater sediment cleaning apparatus comprising:
a cleaning robot put into a water tank to suck contaminated water containing sediment in the water tank;

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a sediment separator located outside the water tank, receiving the contaminated water from the cleaning robot, filtering the sediment from the contaminated water and discharging clean water obtained by filtering the sediment from the contaminated water to the water tank; and
a controller located outside the water tank and connected to the cleaning robot to control the operation of the cleaning robot.

[Claim 16] The underwater sediment cleaning apparatus of claim 15, wherein the sediment separator comprises:
a tank having a first side connected with a contaminated water discharge pipe extended from the cleaning robot;
an intake pipe having a first end connected to a second side of the tank and a second end opened to the water tank to allow the clean water to flow into the water tank; and
a filter set inside the tank to filter the sediment from the contaminated water flowing to the intake pipe.

[Claim 17] The underwater sediment cleaning apparatus of claim 16, further comprising a sediment discharge pipe having a first end connected to the first side of the tank and a second end opened to the outside of the tank.

[Claim 18] The underwater sediment cleaning apparatus of claim 15, wherein the controller is installed in an operating room which is located outside the water tank and movable.

[Claim 19] The underwater sediment cleaning apparatus of claim 15, wherein the controller comprises:
a power supply connected to the cleaning robot through a power cable to provide power supplied from an external supply source to the cleaning robot;
a communication unit connected to the cleaning robot through a communication cable to transmit/receive data to/from the cleaning robot; and
a central processing unit controlling the power supplied to the cleaning robot and processing the data transmitted/received to/from the cleaning robot.

[Claim 20] The underwater sediment cleaning apparatus of claim 19, wherein the controller further comprises:
a wheel driver controlling the moving operation of the cleaning robot;
a screw driver controlling the rotation speed and rotation direction of a screw included in the cleaning robot;

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a tilt driver controlling the tilting angle of a tilting part included in the cleaning robot; and

a pump driver controlling the operation of a suction pump included in the cleaning robot,

wherein the wheel driver, the screw driver, the tilt driver and the pump driver are connected to the central processing unit, and the central processing unit processes control commands generated from wheel driver, the screw driver, the tilt driver and the pump driver.

[Claim 21] The underwater sediment cleaning apparatus of claim 19, wherein the controller further comprises:

a camera unit controlling an image captured by a camera included in the cleaning robot;

a light unit controlling the brightness of a light included in the cleaning robot;

a sensor unit controlling a sensing signal generated from sensors included in the cleaning robot; and

an automatic cleaning unit receiving location information from the cleaning robot and controlling the location of the cleaning robot,

wherein the camera unit, the light unit, the sensor unit and the automatic cleaning unit are connected to the central processing unit, and the central processing unit processes control commands generated from the camera unit, the light unit, the sensor unit and the automatic cleaning unit.

[Claim 22] The underwater sediment cleaning apparatus of claim 15, further comprising an operation console set in a bag carried by an operator, connected to the controller and allowing the operator to operate the cleaning robot.

[Claim 23] The underwater sediment cleaning apparatus of claim 22, wherein the operation console comprises:

a camera switch turning on/off the camera included in the cleaning robot;

a brightness controller controlling the brightness of the light include in the cleaning robot;

a status lamp indicating statuses of the sensors included in the cleaning robot;

a display displaying the image captured by the camera, the route of the cleaning robot and the location of the cleaning robot;

a mode selection switch for selecting one of a manual cleaning mode

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and an automatic cleaning mode of the cleaning robot;
a screw switch for controlling the rotation speed and rotation direction of the screw included in the cleaning robot;
a screw tilt joystick controlling the tilting angle of the screw;
a pump switch turning on/off the suction pump included in the cleaning robot;
a driving joystick steering the cleaning robot;
a speed control switch for controlling the moving speed of the cleaning robot; and
an emergency stop switch for stopping the cleaning unit.

[Claim 24] The underwater sediment cleaning apparatus of claim of claim 15, further comprising:
a generator generating the power supplied to the controller; and
a compressor connected to a balloon included in the cleaning robot to inject a gas into the balloon.

[Claim 25] An underwater sediment cleaning method, comprising:
a preparation step of putting a cleaning robot into a water tank and preparing cleaning the water tank;
a suction step of sucking contaminated water containing sediment in the water tank by means of the cleaning robot moving in the water tank;
a discharging step of discharging the contaminated water to a tank arranged outside the water tank; and
filtering step of discharging the sediment contained in the contaminated water to the outside of the tank and making clean water obtained by filtering the sediment from the contaminated water flow into the water tank.

[Claim 26] The underwater sediment cleaning method of claim 25, wherein the preparation step comprises the steps of:
setting the whole area of the water tank;
setting a moving route of the cleaning robot in the whole area of the water tank;
controlling the space between neighboring route parts of the moving route of the cleaning robot to set a degree of precision of cleaning the water tank; and
selecting one of the automatic cleaning mode and the manual cleaning mode.

[Claim 27] The underwater sediment cleaning method of claim 26, wherein an automatic cleaning operation according to selection of the automatic

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cleaning mode comprises:
a control step of receiving location information from the cleaning robot and controlling the location of the cleaning robot;
a moving step of moving the cleaning robot along the route;
a target point arrival determination unit of determining whether the cleaning robot arrives at a target point; and
a cleaning completion determination step of determining whether the cleaning robot reaches a final target point.

[Claim 28] The underwater sediment cleaning method of claim 27, wherein the control step comprises the steps of:
receiving first location information from a GPS sensor included in the cleaning robot and acquiring second location information from a encoder included in the cleaning robot;
applying the first location information and the second location information to extended Kalman filter to correct the current location of the cleaning robot;
calculating a target point which has to be tracked by the cleaning robot from the current location of the cleaning robot;
calculating a difference between the current location of the cleaning robot and the target point; and
calculating speed values of left and right wheels of the cleaning robot based on the calculated difference.

[Claim 29] The underwater sediment cleaning method of claim 27, when the cleaning robot does not reach the target point in the target point arrival determination step, further comprising:
calculating the current load of the cleaning robot; and
comparing the current load of the cleaning robot with an optimal load of the cleaning robot to detect the load of the cleaning robot

[Claim 30] The underwater sediment cleaning method of claim 29, wherein the optimal load of the cleaning robot is calculated based on the current consumed by the cleaning robot, the speed of the wheels revolving when the cleaning robot is driven and a variation in the location of the cleaning robot.

[Claim 31] The underwater sediment cleaning method of claim 29, wherein a detour of the cleaning robot is generated when the current load of the cleaning robot exceeds the optimal load.

[Claim 32] The underwater sediment cleaning method of claim 31, wherein the operation of generating the detour of the cleaning robot comprises the

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steps of:
detecting a target point at which the cleaning robot cannot arrive from the current location;
removing the detected target point from the route of the cleaning robot;
generating new target point candidates at which the cleaning robot can arrive from the current location; and
selecting a new target point from the generated new target point candidates.

[Claim 33] The underwater sediment cleaning method of claim 29, wherein a moving route of the cleaning robot is secured when the current load of the cleaning robot is less than the optimal load.

[Claim 34] The underwater sediment cleaning method of claim 33, wherein the operation of securing the moving route of the cleaning robot comprising the steps of:
moving the cleaning robot forward; and
moving the cleaning robot backward to return the cleaning robot to the position before being moved forward, the step of moving the cleaning robot forward and the step of returning the cleaning robot are repeated for a predetermined operating time.

[Claim 35] The underwater sediment cleaning method of claim 34, when the cleaning robot cannot be moved forward, further comprising the steps of:
moving the cleaning robot forward while turning the cleaning robot left or right; and
moving the cleaning robot backward to return the cleaning robot to the position before being moved forward, the step of moving the cleaning robot forward and the step of returning the cleaning robot are repeated for a predetermined operating time.

[Claim 36] The underwater sediment cleaning method of claim 35, when the cleaning robot cannot be turned left or right or moved forward, further comprising the step of moving the cleaning robot backward to a position behind the position before being moved forward, the step of moving the cleaning robot forward and the step of moving the cleaning robot backward are repeated for the predetermined operating time.

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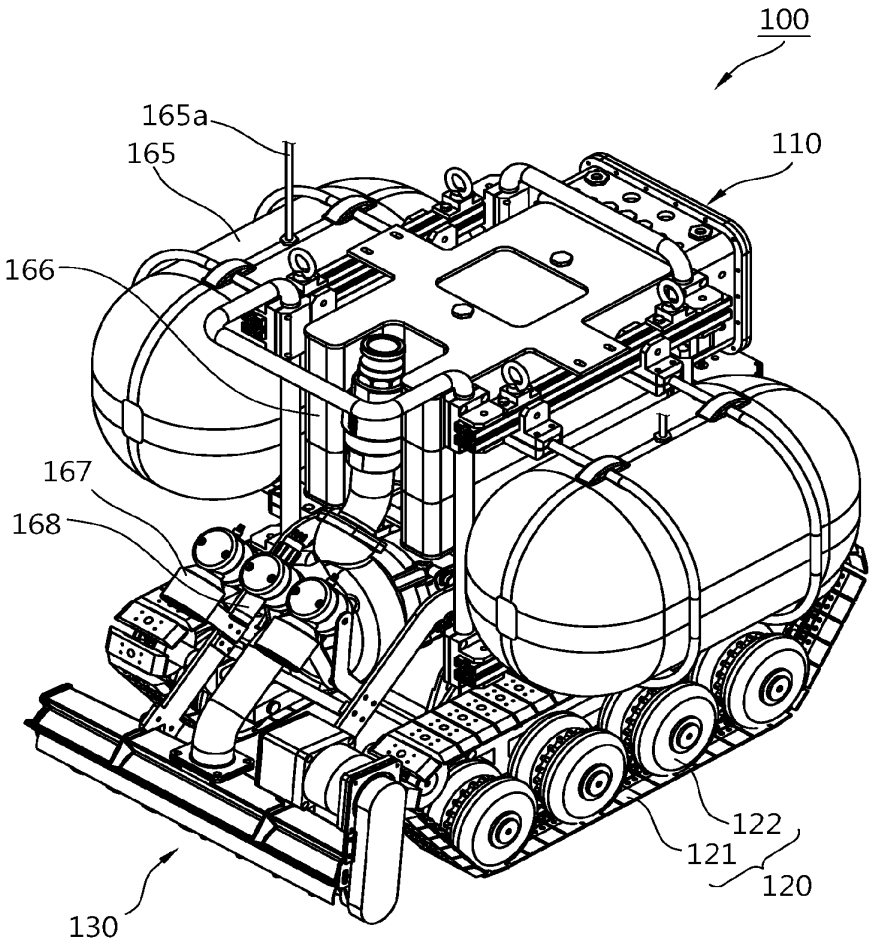
[Fig. 1]



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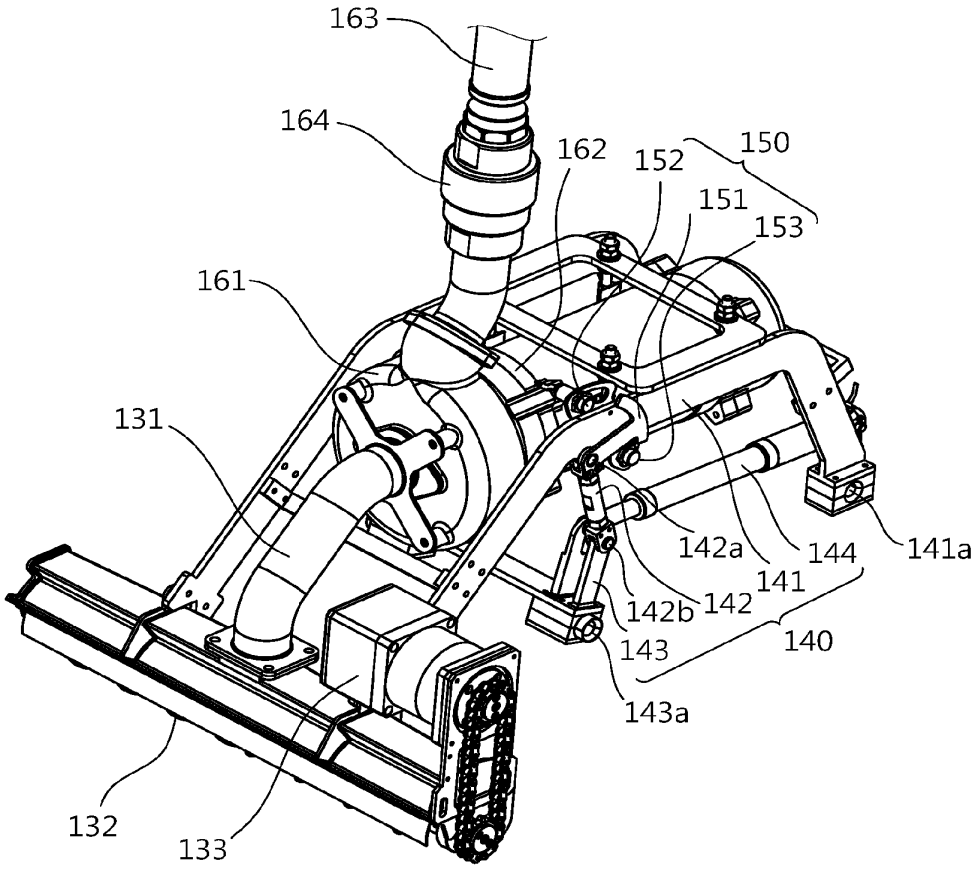
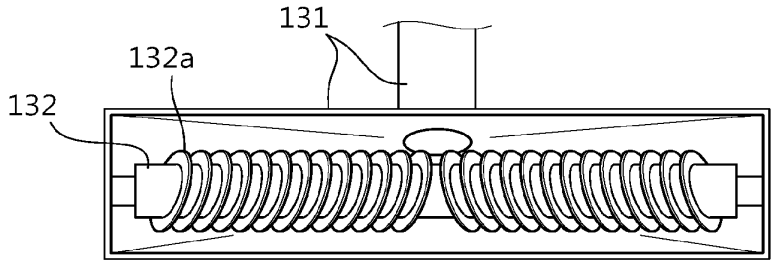
[Fig. 2]



[Fig. 3]



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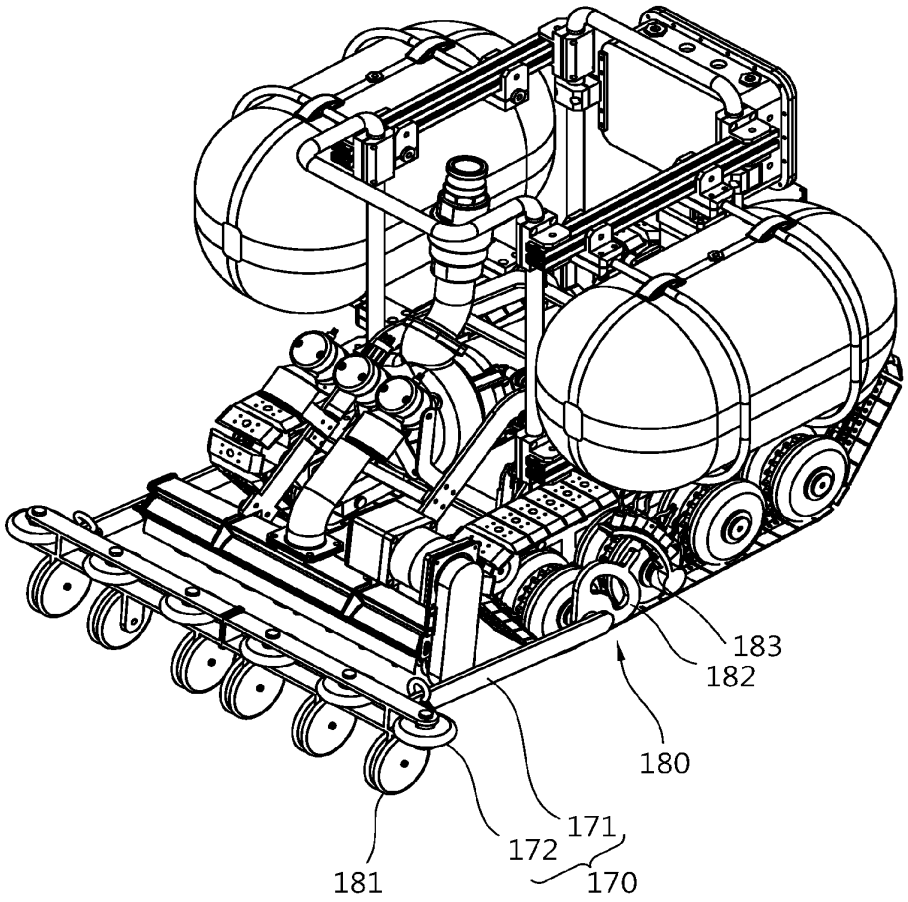
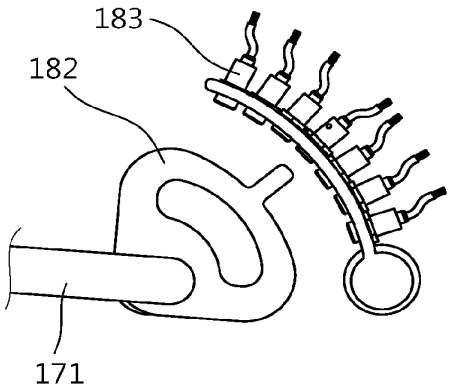
[Fig. 4]



[Fig. 5]



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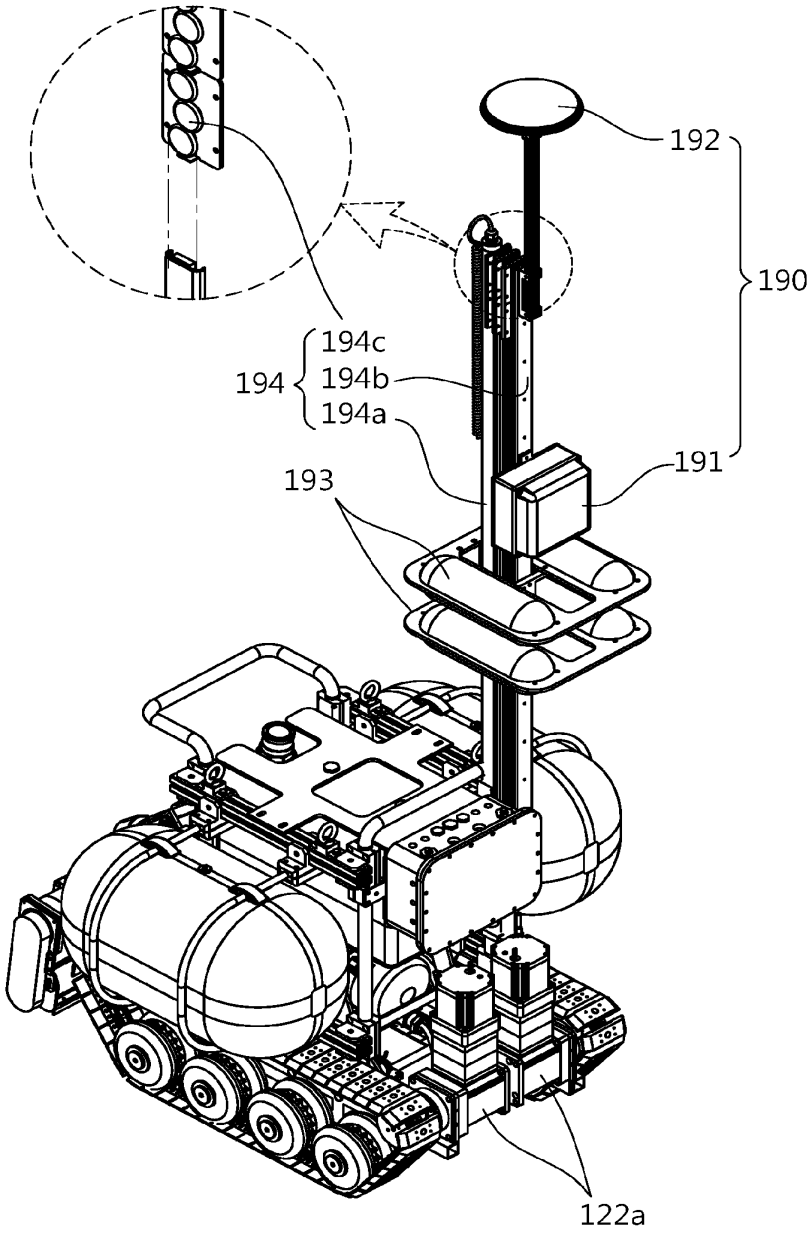
[Fig. 6]



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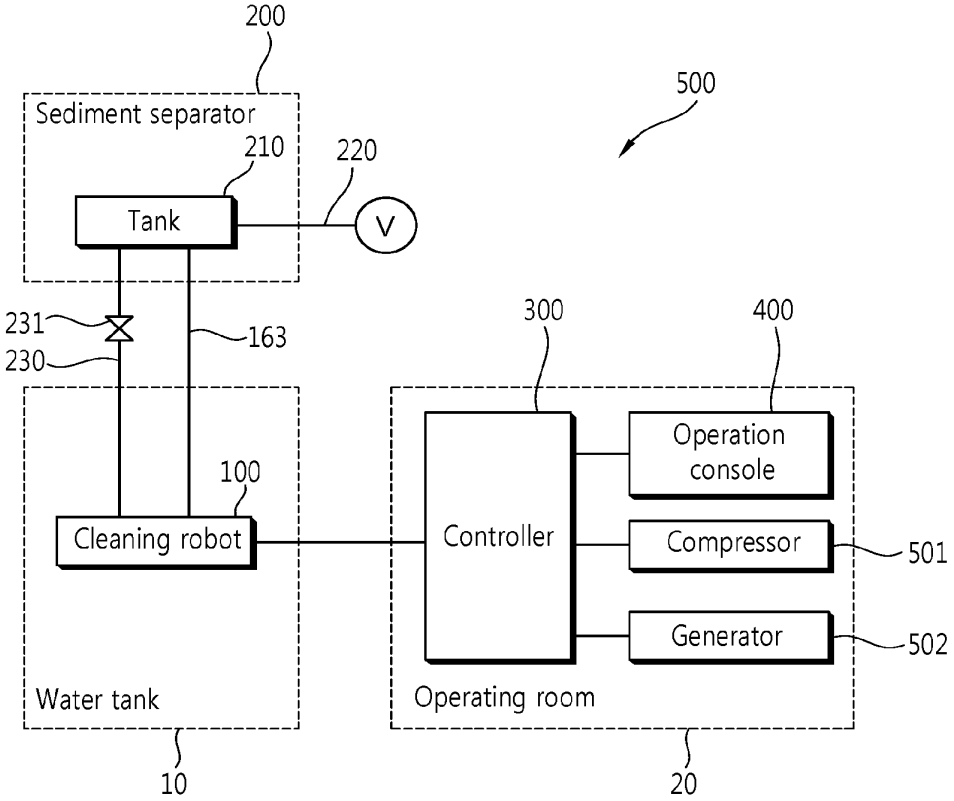
[Fig. 7]



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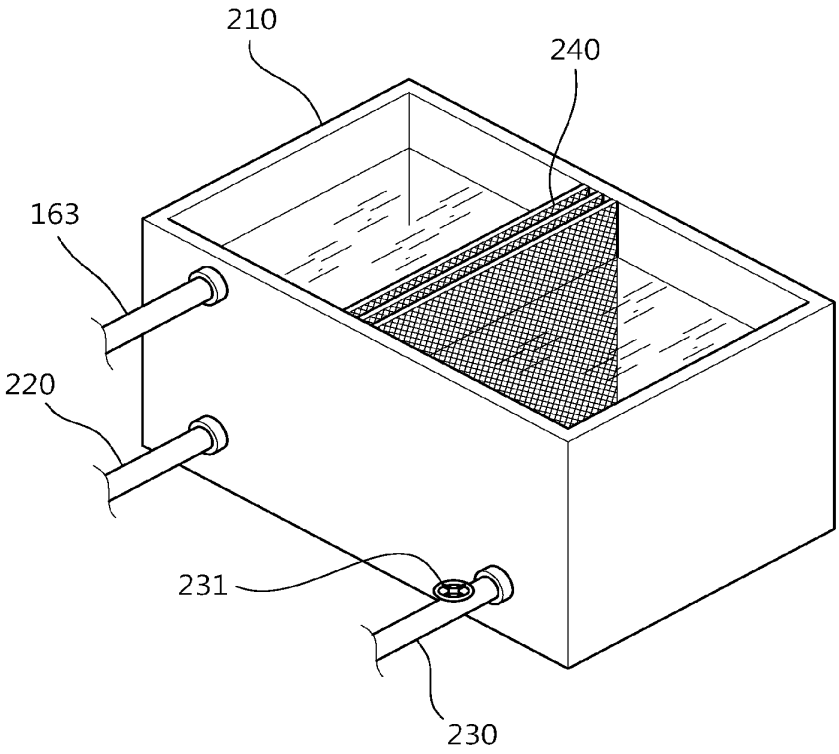
[Fig. 8]



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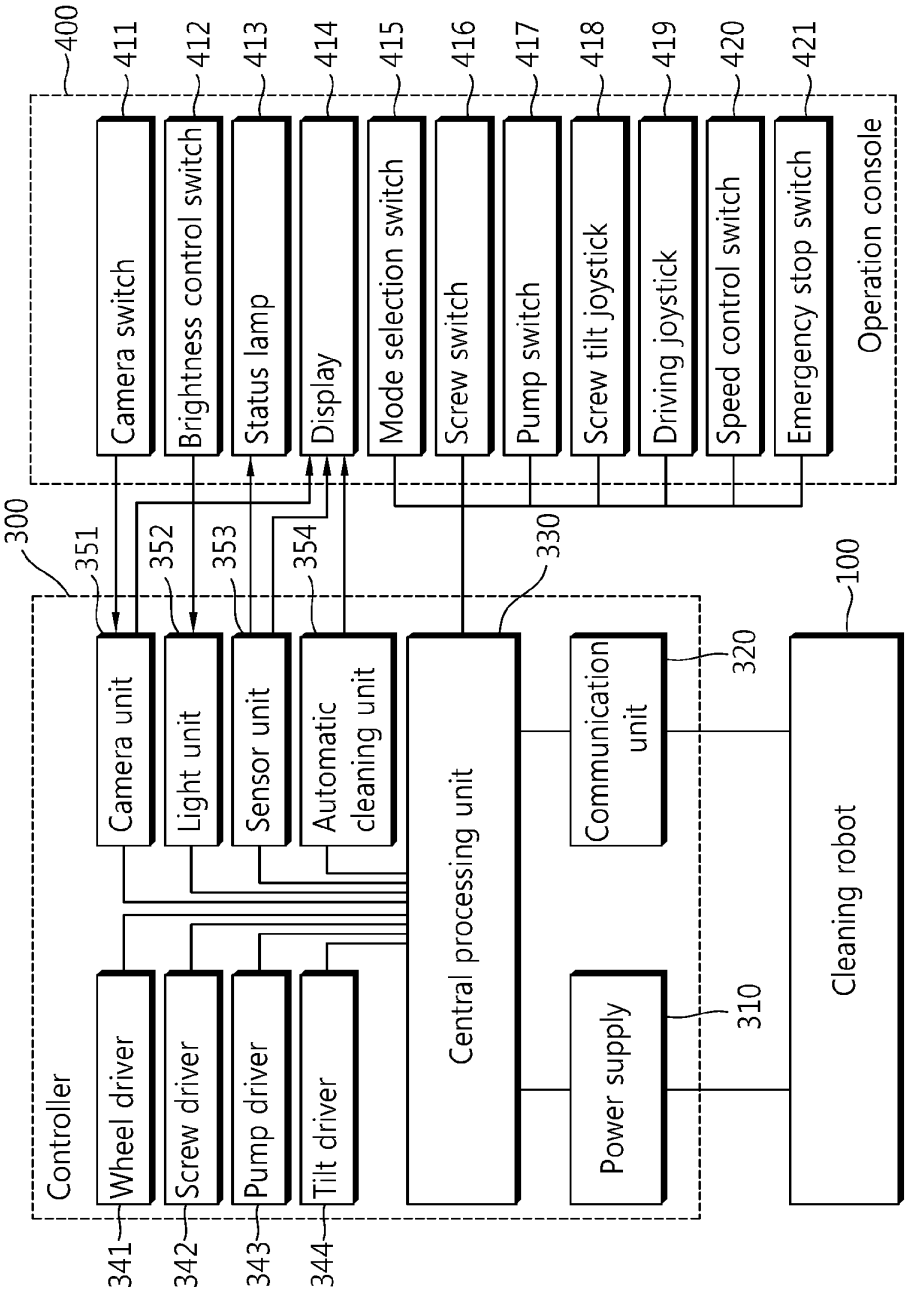
[Fig. 9]



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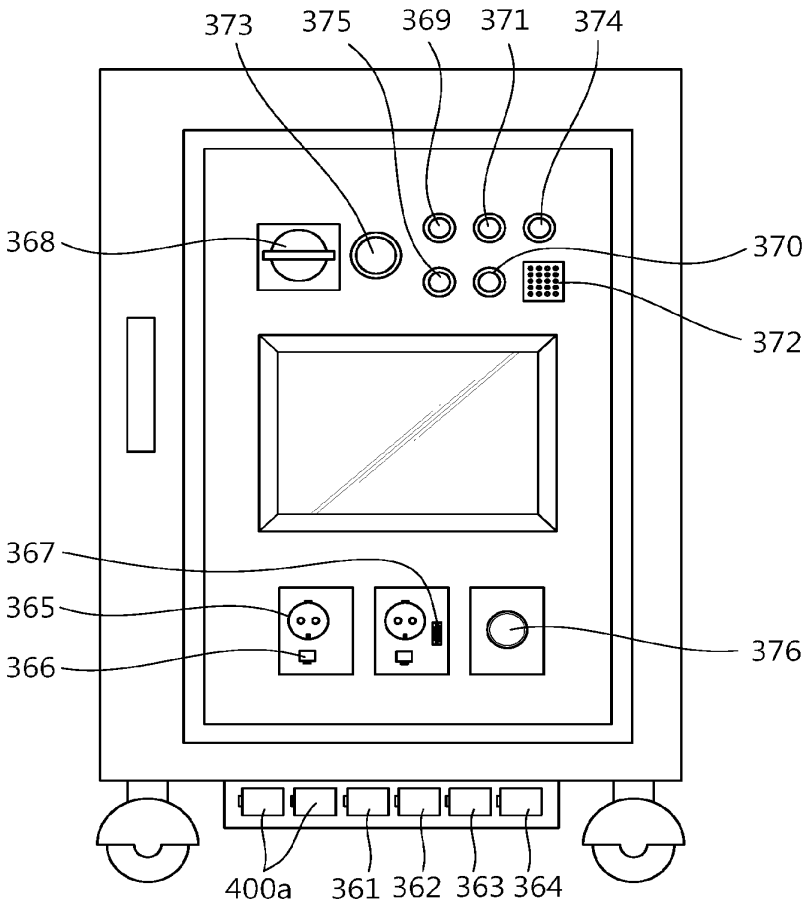
[Fig. 10]



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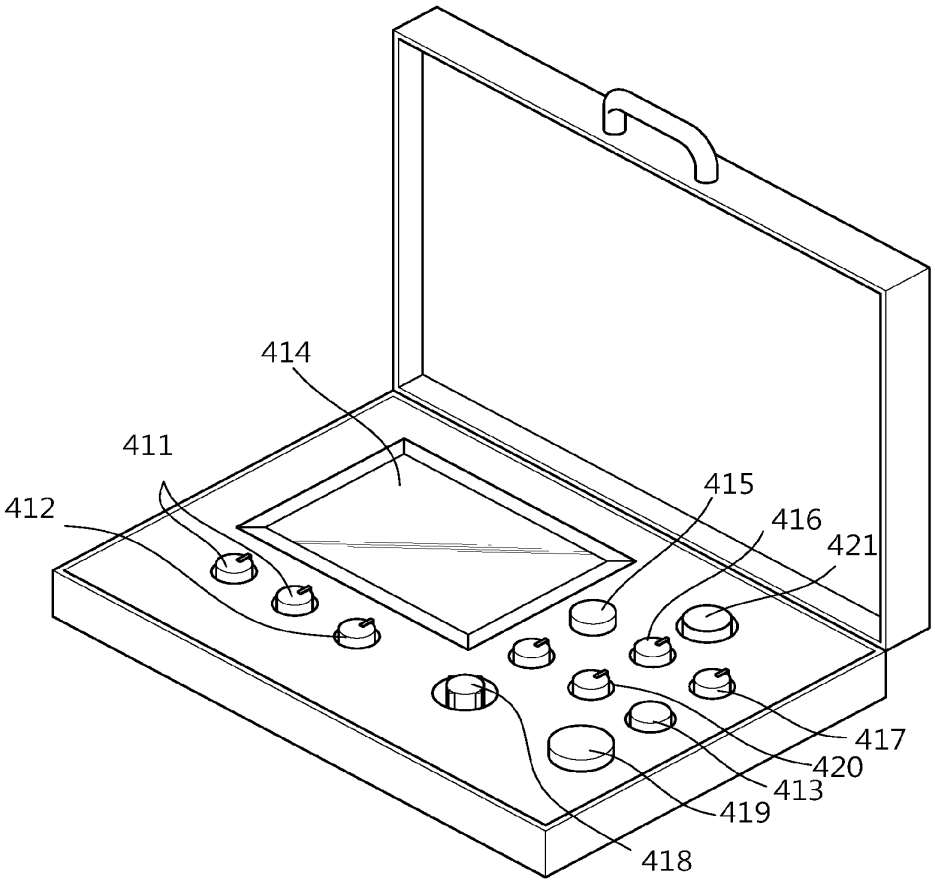
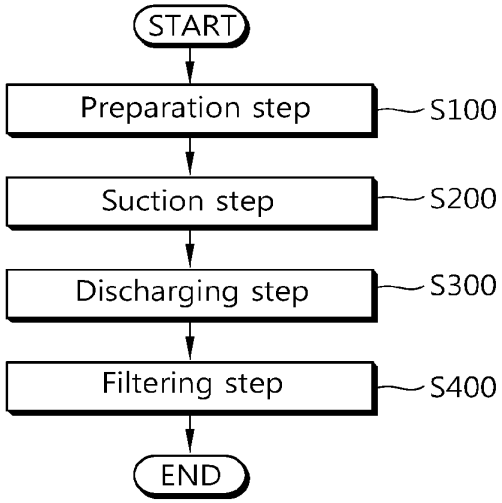
[Fig. 11]



[Fig. 12]



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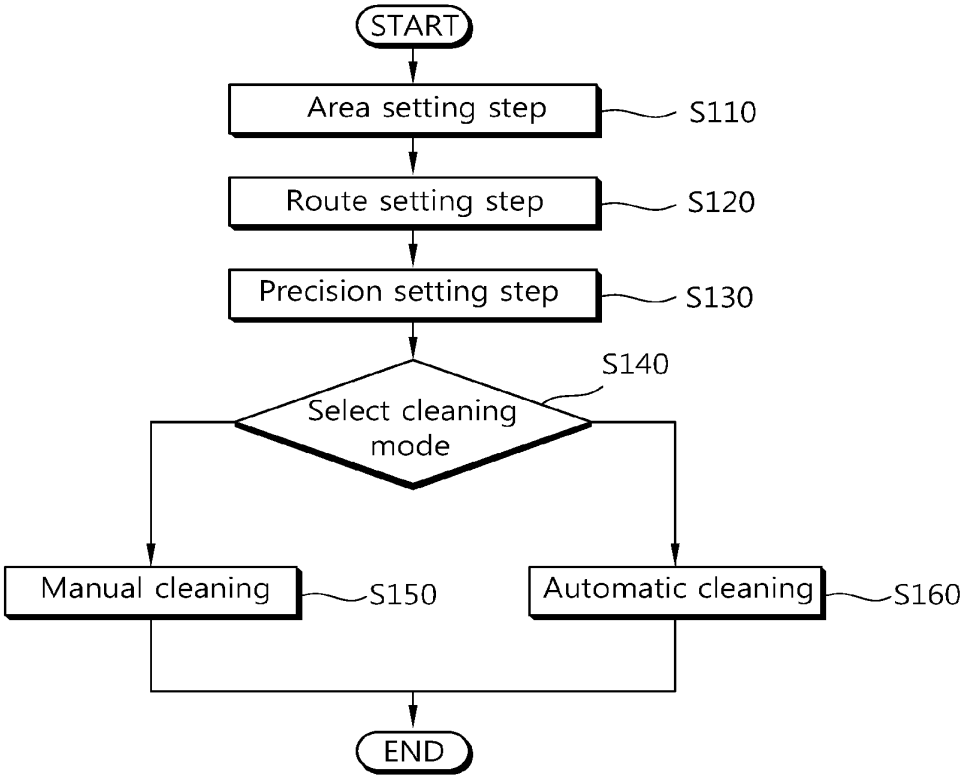
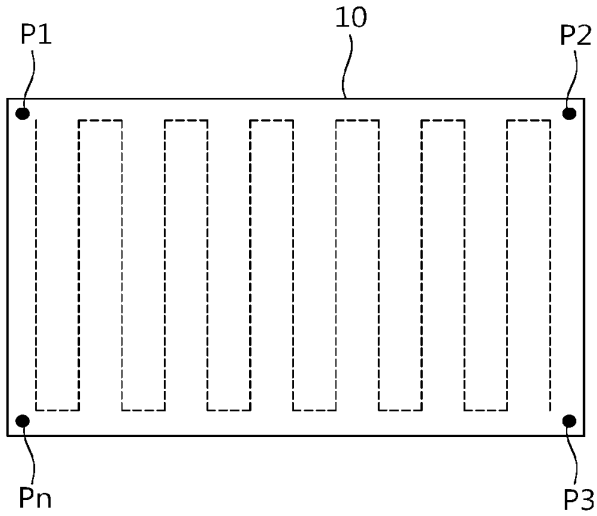
[Fig. 13a]



[Fig. 13b]



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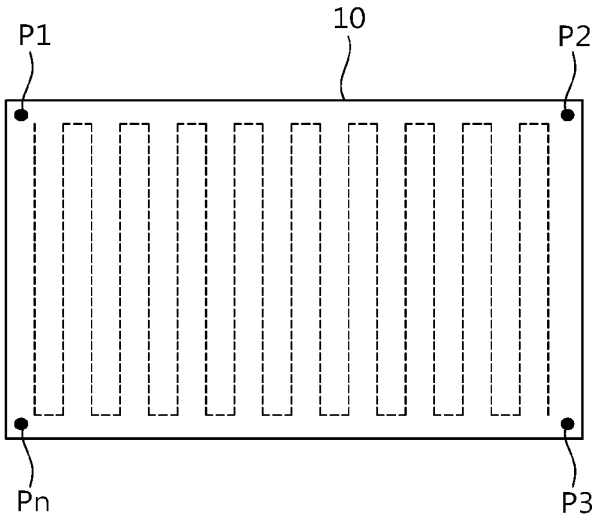
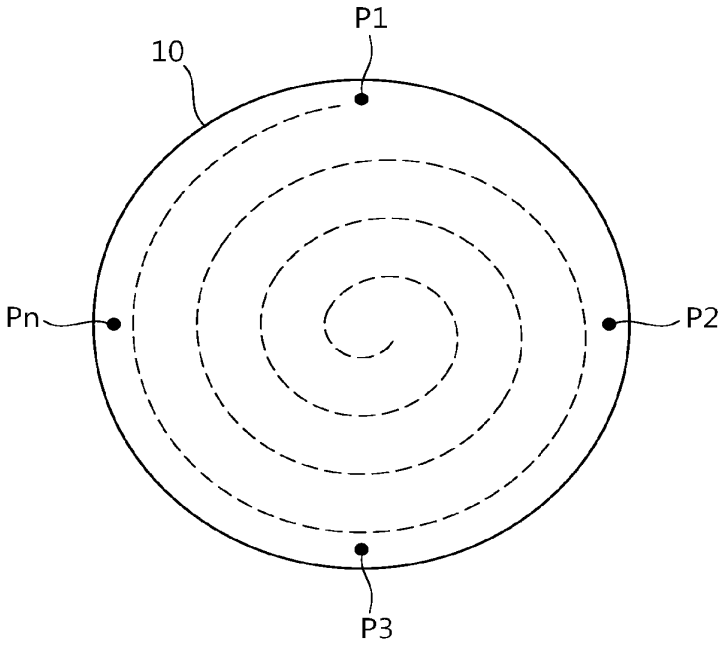
[Fig. 13c]



[Fig. 13d]



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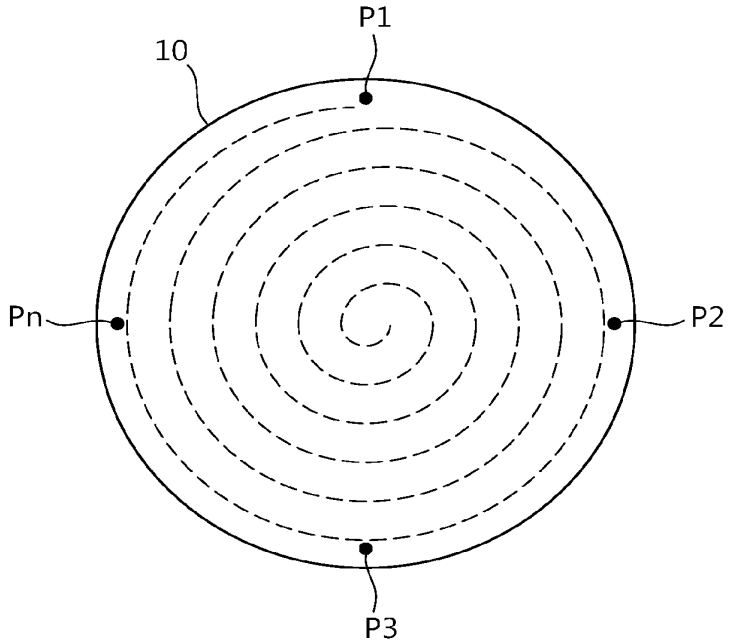
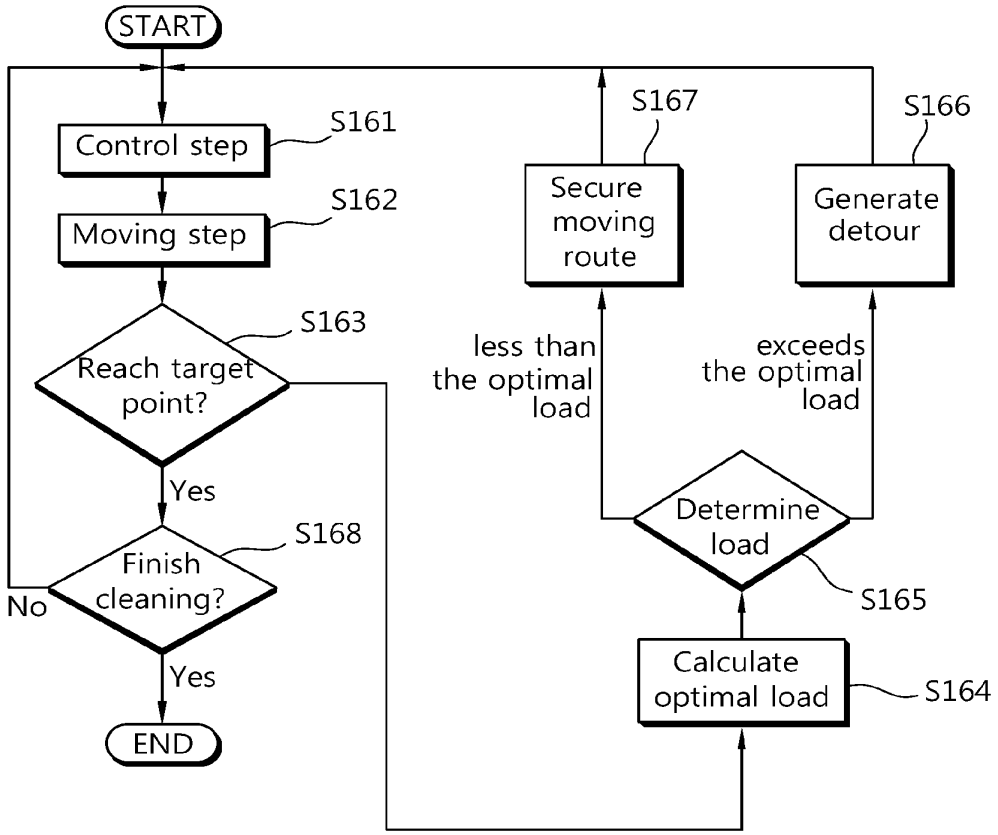
[Fig. 13e]



[Fig. 14]



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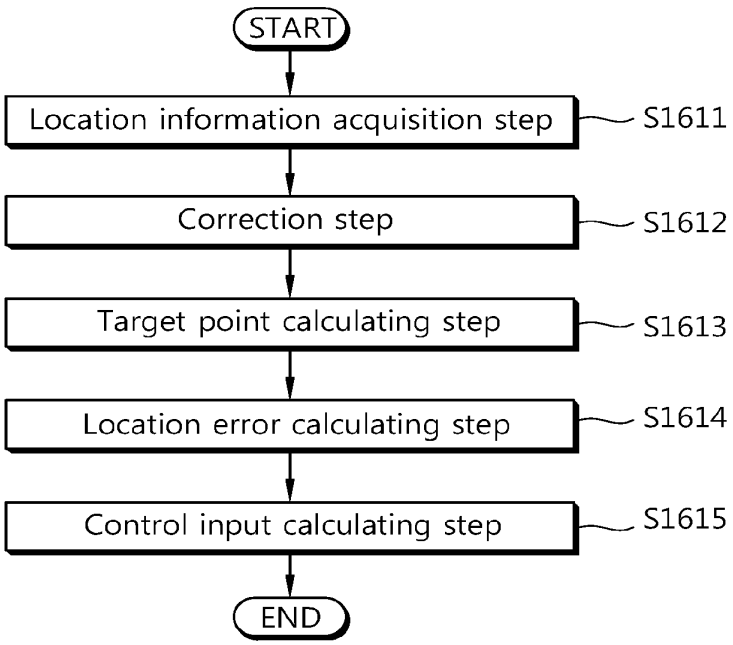
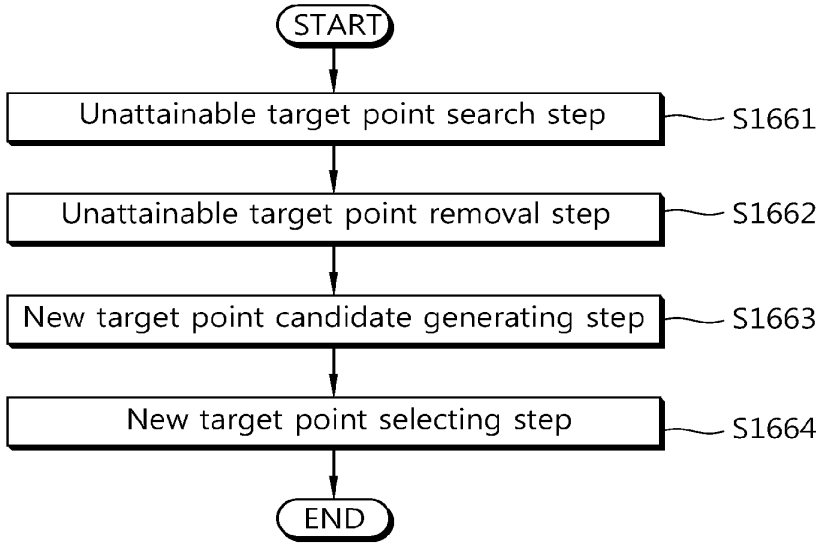
[Fig. 15]

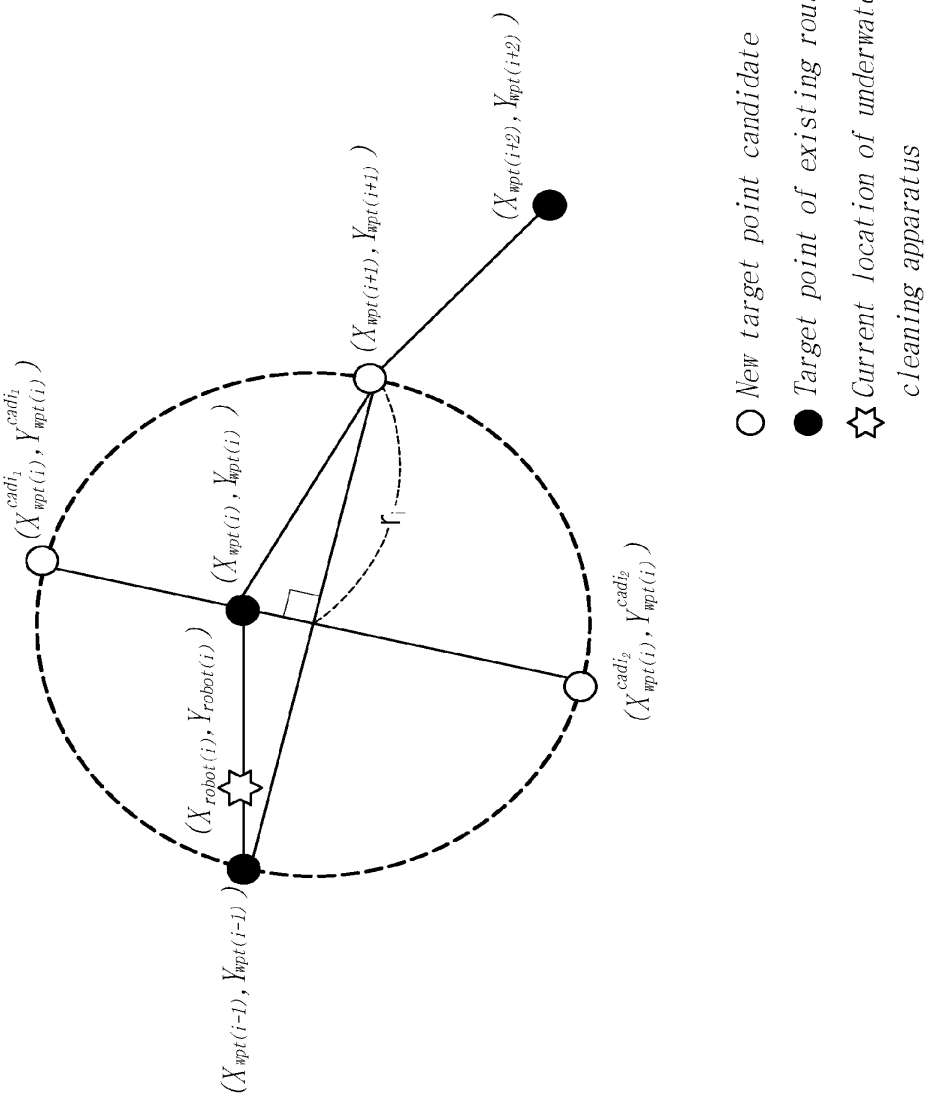


[Fig. 16]



Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

[Fig. 17]



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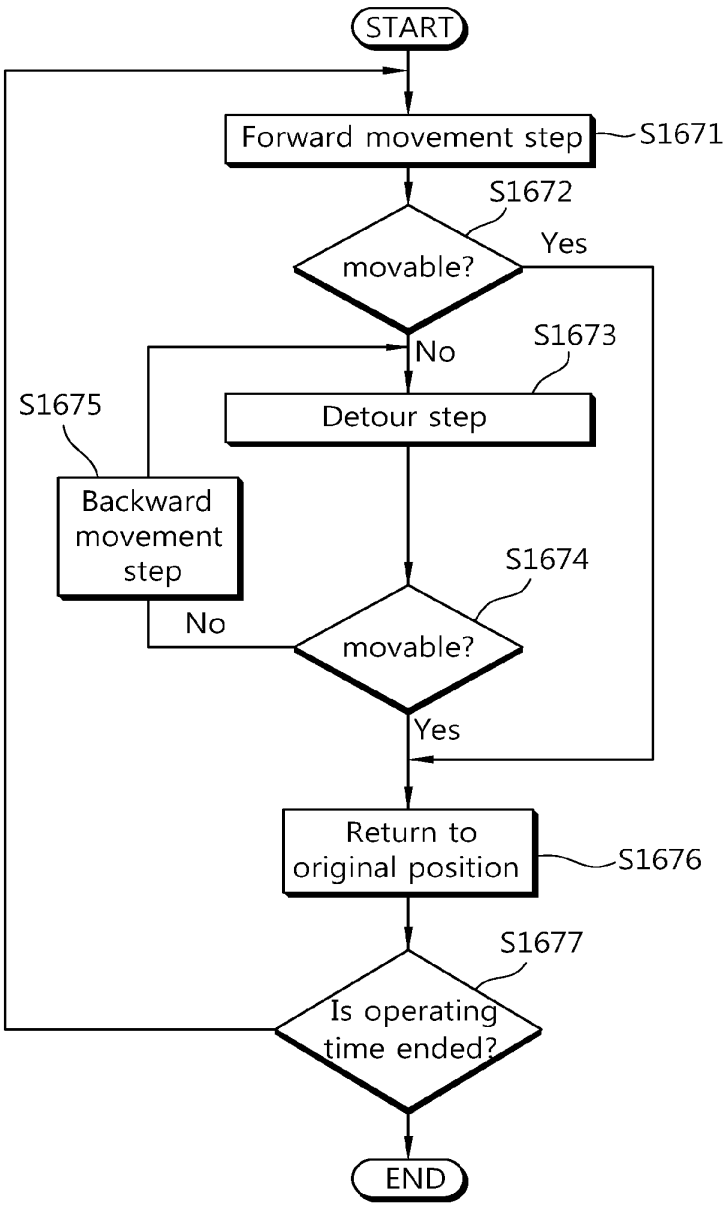
Beatbot v. Zodiac, IPR2026-00200

[Fig. 18]



Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2011/000598

A. CLASSIFICATION OF SUBJECT MATTER

B08B 9/087(2006.01)i, E04H 4/16(2006.01)i, B25J 5/00(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B08B 9/087; B01D 21/00; B08B 1/02; B08B 1/04; A47L 11/20; G05B 19/10; G05D 1/02; A47L 11/30; B08B 9/08; A47L 11/24

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

Korean utility models and applications for utility models
Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: robot, bumper, recycle, route, control

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	JP 06-285448 A (HITACHI ZOSEN CORP) 11 October 1994 See the abstact; claims 1,2; paragraph 12-18.	1-6,10,11 7-9,12,26,27,29-36 13,14
Y	US 2004-0021439 A1 (JOSEPH PORAT et al.) 05 February 2004 See Fig.4; paragraph 5, 56, 92-94.	7-9
Y	JP 06-081677 U (MITSUBISHI HEAVY INDUSTRIES, LTD.) 22 November 1994 See the abstract.	12
X Y	JP 2001-029910 A (TOKYO ELECTRIC POWER CO INC:THE et al.) 06 February 2001 See the abstract; claims 1, 4; Fig.1.	15-19,22,25 26,27,29-36
A	JP 2002-312035 A (TOSHIBA TEC CORP) 25 October 2002 See the abstract; claims 1-3.	25-27,29-36
A	JP 2004-243202 A (MATSUSHITA ELECTRIC IND CO LTD) 02 September 2004 See paragraphs 10-14.	25-27,29-36

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 OCTOBER 2011 (17.10.2011)	**18 OCTOBER 2011 (18.10.2011)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office Government Complex-Daejeon, 189 Cheongsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer PARK, Youg Ju Telephone No. 82-42-481-5512

Form PCT/ISA/210 (second sheet) (July 2009)

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2011/000598

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 20, 21, 23, 24, 28
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

Drivers in claim 20, a camera, a light and sensors in claim 21 and 23, a balloon in claim 24, and a GPS sensor and wheels in claim 28 are merely listed in the claims without giving a specific structure of the subject matter as a whole, thereby rendering the definiteness of the subject matter of the claim unclear.

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required addtional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (July 2009)

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/KR2011/000598

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 06-285448 A	11.10.1994	None	
US 2004-0021439 A1	05.02.2004	EP 1302611 A2	16.04.2003
		EP 1302611 A3	16.04.2003
		EP 1302611 B1	01.12.2004
		EP 1512810 A2	09.03.2005
		EP 1512810 A3	25.05.2005
		EP 1512810 B1	26.11.2008
		IL145930D0	25.07.2002
		US 6815918 B2	09.11.2004
JP 06-081677 U	22.11.1994	JP H0-681677 U	22.11.1994
JP 2001-029910 A	06.02.2001	None	
JP 2002-312035 A	25.10.2002	None	
JP 2004-243202 A	02.09.2004	None	

Form PCT/ISA/210 (patent family annex) (July 2009)

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

BIB DATA SHEET

CONFIRMATION NO. 9590

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
13/545,918	07/10/2012	348	2488	316.091

APPLICANTS

INVENTORS

Kameshwar Durvasula, Lyndhurst, NJ;
William Londono Correa, Bloomfield, NJ;

**** CONTINUING DATA ***************************

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****
07/20/2012

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☑ No Verified and Acknowledged /ALLEN C WONG/ Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		NJ	4	20	4

ADDRESS

ABELMAN, FRAYNE & SCHWAB
666 THIRD AVENUE, 10TH FLOOR
NEW YORK, NY 10017
UNITED STATES

TITLE

POOL CLEANING SYSTEM AND METHOD

FILING FEE RECEIVED		
1500	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

BIB (Rev. 05/07).

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

THIRD-PARTY SUBMISSION UNDER 37 CFR 1.290	Application Number	13545918

U.S. PATENTS				
Cite No	Patent Number	Kind Code [1]	Issue Date (YYYY-MM-DD)	First Named Inventor
1	7123746		2006-10-17	Jerome Meniere
2	7362351		2008-04-22	Jerome Meniere
3	5886630		1999-03-23	EDOUARD MENOUD

U.S. PATENT APPLICATION PUBLICATIONS				
Cite No	Publication Number	Kind Code [1]	Publication Date (YYYY-MM-DD)	First Named Inventor
1	20130269097		2013-10-17	Fahad M. ALAMMARI
2	20040040581	A1	2004-03-04	Frederick Bruwer
3	20140009748	A1	2014-01-03	Alexander Leonessa
4	20130151061	A1	2013-06-13	Young Jin Hong

/Allen Wong/ 06/24/2015

EFS Web 2.1.17

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /AW/

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

Receipt date: 10/02/2014 THIRD-PARTY SUBMISSION UNDER 37 CFR 1.290	Application Number	13545918 - GAU: 2488 13545918

FOREIGN PATENTS AND PUBLISHED FOREIGN PATENT APPLICATIONS						
Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[1]	Publication Date (YYYY-MM-DD)	Applicant, Patentee or First Named Inventor	T[5]
						☐

NON-PATENT PUBLICATIONS (e.g., journal article, Office action)			
Cite No	Author (if any), title of the publication, page(s) being submitted, publication date, publisher (where available), place of publication (where available).	T[5]	E[6]
		☐	☐

STATEMENTS

The party making the submission is not an individual who has a duty to disclose information with respect to the above-identified application under 37 CFR 1.56.

This submission complies with the requirements of 35 U.S.C. 122(e) and 37 CFR 1.290.

☒ The fee set forth in 37 CFR 1.290(f) has been submitted herewith.

☐ The fee set forth in 37 CFR 1.290(f) is not required because this submission lists three or fewer total items and, to the knowledge of the person signing the statement after making reasonable inquiry, this submission is the first and the only submission under 35 U.S.C 122(e) filed in the above-identified application by the party making the submission or by a party in privity with the party.

/Allen Wong/ 06/24/2015

EFS Web 2.1.17

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /AW/

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

Receipt date: 10/02/2014 THIRD-PARTY SUBMISSION UNDER 37 CFR 1.290	Application Number	13545918 - GAU: 2488 13545918

Signature	/OREN RECHES/		
Name/Print	Oren Reches	Registration Number (if applicable)	53506

Examiner Signature	/Allen Wong/	Date Considered	06/24/2015

*EXAMINER: Signature indicates all documents listed above have been considered,except for citations through which a line is drawn. Draw line through citation if not considered. Include a copy of this form with next communication to applicant. 1. If known, enter kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16. See MPEP 901.04(a). 2. Enter the country or patent office that issued the document, by two-letter code under WIPO standard ST.3. See MPEP 1851. 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. If known, enter the kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 . See MPEP 901.04(a). 5. Check mark indicates translation attached. 6. Check mark indicates evidence of publication attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /AW/

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13545918	DURVASULA ET AL.
	Examiner	Art Unit
	ALLEN WONG	2488

CPC- SEARCHED		
Symbol	Date	Examiner
E04H 4/1654, H04N 5/23203, H04N 7/18, H04N 2005/2255	6/25/15	AW

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
348	114, 143, 159	6/25/15	AW
382	103	6/25/15	AW
356	4.03	6/25/15	AW

SEARCH NOTES		
Search Notes	Date	Examiner

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

	/ALLEN WONG/ Primary Examiner.Art Unit 2488

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT:	Kameshwar DURAVASULA	EXAMINER: Allen C. WONG
SERIAL NO.:	13/545,918	ART UNIT: 2488
FILED:	July 10, 2012	CONF. NO.: 9590

FOR: POOL CLEANING SYSTEM AND METHOD

October 26, 2015

Mailstop - Amendment
Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT UNDER 37 C.F.R. 1.111

Honorable Commissioner:

In response to the Office Action dated June 26, 2015, please amend and reconsider the above-identified patent application as follows:

Amendments to the claims begin on page 2 of this document;

Amendments to the specification begin on page 8 of this document; and

Remarks begin on page 9 of this document.

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IN THE CLAIMS:

Please amend and reconsider the claims as follows:

1. (Currently amended) A pool cleaning system comprising:

a powered robotic surface cleaning vehicle to travel on and clean adjacent water containing surfaces of a pool while submerged within the pool;

a camera ~~adapted to be mounted external the pool~~ configured to capture movement of the vehicle while the vehicle is submerged within the pool; ~~and~~

a controller in electronic communication with the camera to generate control signals to steer ~~steering~~ the vehicle based on the signals from the camera; and

sensors, in electronic communication with the controller and carried by the vehicle, to sense the water containing surfaces of the pool after the water containing surfaces of the pool have been cleaned by the vehicle during a pass of the vehicle under control of a pool coverage algorithm, wherein the control signals steer the vehicle so as to reclean the water containing surfaces having a cleanliness characteristic that is sensed by the sensors and fails to satisfy a predefined threshold.

2. (Original) The system of claim 1 further comprising a station remote from the vehicle and in communication with the vehicle, wherein the station includes the controller.

3. (Original) The system of claim 1 further comprising a station remote from the vehicle and in communication with the vehicle, wherein the controller is located remote from the vehicle and the station.

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4. (Currently amended) The system of claim 1, wherein the camera is mounted to the vehicle ~~further comprising a portable electronic device in communication with the camera, with the portable electronic device includes a controller~~.

5. (Original) The system of claim 1 further comprising a portable electronic device having a display, wherein the portable electronic device is configured to present a graphic on the display, the graphic depicting water containing surfaces of the pool and those portions of the water containing surfaces that remain uncleaned as a vehicle traverses the water containing surfaces.

6. (Original) The system of claim 5, wherein the portable electronic device depicts movement of the vehicle on the display.

7. (Currently amended) The system of claim 1, wherein the controller generates second control signals for steering the vehicle based on a coverage algorithm independent of signals from the camera, and wherein the control signals based on the captured coverage steer the vehicle to clean portions of the water containing surfaces missed by the vehicle while being steered according to the second control signals.

8. (Currently amended) The system of claim 1, wherein the camera is mounted remotely from the vehicle ~~portable electronic device is configured to output an alert based on signals from the camera indicating presence of a person at pool satisfying a predefined characteristic~~.

9. (Currently amended) The system of claim 1 further comprising[[:]] a portable electronic device having a display and in electronic communications with the vehicle; ~~and~~

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~~sensors carried by the vehicle, wherein the display presents information based on characteristics of the water containing surfaces of the pool sensed by the sensors.~~

10. (Currently amended) The system of claim 1, wherein the controller is located at ~~further comprising~~ a server remote from the camera and the vehicle~~, the server comprising the controller, wherein the controller generates control signals for steering a plurality of vehicles across a plurality of pools based on signals from a plurality of cameras associated with the plurality of pools.~~

11. Canceled.

12. (Currently amended) An apparatus comprising:

a non-transitory ~~non-transient~~ computer-readable medium comprising code configured to cause a processor to:

generate first control signals for moving a robotic pool cleaning vehicle so as to clean water containing surfaces of a pool;

obtain signals from a camera representing the water containing surfaces of the a pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool;

identify portions of the water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle to satisfy a predefined threshold; and

~~present a graphical depiction of the identified portions~~

automatically generate second control signals to steer the robotic pool cleaning vehicle to reclean the identified portions of the water containing surfaces based upon the signals from the camera.

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13. (Currently amended) The apparatus of claim 12, wherein the code is further configured to ~~direct the processing unit to generate control signals steering the robotic pool cleaning vehicle so as to clean the identified portions~~ present a graphical depiction of the identified portions.

14. (Currently amended) The apparatus of claim [[12]]13 further comprising a portable electronic device comprising:

a processing unit;

a display to present the graphical depiction; and

the non-transitory ~~non-transient~~ computer readable medium.

15. (Currently amended) A method comprising:

moving a robotic pool cleaning vehicle so as to clean water containing surfaces of a pool;

capturing images of a pool being cleaned with a robotic pool cleaning vehicle operating according to a steering algorithm;

obtaining signals from a camera representing the water containing surfaces of the pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool;

identifying portions of the water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle to satisfy a predefined threshold; and

~~presenting a graphical depiction of the identified portions~~

steering the robotic pool cleaning vehicle based upon signals from the camera to reclean the identified portions.

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16. (Currently amended) The method of claim 15 further comprising ~~steering the robotic pool cleaning vehicle based upon signals from the camera to reclean the identified portions~~ presenting a graphical depiction of the identified portions.

17. (Currently amended) A pool cleaning system comprising:

a powered robotic pool cleaning vehicle to travel adjacent to water containing surfaces of a pool while submerged within the pool;

a camera configured to capture movement of the vehicle while the vehicle is submerged within the pool and identify debris located on the water containing surfaces;

a controller in electronic communication with the camera to generate control signals to steer the vehicle, wherein the controller automatically steers the robotic pool cleaning vehicle to reclean identified portions of the water containing surfaces still having debris based on the signals from the camera; and

a dry station remote from the pool and in communication with the vehicle[[;]]

~~a server in communication with the dry station across a wide area network; and~~

~~a portable electronic device in communication with the server~~.

18. (Currently amended) The system of claim 17, further comprising:

one or more processing units;

at least one non-transitory ~~non-transient~~ computer-readable medium comprising code configured to direct the one or more processing units to cause the portable electronic device to display coverage of the water containing surfaces of the pool by the vehicle.

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19. (Currently amended) The system of claim [[18]]17 further comprising ~~a camera to capture movement of the vehicle while the vehicle is submerged within the pool~~ sensors, in electronic communication with the controller and carried by the vehicle, to sense the water containing surfaces of the pool after the water containing surfaces of the pool have been cleaned by the vehicle during a pass of the vehicle under control of a pool coverage algorithm, wherein the control signals steer the vehicle so as to reclean the water containing surfaces having a cleanliness characteristic that is sensed by the sensors and fails to satisfy a predefined threshold.

20. (Currently amended) The system of claim 19, wherein the camera comprises a pool security camera and wherein the at least one non-transitory ~~non-transient~~ computer-readable medium causes the portable electronic device to output an alert based on signals from the camera indicating presence of a person at pool satisfying a predefined characteristic.

21. (New) The system of claim 17, wherein the camera is mounted remotely from the vehicle.

22. (New) The system of claim 17, further comprising a server in communication with the dry station across a wide area network.

23. (New) The system of claim 22, further comprising a portable electronic device in communication with the server.

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IN THE SPECIFICATION:

On page 1, beginning on line 1, please amend the title of invention as follows:

POOL CLEANING SYSTEM AND METHOD TO AUTOMATICALLY CLEAN SURFACES OF A POOL USING IMAGES FROM A CAMERA

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REMARKS

This Amendment is intended as a full and complete response to the non-final Office Action dated June 26, 2015. In the Office Action, the Examiner states that Claims 1-20 are pending and stand rejected.

By this amendment, claims 1, 4, 7-10, 12-20 are amended, claim 11 is canceled, new claims 21-23 are added, and claims 2, 3, 5 and 6 continue unamended. No new subject matter has been added to the claims.

In view of both the amendments presented above and the following discussion, it is submitted that the pending claims are now in allowable form.

REJECTIONS

I. The Rejection under 35 U.S.C. §101

A. The Examiner has rejected claims 12-14 and 18-20 as not falling within one of the four statutory categories of invention.

In response, claims 12, 14, 18 and 20 have been amended to change each instance of the limitation of "non-transient" to "non-transitory", as suggested by the Examiner. It is submitted that claims 12-14 and 18-20 fully comply with 35 U.S.C. §101 and are patentable thereunder. Withdrawal of the rejection is respectfully requested.

II. The Rejection under 35 U.S.C. §102

A. The Examiner has rejected claims 12 and 14-16 as being anticipated by International publication no. WO 2012/023676 to Hong. The rejection is respectfully traversed.

As a preliminary matter, we believe that it would be helpful to review the appropriate standard under 35 U.S.C. § 102 for analyzing the features of a claim with respect to the prior art. It is well settled that "unless a reference discloses within the four corners of the

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document not only all of the limitations claimed but also all of the limitations arranged or combined in the same way as recited in the claim, it cannot be said to prove prior invention of the thing claimed and, thus, cannot anticipate under 35 U.S.C. § 102." (Moneyin Inc. v. Verisign Inc., 545 F.3d 1359 (Fed. Cir. 2008) (emphasis added). That is, "[a]nticipation requires the presence in a single prior art reference disclosure of each and every element of the claimed invention, arranged as in the claim" (Lindemann Maschinenfabrik GmbH v. American Hoist & Derrick Co., 730 F.2d 1452, 221 USPQ 481, 485 (Fed. Cir. 1984) (citing Connell v. Sears, Roebuck & Co., 722 F.2d 1542, 220 USPQ 193 (Fed. Cir. 1983)) (emphasis added). The cited reference fails to disclose each and every element of the claimed invention, as arranged in the claim.

Independent claim 12 has been amended to recite:

12. An apparatus comprising:
a non-transitory computer-readable medium comprising code configured to cause a processor to:
generate first control signals for moving a robotic pool cleaning vehicle so as to clean water containing surfaces of a pool;
obtain signals from a camera representing the water containing surfaces of the a pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool;
identify portions of the water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle to satisfy a predefined threshold; and
automatically generate second control signals to steer the robotic pool cleaning vehicle to reclean the identified portions of the water containing surfaces based upon the signals from the camera. (Emphasis added).

Similarly, independent claim 15 has been amended to recite:

15. A method comprising:
moving a robotic pool cleaning vehicle so as to clean water containing surfaces of a pool;
capturing images of a pool being cleaned with a robotic pool cleaning vehicle operating according to a steering algorithm;
obtaining signals from a camera representing the water containing surfaces of the pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool;
identifying portions of the water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle to satisfy a predefined threshold; and

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steering the robotic pool cleaning vehicle based upon signals from the camera to reclean the identified portions. (Emphasis added).

The pool cleaning vehicle includes a controller that receives signals from a camera which captures the conditions of the surface of the pool over which the vehicle moves and cleans. The controller regulates or controls the movement of the cleaner and will generate second control signals to steer the vehicle to reclean portions of the pool surface that were identified by the camera as still having debris thereon.

The Hong patent fails to disclose the limitation of "automatically generat[ing] second control signals to steer the robotic pool cleaning vehicle to reclean the identified portions of the water containing surfaces based upon the signals from the camera." In particular, Hong discloses that when the cleaner cannot reach its predetermined target destination based on a programmed algorithm, the current load of the vehicle's wheels or tracks are measured and various techniques are implemented to reach the target destination. For example, when the cleaner cannot reach the target and the drive current load exceeds an optimal load value, a new target destination is selected for the cleaner to move to in a forward direction (See Hong, WO2012/023676, paragraphs 0168-0174). Alternatively, when the cleaner cannot reach the target but the drive current load does not exceed the optimal load value, a forward and backward movement of the cleaner is initiated to try to finally reach the initial target destination. (See Hong, Id. at paragraphs 0175-0179).

Although the Hong cleaner may repeatedly drive over portions of it cleaning path, such movement is because of obstructions that are sensed by current load sensor, as opposed to "identifying portions of the water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle to satisfy a predefined threshold." That is, the cleaner of Hong is responsive to blockages along it travel path, as opposed to seeking out and identifying unclean portions of the pool that the cleaner has previously traversed.

Hong fails to teach, disclose or even suggest the claimed limitations of "generate first control signals for moving a robotic pool cleaning vehicle so as to clean water containing surfaces of a pool; obtain signals from a camera representing the water containing surfaces of

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the a pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool; identify portions of the water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle to satisfy a predefined threshold; and automatically generate second control signals to steer the robotic pool cleaning vehicle to reclean the identified portions of the water containing surfaces based upon the signals from the camera." Therefore, Hong fails to disclose, teach or even suggest each and every element of the claimed invention, as arranged in the claim.

It is submitted that amended claims 12 and 15 are not anticipated and fully satisfy the requirements under 35 U.S.C. §102 and are patentable thereunder. Furthermore, claims 14 and 16 respectively depend from independent claims 12 and 15 and recite additional features considered inventive. For at least the same reasons discussed above, it is submitted that these dependent claims also fully satisfy the requirements under 35 U.S.C. §102 and are patentable thereunder. Withdrawal of the rejection is respectfully requested.

III. The Rejection under 35 U.S.C. §103 is Obviated

A. Claims 1, 5-9 and 11

Claims 1, 5-9 and 11 stand rejected under 35 U.S.C. §103 as being obvious over WO 2012/023676 to Hong in view of US patent no. 7,362,351 to Meniere. The rejection is respectfully traversed.

As a preliminary matter, we believe that it would be helpful to review the appropriate standard under 35 U.S.C. § 103 for analyzing the features of a claim with respect to the prior art. It is well settled that [t]he test under 35 U.S.C. § 103 is not whether an improvement or a use set forth in a patent would have been obvious or non-obvious; rather the test is whether the claimed invention, considered as a whole, would have been obvious. Jones v. Hardy, 110 USPQ 1021, 1024 (Fed. Cir. 1984) (emphasis added). Moreover, the invention as a whole is not restricted to the specific subject matter claimed, but also embraces its properties and the problem it solves. In re Wright, 6 USPQ 2d 1959, 1961 (Fed. Cir. 1988) (emphasis added).

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Independent claim 1 has been amended to incorporate the limitations of dependent claim 11. In particular, amended claim 1 recites:

> 1. A pool cleaning system comprising:
> a powered robotic surface cleaning vehicle to travel on and clean adjacent water containing surfaces of a pool while submerged within the pool;
> a camera configured to capture movement of the vehicle while the vehicle is submerged within the pool;
> a controller in electronic communication with the camera to generate control signals to steer the vehicle based on the signals from the camera; and
> sensors, in electronic communication with the controller and carried by the vehicle, to sense the water containing surfaces of the pool after the water containing surfaces of the pool have been cleaned by the vehicle during a pass of the vehicle under control of a pool coverage algorithm, wherein the control signals steer the vehicle so as to reclean the water containing surfaces having a cleanliness characteristic that is sensed by the sensors and fails to satisfy a predefined threshold. (Emphasis added).

As discussed above, although the Hong cleaner may repeatedly drive over portions of it cleaning path, such movement is because of obstructions that are sensed by current load sensors, as opposed to "sens[ing] the water containing surfaces of the pool after the water containing surfaces have been cleaned by the vehicle during a pass of the vehicle under control of a pool coverage algorithm." That is, the cleaner of Hong is responsive to blockages along it travel path, as opposed to seeking out and identifying unclean portions of the pool that the cleaner has previously traversed. In other words, the Hong cleaner does not look back over the path it already traversed.

The '351 Meniere patent discloses:

> The invention also relates to a system and to devices for detecting an object in a zone situated in the proximity of an interface between two liquid and/or gaseous media having different refractive indices, especially an interface of the water/air type. Within the meaning of the present invention; "in the proximity of" also denotes "at the interface".
> The said system comprises means, especially a video camera, for creating at least one video image of the said interface and of the said zone from at least one observation point. (See '351 Meniere, col. 6, lines 21-30).

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The combination of Hong and Meniere discloses a pool cleaner that can move in the forward and reverse direction when its path is obstructed and an external camera to view the cleaner. Nowhere in the combined prior art is there any teaching, suggestion or even prediction of the limitation "sensors, in electronic communication with the controller and carried by the vehicle, to sense the water containing surfaces of the pool after the water containing surfaces of the pool have been cleaned by the vehicle during a pass of the vehicle under control of a pool coverage algorithm, wherein the control signals steer the vehicle so as to reclean the water containing surfaces having a cleanliness characteristic sensed by the sensors failing to satisfy a predefined threshold." The Hong cleaner only moves in forward and reverse directions in an attempt to get past an obstruction when the current load is not being exceeded.

By contrast, the claimed invention uses the sensors to identify debris on a surface of a pool over which the cleaner has previously passed, and directs the cleaner to pass over and reclean such area. Therefore, the combined prior art does not teach, suggest or predict the present invention as a whole.

As such, it is submitted that independent claim 1 is not obvious and fully satisfies the requirements under 35 U.S.C. § 103 and is patentable thereunder. Furthermore, claims 5-9 and 11 depend directly or indirectly from independent claim 1 and recite additional features considered inventive. For at least the same reasons discussed above, it is submitted that these dependent claims also fully satisfy the requirements under 35 U.S.C. §103 and are patentable thereunder. Withdrawal of the rejection is respectfully requested.

B. Claims 2-4 and 10

Claims 2-4 and 10 stand rejected under 35 U.S.C. §103 as being obvious over WO 2012/023676 to Hong in view of US patent no. 7,362,351 to Meniere and US patent no. 7,123,746 to Meniere. The rejection is respectfully traversed.

Claims 2-4 and 10 depend from independent claim 1 and recite in part:

A pool cleaning system comprising:

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a powered robotic surface cleaning vehicle to travel on and clean adjacent water containing surfaces of a pool while submerged within the pool;

a camera configured to capture movement of the vehicle while the vehicle is submerged within the pool;

a controller in electronic communication with the camera to generate control signals to steer the vehicle based on the signals from the camera; and

sensors, in electronic communication with the controller and carried by the vehicle, to sense the water containing surfaces of the pool after the water containing surfaces of the pool have been cleaned by the vehicle during a pass of the vehicle under control of a pool coverage algorithm, wherein the control signals steer the vehicle so as to reclean the water containing surfaces having a cleanliness characteristic that is sensed by the sensors and fails to satisfy a predefined threshold. (Emphasis added).

As discussed above, the combination of Hong and `351 to Meniere only discloses a pool cleaner that can move in the forward and reverse direction when its path is obstructed and an external camera to view the cleaner.

The `746 Meniere patent discloses:

Cables 33, 43 which cross boxes 32, 42 containing cameras 31, 41, are coax cables, connected to a micro computer 72, for example of the "IBM compatible" type constructed around a PENTIUM microprocessor, by means of a multiplex system 71. A continuous power supply is established on each cable 33, 43 intended to supply the corresponding camera 31, 41. The said camera 31, 41 sends a modulation, which constitutes the signal to be processed through the cable 33, 43. Before input into the multiplex system 71, the separation of the continuous component must be assured thanks to the demodulation means which supply the signal emitted by the camera of the "CCD" type, solely by means of a multiplex system. The microcomputer 72 includes a central processing unit 73, means for temporary storage, or RAM (Random Access Memory), means for permanent storage, or hard disk 75, and a remote control card 76 which is able to control the alarm systems 77. In addition, the microcomputer 72 is connected to a control screen E, said screen is a touch screen which allows control of operation. The microcomputer 72 is configured as "multimedia" and is equipped with a video capture card 78, which converts these into digital images. (See `746 Meniere, col. 11, lns 1-22).

The combination of Hong, `351 Meniere and `746 Meniere only discloses a pool cleaner that can move in the forward and reverse direction when its path is obstructed, an external camera to view the cleaner, and a microcomputer positioned remote from the pool cleaner and in electronic communications with the camera.

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Nowhere in the combined prior art is there any teaching, suggestion or even prediction of the limitation "sensors, in electronic communication with the controller and carried by the vehicle, to sense the water containing surfaces of the pool after the water containing surfaces of the pool have been cleaned by the vehicle during a pass of the vehicle under control of a pool coverage algorithm, wherein the control signals steer the vehicle so as to reclean the water containing surfaces having a cleanliness characteristic that is sensed by the sensors and fails to satisfy a predefined threshold." The combined prior art, i.e., the Hong cleaner, only moves forward and reverse in an attempt to get past an obstruction when the current load is not being exceeded.

By contrast, the claimed invention uses the sensors to identify debris on a surface of a pool over which the cleaner has previously passed, and directs the cleaner to pass over and reclean such area. Therefore, the combined prior art does not teach, suggest or predict the present invention as a whole.

As such, it is submitted that dependent claims 2-4 and 10 are not obvious and fully satisfy the requirements under 35 U.S.C. § 103 and are patentable thereunder. Withdrawal of the rejection is respectfully requested.

C. Claim 13

Claim 13 stands rejected under 35 U.S.C. §103 as being obvious over WO 2012/023676 to Hong in view of US publication no. 2014/0009748 to Leonessa. The rejection is respectfully traversed.

Claim 13 depends from independent claim 12 and recites:

> An apparatus comprising:
> a non-transitory computer-readable medium comprising code configured to cause a processor to:
> generate first control signals for moving a robotic pool cleaning vehicle so as to clean water containing surfaces of a pool;
> obtain signals from a camera representing the water containing surfaces of the a pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool;

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> identify portions of the water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle to satisfy a predefined threshold; and
>
> automatically generate second control signals to steer the robotic pool cleaning vehicle to reclean the identified portions of the water containing surfaces based upon the signals from the camera, wherein the code is further configured to present a graphical depiction of the identified portions. (Emphasis added).

As discussed above, Hong only discloses a pool cleaner that can move in the forward and reverse direction when its path is obstructed and an external camera to view the cleaner.

Leonessa discloses:

> The control system 10 can include a controller14, a first sensor assembly or laser range finder 16 including a first laser 18, a second laser 20, and a camera 22, a second sensor assembly 24, and a directional control mechanism 26. The control system 10 can be located on and/or within the pool cleaner 12 and can optimize operation of the pool cleaner 12 by mapping a swimming pool or spa environment and accurately positioning the pool cleaner 12 throughout the environment. Furthermore, the control system 10 can optimize cleaning routes and identify specific locations of debris within the environment. Generally, the controller 14 can operate and receive inputs from the laser range finder 16 and/or the second sensor assembly 24 and can operate the directional control mechanism 26 to move the pool cleaner 12 along a desired route within the underwater environment based on these inputs, as further described below. (See Leonessa, paragraph 0027 and FIG. 1).

The combination of Hong and Leonessa only discloses a pool cleaner that can move in the forward and reverse direction when its path is obstructed, and control system for identify specific locations of debris within the environment. Nowhere in the combined prior art is there any teaching, suggestion or prediction of the limitation "automatically generate second control signals to steer the robotic pool cleaning vehicle to reclean the identified portions of the water containing surfaces based upon the signals from the camera, wherein the code is further configured to present a graphical depiction of the identified portions." The combined prior art only moves forward and reverse in an attempt to get past an obstruction when the current load is not being exceeded. Therefore, the combined prior art does not teach, suggest or predict the present invention as a whole.

As such, it is submitted that dependent claim 13 is not obvious and fully satisfies the requirements under 35 U.S.C. § 103 and is patentable thereunder. Withdrawal of the rejection is respectfully requested.

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D. Claims 17-19

Claims 17-19 stand rejected under 35 U.S.C. §103 as being obvious over WO 2012/023676 to Hong in view of US publication no. 2002/0097322 to Monroe. The rejection is respectfully traversed.

Independent claim 17 has been amended in part to incorporate the limitations of dependent claim 11. In particular, amended claim 17 recites:

> A pool cleaning system comprising:
> a powered robotic pool cleaning vehicle to travel adjacent to water containing surfaces of a pool while submerged within the pool;
> a camera configured to capture movement of the vehicle while the vehicle is submerged within the pool and identify debris located on the water containing surfaces;
> a controller in electronic communication with the camera to generate control signals to steer the vehicle, wherein the controller automatically steers the robotic pool cleaning vehicle to reclean identified portions of the water containing surfaces still having debris based on the signals from the camera; and
> a dry station remote from the pool and in communication with the vehicle. (Emphasis added).

As discussed above, Hong only discloses a pool cleaner that can move in the forward and reverse direction when its path is obstructed and an external camera to view the cleaner.

Monroe discloses:

> The video surveillance system of the subject invention is specifically adapted for distributing digitized camera video on a real-time or near real-time basis over a LAN and/or a WAN. As shown in FIG. 1, the system uses a plurality of video cameras C1, C2 . . . Cn, disposed around a facility to view scenes of interest. Each camera captures the desired scene, digitizes the resulting video signal at a dedicated encoder module E1, E2 . . . En, respectively, compresses the digitized video signal at the respective compressor P1, P2 . . . Pn, and sends the resulting compressed digital video stream to a multicast address router R. One or more display stations D1, D2 . . . Dn may thereupon view the captured video via the intervening network N. The network may be hardwired or wireless, or a combination, and may either a Local Area Network (LAN) or a Wide Area Network (WAN), or both. (See Monroe, paragraph 0061).

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The combination of Hong and Monroe only disclose a pool cleaner that can move in the forward and reverse direction when its path is obstructed, and sending control signal over a wide area network. Nowhere in the combined prior art is there any teaching, suggestion or prediction of the limitation "a controller in electronic communication with the camera to generate control signals to steer the vehicle, wherein the controller automatically steers the robotic pool cleaning vehicle to reclean identified portions of the water containing surfaces still having debris based on the signals from the camera." The combined prior art, i.e., the Hong cleaner, only moves forward and reverse in an attempt to get past an obstruction when the current load is not being exceeded. Therefore, the combined prior art does not teach, suggest or predict the present invention as a whole.

As such, it is submitted that independent claim 17 is not obvious and fully satisfies the requirements under 35 U.S.C. § 103 and is patentable thereunder. Furthermore, claims 18 and 19 depend from independent claim 17 and recite additional features considered inventive. For at least the same reasons discussed above, it is submitted that these dependent claims also fully satisfy the requirements under 35 U.S.C. §103 and are patentable thereunder. Withdrawal of the rejection is respectfully requested.

E. Claim 20

Claim 20 stands rejected under 35 U.S.C. §103 as being obvious over WO 2012/023676 to Hong in view of US publication no. 2002/0097322 to Monroe and in further view of US patent no. 7,123,746 to Meniere. The rejection is respectfully traversed.

Claim 20 depends from independent claim 19 and recites in part:

> A pool cleaning system comprising:
> a powered robotic pool cleaning vehicle to travel adjacent to water containing surfaces of a pool while submerged within the pool;
> a camera configured to capture movement of the vehicle while submerged within the pool and identify debris located on the water containing surfaces;
> a controller in electronic communication with the camera to generate control signals to steer the vehicle, wherein the controller automatically steers the robotic pool cleaning vehicle to reclean identified portions of the water containing surfaces still having debris based on the signals from the camera; and

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a dry station remote from the pool and in communication with the vehicle. (Emphasis added).

As discussed above, the combination Hong and Monroe only disclose a pool cleaner that can move in the forward and reverse direction when its path is obstructed and sending control signal over a wide area network.

Further, the '746 Meniere patent discloses:

> The central processing unit 73 combined with appropriate software, also constitutes means of estimating the nature of a body 1, for which the computer-generated image is obtained (human body or not), of the trajectory and of the changes of attitude of this body. In addition the central unit 73 and the software are provided to constitute the means for making decisions appropriate for setting off an alarm in the event of a suspicious trajectory or movements of the body being observed. The fact that the matrix of the initial image is known (empty swimming pool), makes it possible to count and follow the different forms moving in the swimming pool captured by the cameras individually. (See '746 Meniere, col. 11, ln 58 to col. 12, ln 3).

Thus, the combined prior art only discloses a pool cleaner that can move in the forward and reverse direction when its path is obstructed, sending control signal over a wide area network, and an alarm signal is emitted indicating a person in the pool.

Nowhere in the combined prior art is there any teaching, suggestion or prediction of the limitation "a controller in electronic communication with the camera to generate control signals to steer the vehicle, wherein the controller automatically steers the robotic pool cleaning vehicle to reclean identified portions of the water containing surfaces still having debris based on the signals from the camera." The combined prior art, i.e., the Hong cleaner, only moves forward and reverse in an attempt to get past an obstruction when the current load is not being exceeded. Therefore, the combined prior art does not teach, suggest or predict the present invention as a whole.

As such, it is submitted that dependent claim 20 is not obvious and fully satisfies the requirements under 35 U.S.C. § 103 and is patentable thereunder. Withdrawal of the rejection is respectfully requested.

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Conclusion

If the Examiner believes that there are any issues regarding this application that have not been completely addressed by this response, it is respectfully requested that the Examiner telephone the Applicant's representative, Steven M. Hertzberg, at (212) 885-9223 so that appropriate arrangements can be made for resolving such issues as expeditiously as possible.

Extension of Time

A Petition for a one-month extension of time is also being filed with this Amendment. The Commissioner is hereby authorized to charge any additional fees, or to credit any overpayment due by reason of this Response to Deposit Account No. 01-0035.

Respectfully submitted,

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PTO/AIA/22 (03-13)
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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.

PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)	Docket Number (Optional) 316,091
Application Number 13/545,918	Filed July 10, 2012
For POOL CLEANING SYSTEM AND METHOD	
Art Unit 2488	Examiner WONG, Allen C.

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above-identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

		Fee	Small Entity Fee	Micro Entity Fee	
☑	One month (37 CFR 1.17(a)(1))	$200	$100	$50	$ 200
☐	Two months (37 CFR 1.17(a)(2))	$600	$300	$150	$
☐	Three months (37 CFR 1.17(a)(3))	$1,400	$700	$350	$
☐	Four months (37 CFR 1.17(a)(4))	$2,200	$1,100	$550	$
☐	Five months (37 CFR 1.17(a)(5))	$3,000	$1,500	$750	$

☐ Applicant asserts small entity status. See 37 CFR 1.27.

☐ Applicant certifies micro entity status. See 37 CFR 1.29.
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 01-0035.

☑ Payment made via EFS-Web.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant.

☑ attorney or agent of record. Registration number 41834.

☐ attorney or agent acting under 37 CFR 1.34. Registration number _____.

/Steven M. Hertzberg/	October 26, 2015
Signature	Date
Steven M. Hertzberg	(212) 949-9022
Typed or printed name	Telephone Number

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

☑ * Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.136(a). 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 6 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: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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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.

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Electronic Patent Application Fee Transmittal	
Application Number:	13545918
Filing Date:	10-Jul-2012
Title of Invention:	POOL CLEANING SYSTEM AND METHOD
First Named Inventor/Applicant Name:	Kameshwar Durvasula
Filer:	Steven M. Hertzberg/Steven Ortiz
Attorney Docket Number:	316.091
Filed as Large Entity	

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

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Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 1 month with $0 paid	1251	1	200	200
Miscellaneous:				
		Total in USD ($)		**200**

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Electronic Acknowledgement Receipt	
EFS ID:	23893314
Application Number:	13545918
International Application Number:	
Confirmation Number:	9590
Title of Invention:	POOL CLEANING SYSTEM AND METHOD
First Named Inventor/Applicant Name:	Kameshwar Durvasula
Customer Number:	38137
Filer:	Steven M. Hertzberg/Steven Ortiz
Filer Authorized By:	Steven M. Hertzberg
Attorney Docket Number:	316.091
Receipt Date:	26-OCT-2015
Filing Date:	10-JUL-2012
Time Stamp:	17:11:44
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$200
RAM confirmation Number	6972
Deposit Account	010035
Authorized User	HERTZBERG, STEVEN
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment/Req. Reconsideration-After Non-Final Reject	316091_Amendment.pdf	1900603 0e6812c239dc9491a52ecda68c4fe4847854a108	no	21
Warnings:					
Information:					
2	Extension of Time	316091_Extension.pdf	163386 747f7c762237307f180ee8d5d7ce3e15cafd3354	no	2
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30842 c8de521fb7d0d0cce1ba11eb4a76484b065ad7aa	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	2094831		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a 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.

<u>National Stage of an International Application under 35 U.S.C. 371</u>
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.

<u>New International Application Filed with the USPTO as a Receiving Office</u>
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.

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

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 13/545,918	Filing Date 07/10/2012	☐ 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 $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ 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

AMENDMENT **10/26/2015**

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 22	Minus	** 20	= 2	X $80 =	160
Independent (37 CFR 1.16(h))	* 4	Minus	***4	= 0	X $420 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	**160**

AMENDMENT

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

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/ANNETTE SMITH/

This collection of information is required by 37 CFR 1.16. 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 12 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.

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Document code: WFEE

United States Patent and Trademark Office
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01 FC : 1202 160.00 DA

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Beatbot v. Zodiac, IPR2026-00200

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
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Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

38137 7590 12/31/2015
ABELMAN, FRAYNE & SCHWAB
666 THIRD AVENUE, 10TH FLOOR
NEW YORK, NY 10017

EXAMINER
WONG, ALLEN C

ART UNIT	PAPER NUMBER
2488	

DATE MAILED: 12/31/2015

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/545,918	07/10/2012	Kameshwar Durvasula	316.091	9590

TITLE OF INVENTION: POOL CLEANING SYSTEM AND METHOD TO AUTOMATICALLY CLEAN SURFACES OF A POOL USING IMAGES FORM A CAMERA

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	03/31/2016

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PTOL-85 (Rev. 02/11)

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

38137 7590 12/31/2015
ABELMAN, FRAYNE & SCHWAB
666 THIRD AVENUE, 10TH FLOOR
NEW YORK, NY 10017

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/545,918	07/10/2012	Kameshwar Durvasula	316.091	9590

TITLE OF INVENTION: POOL CLEANING SYSTEM AND METHOD TO AUTOMATICALLY CLEAN SURFACES OF A POOL USING IMAGES FORM A CAMERA

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	03/31/2016

EXAMINER	ART UNIT	CLASS-SUBCLASS
WONG, ALLEN C	2488	348-114000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:
❑ Issue Fee
❑ Publication Fee (No small entity discount permitted)
❑ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
❑ A check is enclosed.
❑ Payment by credit card. Form PTO-2038 is attached.
❑ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
❑ Applicant certifying micro entity status. See 37 CFR 1.29
NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
❑ Applicant asserting small entity status. See 37 CFR 1.27
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
❑ Applicant changing to regular undiscounted fee status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/545,918	07/10/2012	Kameshwar Durvasula	316.091	9590

38137 7590 12/31/2015

ABELMAN, FRAYNE & SCHWAB
666 THIRD AVENUE, 10TH FLOOR
NEW YORK, NY 10017

EXAMINER	
WONG, ALLEN C	
ART UNIT	PAPER NUMBER
2488	

DATE MAILED: 12/31/2015

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. 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 12 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, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. 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.

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.

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

Notice of Allowability	Application No. 13/545,918	Applicant(s) DURVASULA ET AL.	
	Examiner ALLEN WONG	Art Unit 2488	AIA (First Inventor to File) Status No

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

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *amendment filed 10/26/15*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ 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.
3. ☒ The allowed claim(s) is/are *1-10 and 12-23*. As a result of the allowed claim(s), 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 .
4. ☐ 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)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
5. ☐ Examiner's Amendment/Comment
6. ☒ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/ALLEN WONG/
Primary Examiner, Art Unit 2488

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

DETAILED ACTION

The present application is being examined under the pre-AIA first to invent provisions.

Allowable Subject Matter

Claims 1-10, 12-23 are allowed.

The following is an examiner's statement of reasons for allowance: the present invention pertains to robotic pool cleaning.

Hong (WO 2012/023676 A1) discloses an apparatus comprising: a non-transitory computer-readable medium comprising code configured to cause a processor (paragraph 130, element 330) to:

generate first control signals for moving a robotic pool cleaning vehicle so as to clean water containing surfaces of a pool (paragraph 178-179);

capturing images of a pool being cleaned with a robotic pool cleaning vehicle operating according to a steering algorithm (paragraph 137, camera 168; paragraph 68, operating according to a steering algorithm for cleaning pool);

obtain signals from a camera representing water containing surfaces of a pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool (paragraph 1, 178-179, pool cleaning robot for cleaning pool, paragraph 137, camera 168);

identify portions of the water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle to satisfy a predefined threshold (paragraph 31 and 137);

a powered robotic surface cleaning vehicle to travel adjacent water containing surfaces of a pool while submerged within the pool (abstract and paragraph [1]);

a camera configured to capture movement of the vehicle (paragraph 111, element 168);

a controller in electronic communication with the camera to generate control signals to steer the vehicle based on the signals from the camera (paragraph 31 and 36).

Meniere (US 7,362,351) discloses a camera adapted to be mounted external the pool to capture movement of the vehicle while submerged within the pool (col.6, ln.21-30).

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The prior art, either singularly or in combination, does not disclose the limitation "automatically generate second control signals to steer the robotic pool cleaning vehicle to reclean the identified portions of the water containing surfaces based upon the signals from the camera" of claim 12.

Thus, the prior art does not disclose the aforementioned limitation used in combination with all of the other limitations of claim 12. Claim 15 is patentable for at least similar reasons as claim 12. Also, peruse pages 9-12 of Applicant's remarks filed 10/26/15.

Also, the prior art, either singularly or in combination, does not disclose the limitation "sensors, in electronic communication with the controller and carried by the vehicle, to sense the water containing surfaces of the pool after the water containing surfaces of the pool have been cleaned by the vehicle during the pass of the water under control of a pool coverage algorithm, wherein the control signals steer the vehicle so as to reclean the water containing surfaces having a cleanliness characteristic that is sensed by the sensors and fails to satisfy a predetermined threshold" of claim 1.

Thus, the prior art does not disclose the aforementioned limitation used in combination with all of the other limitations of claim 1. Also, peruse pages 12-14 of Applicant's remarks filed 10/26/15.

And, the prior art, either singularly or in combination, does not disclose the limitation "wherein the controller automatically steers the robotic pool cleaning vehicle to reclean identified portions of the water containing surfaces still having debris based on the signals from the camera" of claim 17.

Thus, the prior art does not disclose the aforementioned limitation used in combination with all of the other limitations of claim 17. Also, peruse pages 18-19 of Applicant's remarks filed 10/26/15.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Contact Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to ALLEN WONG whose telephone number is (571)272-7341. The examiner can normally be reached on Flex Monday to Thursday 8am-6pm.

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Beatbot v. Zodiac, IPR2026-00200

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, SATH PERUNGAVOOR can be reached on (571) 272-7455. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/ALLEN WONG/
Primary Examiner, Art Unit 2488

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13545918	DURVASULA ET AL.
	Examiner	Art Unit
	ALLEN WONG	2488

CPC- SEARCHED		
Symbol	Date	Examiner
E04H 4/1654, H04N 5/23203, H04N 7/18, H04N 2005/2255	6/25/15	AW
search updated	12/16/15	AW

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
348	114, 143, 159	6/25/15	AW
382	103	6/25/15	AW
356	4.03	6/25/15	AW
search	updated	12/16/15	AW

SEARCH NOTES		
Search Notes	Date	Examiner

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
348	114	12/16/15	AW
E04H	4/1654	12/16/15	AW
H04N	7/18, 5/23203, 2005/2255	12/16/15	AW

	/ALLEN WONG/ Primary Examiner.Art Unit 2488

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

BIB DATA SHEET

CONFIRMATION NO. 9590

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
13/545,918	07/10/2012 RULE	348	2488	316.091

APPLICANTS

INVENTORS

Kameshwar Durvasula, Lyndhurst, NJ;
William Londono Correa, Bloomfield, NJ;

** CONTINUING DATA **********

** FOREIGN APPLICATIONS **********

** IF REQUIRED, FOREIGN FILING LICENSE GRANTED **
07/20/2012

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☑ No Verified and Acknowledged /ALLEN C WONG/ Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		NJ	4	20	4

ADDRESS

ABELMAN, FRAYNE & SCHWAB
666 THIRD AVENUE, 10TH FLOOR
NEW YORK, NY 10017
UNITED STATES

TITLE

POOL CLEANING SYSTEM AND METHOD TO AUTOMATICALLY CLEAN SURFACES OF A POOL USING IMAGES FORM A CAMERA

FILING FEE RECEIVED		
1660	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

BIB (Rev. 05/07).

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13545918	DURVASULA ET AL.
	Examiner	**Art Unit**
	ALLEN WONG	2488

CPC							
Symbol						**Type**	**Version**
E04H		4	/	1654		F	2013-01-01
H04N		7	/	18		I	2013-01-01
H04N		5	/	23203		I	2013-01-01
H04N		2005	/	2255		A	2013-01-01
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CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
			/					
			/					

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	22	
/ALLEN WONG/ Primary Examiner.Art Unit 2488	12/17/2015	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office — Part of Paper No. 20151215

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13545918	DURVASULA ET AL.
	Examiner	Art Unit
	ALLEN WONG	2488

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION										
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED					
348	114	H	0	4	N	7 / 18 (2006.01.01)						

CROSS REFERENCE(S)					
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	22	
/ALLEN WONG/ Primary Examiner.Art Unit 2488	12/17/2015	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office

Part of Paper No. 20151215

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13545918	DURVASULA ET AL.
	Examiner	**Art Unit**
	ALLEN WONG	2488

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	16	17												
2	2	17	18												
3	3	18	19												
4	4	19	20												
5	5	20	21												
6	6	21	22												
7	7	22	23												
8	8														
9	9														
10	10														
	11														
11	12														
12	13														
13	14														
14	15														
15	16														

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	22	
/ALLEN WONG/ Primary Examiner.Art Unit 2488	12/17/2015	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office Part of Paper No. 20151215

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13545918	DURVASULA ET AL.
	Examiner	**Art Unit**
	ALLEN WONG	2488

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

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	06/25/2015	12/17/2015							
1	1	✓	=							
2	2	✓	=							
3	3	✓	=							
4	4	✓	=							
5	5	✓	=							
6	6	✓	=							
7	7	✓	=							
8	8	✓	=							
9	9	✓	=							
10	10	✓	=							
	11	✓	-							
11	12	✓	=							
12	13	✓	=							
13	14	✓	=							
14	15	✓	=							
15	16	✓	=							
16	17	✓	=							
17	18	✓	=							
18	19	✓	=							
19	20	✓	=							
20	21		=							
21	22		=							
22	23		=							

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT:	Kameshwar DURAVASULA	EXAMINER: Allen C. WONG
SERIAL NO.:	13/545,918	ART UNIT: 2488
FILED:	July 10. 2012	CONF. NO.: 9590

FOR: POOL CLEANING SYSTEM AND METHOD TO AUTOMATICALLY CLEAN SURFACES OF A POOL USING IMAGES FROM A CAMERA

January 6, 2016

Mailstop – Issue Fee
Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT UNDER 37 C.F.R. 1.312

Dear Commissioner:

In response to the Notice of Allowance mailed December 31, 2015, please amend and reconsider the above-identified application as follows:

Amendments to the specification begin on page 2 of this document;

Amendments to the claims begin on page 3 of this document; and

Remarks begin on page 8 of this document.

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

IN THE SPECIFICATION:

Please amend the Title of Invention beginning on page 1,line 1 as follows:

POOL CLEANING SYSTEM AND METHOD TO AUTOMATICALLY CLEAN SURFACES OF A POOL USING IMAGES ~~FORM~~ FROM A CAMERA

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

IN THE CLAIMS:

Please amend and reconsider the claims as follows:

1. (Previously presented) A pool cleaning system comprising:

a powered robotic surface cleaning vehicle to travel on and clean adjacent water containing surfaces of a pool while submerged within the pool;

a camera configured to capture movement of the vehicle while the vehicle is submerged within the pool;

a controller in electronic communication with the camera to generate control signals to steer the vehicle based on the signals from the camera; and

sensors, in electronic communication with the controller and carried by the vehicle, to sense the water containing surfaces of the pool after the water containing surfaces of the pool have been cleaned by the vehicle during a pass of the vehicle under control of a pool coverage algorithm, wherein the control signals steer the vehicle so as to reclean the water containing surfaces having a cleanliness characteristic that is sensed by the sensors and fails to satisfy a predefined threshold.

2. (Original) The system of claim 1 further comprising a station remote from the vehicle and in communication with the vehicle, wherein the station includes the controller.

3. (Original) The system of claim 1 further comprising a station remote from the vehicle and in communication with the vehicle, wherein the controller is located remote from the vehicle and the station.

4. (Previously presented) The system of claim 1, wherein the camera is mounted to the vehicle.

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Beatbot v. Zodiac, IPR2026-00200

5. (Original) The system of claim 1 further comprising a portable electronic device having a display, wherein the portable electronic device is configured to present a graphic on the display, the graphic depicting water containing surfaces of the pool and those portions of the water containing surfaces that remain uncleaned as a vehicle traverses the water containing surfaces.

6. (Original) The system of claim 5, wherein the portable electronic device depicts movement of the vehicle on the display.

7. (Previously presented) The system of claim 1, wherein the controller generates second control signals for steering the vehicle based on a coverage algorithm independent of signals from the camera, and wherein the control signals based on the captured coverage steer the vehicle to clean portions of the water containing surfaces missed by the vehicle while being steered according to the second control signals.

8. (Previously presented) The system of claim 1, wherein the camera is mounted remotely from the vehicle.

9. (Previously presented) The system of claim 1 further comprising a portable electronic device having a display and in electronic communications with the vehicle.

10. (Previously presented) The system of claim 1, wherein the controller is located at a server remote from the camera and the vehicle.

11. Canceled.

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Beatbot v. Zodiac, IPR2026-00200

12. (Previously presented) An apparatus comprising:

a non-transitory computer-readable medium comprising code configured to cause a processor to:

generate first control signals for moving a robotic pool cleaning vehicle so as to clean water containing surfaces of a pool;

obtain signals from a camera representing the water containing surfaces of the ~~a~~ pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool;

identify portions of the water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle to satisfy a predefined threshold; and

automatically generate second control signals to steer the robotic pool cleaning vehicle to reclean the identified portions of the water containing surfaces based upon the signals from the camera.

13. (Previously presented) The apparatus of claim 12, wherein the code is further configured to present a graphical depiction of the identified portions.

14. (Previously presented) The apparatus of claim 13 further comprising a portable electronic device comprising:

a processing unit;

a display to present the graphical depiction; and

the non-transitory computer readable medium.

15. (Previously presented) A method comprising:

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Beatbot v. Zodiac, IPR2026-00200

moving a robotic pool cleaning vehicle so as to clean water containing surfaces of a pool;

capturing images of a pool being cleaned with a robotic pool cleaning vehicle operating according to a steering algorithm;

obtaining signals from a camera representing the water containing surfaces of the pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool;

identifying portions of the water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle to satisfy a predefined threshold; and

steering the robotic pool cleaning vehicle based upon signals from the camera to reclean the identified portions.

16. (Previously presented) The method of claim 15 further comprising presenting a graphical depiction of the identified portions.

17. (Previously presented) A pool cleaning system comprising:

a powered robotic pool cleaning vehicle to travel adjacent to water containing surfaces of a pool while submerged within the pool;

a camera configured to capture movement of the vehicle while the vehicle is submerged within the pool and identify debris located on the water containing surfaces;

a controller in electronic communication with the camera to generate control signals to steer the vehicle, wherein the controller automatically steers the robotic pool cleaning vehicle to reclean identified portions of the water containing surfaces still having debris based on the signals from the camera; and

a dry station remote from the pool and in communication with the vehicle.

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18. (Currently amended) The system of claim 17, further comprising:

one or more processing units;

at least one non-transitory computer-readable medium comprising code configured to direct the one or more processing units to cause a ~~the~~ portable electronic device to display coverage of the water containing surfaces of the pool by the vehicle.

19. (Previously presented) The system of claim 17 further comprising sensors, in electronic communication with the controller and carried by the vehicle, to sense the water containing surfaces of the pool after the water containing surfaces of the pool have been cleaned by the vehicle during a pass of the vehicle under control of a pool coverage algorithm, wherein the control signals steer the vehicle so as to reclean the water containing surfaces having a cleanliness characteristic that is sensed by the sensors and fails to satisfy a predefined threshold.

20. (Currently amended) The system of claim 19, wherein the camera comprises a pool security camera and wherein the at least one non-transitory computer-readable medium causes a ~~the~~ portable electronic device to output an alert based on signals from the camera indicating presence of a person at pool satisfying a predefined characteristic.

21. (Previously presented) The system of claim 17, wherein the camera is mounted remotely from the vehicle.

22. (Previously presented) The system of claim 17, further comprising a server in communication with the dry station across a wide area network

23. (Previously presented) The system of claim 22, further comprising a portable electronic device in communication with the server.

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REMARKS

This amendment under 37 C.F.R. 1.312 is submitted in accordance with the telephone interview conducted on January 4, 2016 as between Examiner Wong and the Applicants' representative, Steven M. Hertzberg. During the discussion, claims 18 and 20 were identified as having improper antecedent basis for the limitation of the "portable electronic device". The Examiner advised that a 1.312 Amendment be submitted to correct the improper antecedent basis issues. The Applicant thanks the Examiner for reviewing this proposed Amendment and indicating that the amendments would likely be entered if formally filed before payment of the issue fee.

In the Claims:

Claims 18 and 20 are amended to change the limitation of "the portable electronic device" to "a portable electronic device". Support for the portable electronic device as recited in dependent claims 18 and 20 may be found in original independent claim 17, as well as paragraphs 0026, 0032, 0033 and 0045 of the specification, and FIG. 4 of the drawings.

In the Specification:

The Title of Invention is being amended to correct a typographical error of the title as set forth in the PAIR system. In particular, the Applicant amended the Title of Invention in the Amendment electronically filed with the USPTO on October 26, 2015. However, the PAIR System incorrectly recites the latter portion of the title of invention as "USING IMAGES FORM A CAMERA" instead of "USING IMAGES FROM A CAMERA". It is respectfully requested that the word "FORM" be properly changed to the word "FROM" in the title of invention so that the correct title of invention will be published in the issued patent.

Conclusion

It is submitted that no new subject matter has been added to the claims and that no further search is required. If, however, the Examiner believes that any new issue is raised by the requested amendment, it is respectfully requested that the Examiner telephone Steven M.

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

Hertzberg (212) 885-9223 so that the appropriate arrangements can be made for resolving such issues as expeditiously as possible.

Any fees associated with this Amendment may be charged to Deposit Account No. 01-0035.

Respectfully submitted,
Attorneys for Applicants

/Steven M. Hertzberg/
Steven M. Hertzberg
Registration No. 41,834

ABELMAN, FRAYNE & SCHWAB
666 Third Avenue
New York, New York 10017-5621
Tel: (212) 949-9022
Fax: (212) 949-9190
Customer No. 38137

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

Electronic Acknowledgement Receipt	
EFS ID:	24538975
Application Number:	13545918
International Application Number:	
Confirmation Number:	9590
Title of Invention:	POOL CLEANING SYSTEM AND METHOD TO AUTOMATICALLY CLEAN SURFACES OF A POOL USING IMAGES FORM A CAMERA
First Named Inventor/Applicant Name:	Kameshwar Durvasula
Customer Number:	38137
Filer:	Steven M. Hertzberg/Steven Ortiz
Filer Authorized By:	Steven M. Hertzberg
Attorney Docket Number:	316.091
Receipt Date:	06-JAN-2016
Filing Date:	10-JUL-2012
Time Stamp:	11:36:02
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment after Notice of Allowance (Rule 312)	316091_312_amendment.pdf	33782 163f418b869fef95eeb1bfdf453b48aa84e7510d	no	9

Warnings:
Information:

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

Total Files Size (in bytes):	33782

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a 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.

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT:	Kameshwar DURAVASULA	EXAMINER: Allen C. WONG
SERIAL NO.:	13/545,918	ART UNIT: 2488
FILED:	July 10. 2012	CONF. NO.: 9590

FOR: POOL CLEANING SYSTEM AND METHOD TO AUTOMATICALLY CLEAN SURFACES OF A POOL USING IMAGES FROM A CAMERA

January 6, 2016

Mailstop – Issue Fee
Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

OK TO ENTER: /AW/

AMENDMENT UNDER 37 C.F.R. 1.312 01/11/2016

Dear Commissioner:

In response to the Notice of Allowance mailed December 31, 2015, please amend and reconsider the above-identified application as follows:

Amendments to the specification begin on page 2 of this document;

Amendments to the claims begin on page 3 of this document; and

Remarks begin on page 8 of this document.

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/545,918	07/10/2012	Kameshwar Durvasula	316.091	9590

38137 7590 01/13/2016

ABELMAN, FRAYNE & SCHWAB
666 THIRD AVENUE, 10TH FLOOR
NEW YORK, NY 10017

EXAMINER	
WONG, ALLEN C	

ART UNIT	PAPER NUMBER
2488	

MAIL DATE	DELIVERY MODE
01/13/2016	PAPER

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.

Response to Rule 312 Communication	Application No.	Applicant(s)
	13/545,918	DURVASULA ET AL.
	Examiner	Art Unit
	ALLEN WONG	2488

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

1. ☒ The amendment filed on *06 January 2016* under 37 CFR 1.312 has been considered, and has been:

a) ☐ entered.

b) ☒ entered as directed to matters of form not affecting the scope of the invention.

c) ☐ disapproved because the amendment was filed after the payment of the issue fee.
Any amendment filed after the date the issue fee is paid must be accompanied by a petition under 37 CFR 1.313(c)(1) and the required fee to withdraw the application from issue.

d) ☐ disapproved. See explanation below.

e) ☐ entered in part. See explanation below.

/ALLEN WONG/
Primary Examiner, Art Unit 2488

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
13/545,918	07/10/2012	2488	1660	316.091	20	4

CONFIRMATION NO. 9590

38137
ABELMAN, FRAYNE & SCHWAB
666 THIRD AVENUE, 10TH FLOOR
NEW YORK, NY 10017

CORRECTED FILING RECEIPT

OC000000079978975

Date Mailed: 01/19/2016

Receipt is acknowledged of this non-provisional 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 APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)
Kameshwar Durvasula, Lyndhurst, NJ;
William Londono Correa, Bloomfield, NJ;

Applicant(s)
Kameshwar Durvasula, Lyndhurst, NJ;
William Londono Correa, Bloomfield, NJ;

Assignment For Published Patent Application
AQUA PRODUCTS, INC., Cedar Grove, NJ

Power of Attorney: The patent practitioners associated with Customer Number 38137

Domestic Applications for which benefit is claimed - None.
A proper domestic benefit claim must be provided in an Application Data Sheet in order to constitute a claim for domestic benefit. See 37 CFR 1.76 and 1.78.

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.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: No

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

If Required, Foreign Filing License Granted: 07/20/2012

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/545,918**

Projected Publication Date: Not Applicable

Non-Publication Request: No

Early Publication Request: No

Title

POOL CLEANING SYSTEM AND METHOD TO AUTOMATICALLY CLEAN SURFACES OF A POOL USING IMAGES FROM A CAMERA

Preliminary Class

348

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

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

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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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Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

Doc code: RCEX
Doc description: Request for Continued Examination (RCE)

PTO/SB/30EFS (07-14)
Approved for use through 07/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL
(Submitted Only via EFS-Web)

Application Number	13/545,918	Filing Date	2012-07-10	Docket Number (if applicable)	316,091	Art Unit	2488
First Named Inventor	DURVASULA, Kameshwar			Examiner Name	WONG, Allen C.		

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, to any international application that does not comply with the requirements of 35 U.S.C. 371, or to any design application. The Instruction Sheet for this form is located at WWW.USPTO.GOV.

SUBMISSION REQUIRED UNDER 37 CFR 1.114

Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

- ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____
- ☐ Other _____

☒ Enclosed

- ☐ Amendment/Reply
- ☒ Information Disclosure Statement (IDS)
- ☐ Affidavit(s)/ Declaration(s)
- ☐ Other _____

MISCELLANEOUS

☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of months _____
(Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

☐ Other _____

FEES

☒ **The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.**
The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account No 010035

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature

Applicant Signature

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

PTO/SB/30EFS (07-14)
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Signature of Registered U.S. Patent Practitioner			
Signature	/Steven M. Hertzberg/	Date (YYYY-MM-DD)	2016-01-20
Name	Steven M. Hertzberg	Registration Number	41834

This collection of information is required by 37 CFR 1.114. 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 12 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.

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

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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.

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 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.

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(Not for submission under 37 CFR 1.99)

Application Number	13545918
Filing Date	2012-07-10
First Named Inventor	DURVASULA
Art Unit	2488
Examiner Name	Allen C. WONG
Attorney Docket Number	316091

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	1	0687964	EP	A1	1995-12-20	Zeltron SPA		
	2	0811432	EP	A2	1997-12-10	Pehrson Jonas		

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	Application Number	13545918
	Filing Date	2012-07-10
	First Named Inventor	DURVASULA
	Art Unit	2488
	Examiner Name	Allen C. WONG
	Attorney Docket Number	316091

	3	101139007	CN	A	2008-03-12	Bejing Inst. Technology		
	4	S6162905	JP	A	1986-03-31	Komatsu MFG Co		
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	6	2009031361	WO	A1	2009-30-12	Yotsuyanagi Co. Ltd		
	7	2012023676	WO	A1	2012-02-23	Pohang Inst. of Intelligent Robotics		

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[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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Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13545918
	Filing Date	2012-07-10
	First Named Inventor	DURVASULA
	Art Unit	2488
	Examiner Name	Allen C. WONG
	Attorney Docket Number	316091

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 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

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See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Steven M. HERTZBERG/	Date (YYYY-MM-DD)	2016-01-20
Name/Print	Steven M. HERTZBERG	Registration Number	41834

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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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.

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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.

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

US005205174A

United States Patent [19]

Silverman et al.

[11] Patent Number: 5,205,174

[45] Date of Patent: Apr. 27, 1993

[54] **SCAVENGER SUBMERSIBLE VISUAL AND ACOUSTICAL TANK INSPECTION SYSTEM AND METHOD**

[76] Inventors: **Eugene B. Silverman**, 4217 Scarlet Sage Ct., Ellicott City, Md. 21043; **Seymour R. Kotler**, 1054 St. Margarets Dr., Annapolis, Md. 21401; **Harry T. Roman**, 25 Laurel Ave., East Orange, N.J. 07017

[21] Appl. No.: **705,687**

[22] Filed: **May 24, 1991**

[51] **Int. Cl.**[5] **G01N 29/10**; G01N 29/24

[52] **U.S. Cl.** ..... **73/623**; 15/321; 15/339; 376/310; 376/316; 134/167 C; 358/99

[58] **Field of Search** ..... 15/321, 320, 339, 304; 376/310, 316; 73/601, 620, 623, 627, 628, 629, 644; 358/99; 134/167 C

[56] **References Cited**

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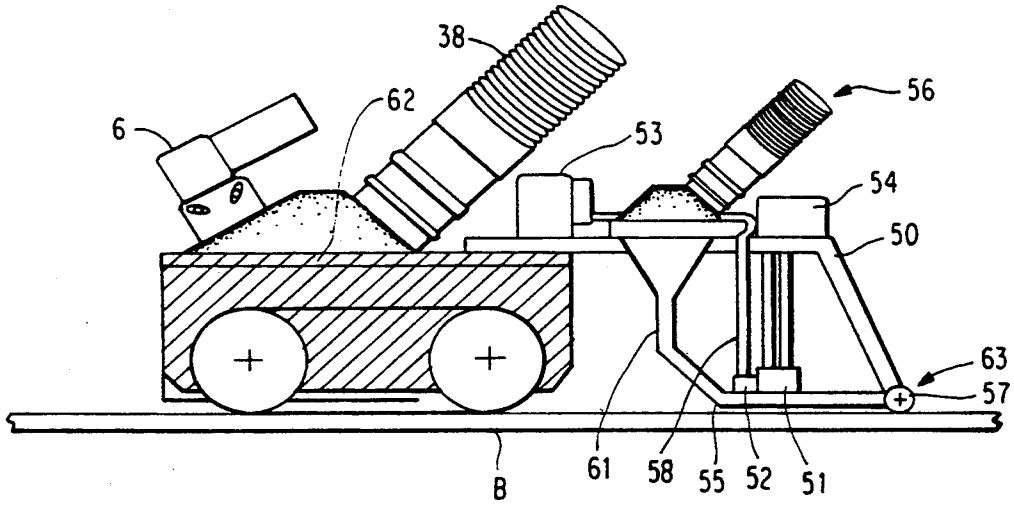
4,910,823	3/1990	Silverman et al.	15/1
5,073,258	12/1991	Boullain, II et al.	15/321

Primary Examiner—Herzon E. Williams
Assistant Examiner—Rose M. Finley
Attorney, Agent, or Firm—Sughrue, Mion, Zinn, Macpeak & Seas

[57] **ABSTRACT**

The present invention is an apparatus and method of preparing and inspecting a submerged surface of a fluid reservoir. The apparatus includes a chassis sized and shaped to provide an optimally low center of gravity, a propulsion system comprising two independently controllable motor and track means, a scrubbing/vacuuming system disposed at the front of the chassis which includes a scrubbing system designed to mechanically break up sediment on the surface beneath the apparatus and a vacuuming system to remove sediment and sediment-containing fluid from beneath the apparatus, and an inspection system located immediately behind the scrubbing/vacuuming system with respect to the direction of apparatus travel and operative to inspect the freshly cleaned surface with either ultrasonics, optics, or a combination of both.

16 Claims, 9 Drawing Sheets



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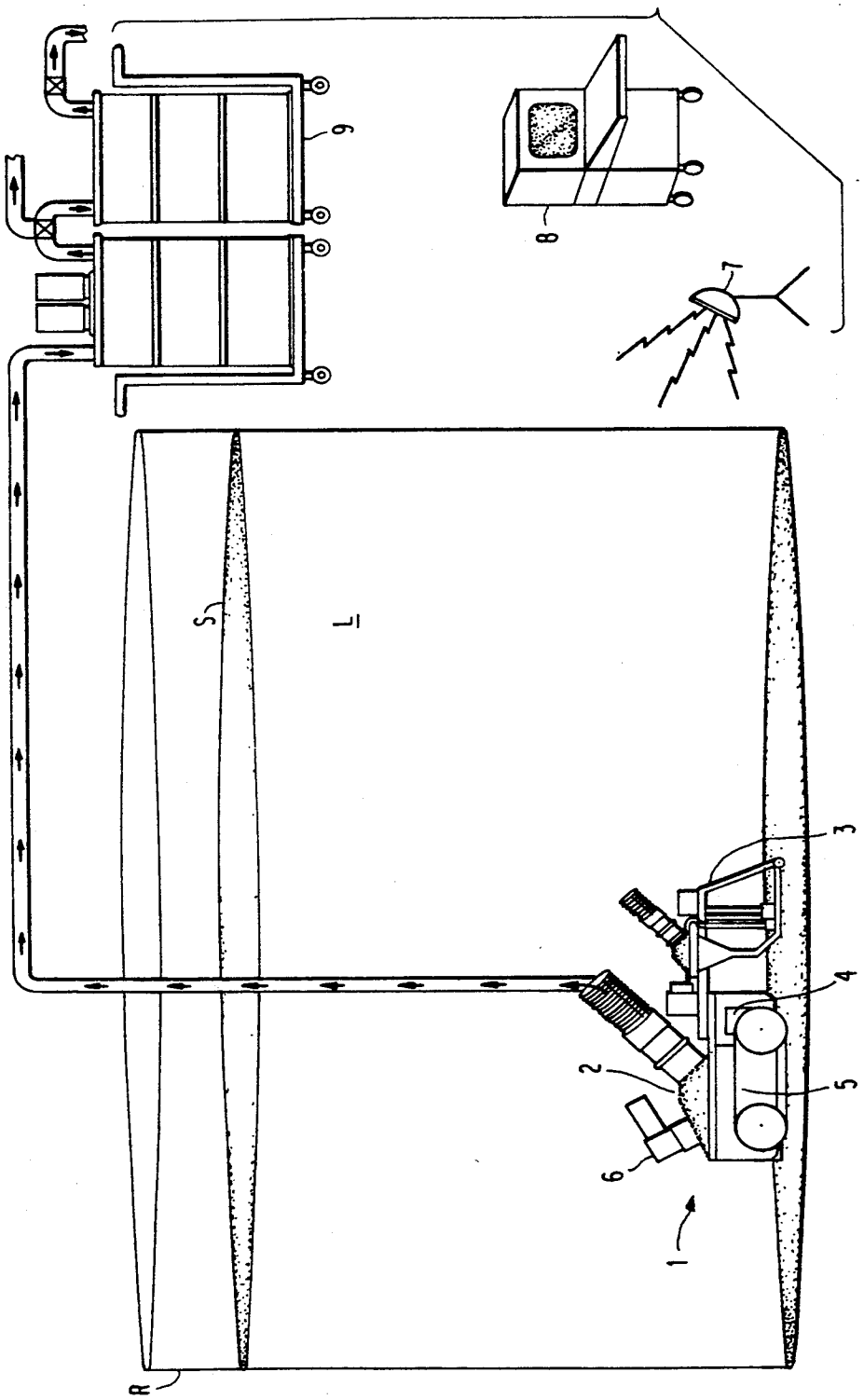

FIG. 1

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FIG. 2A

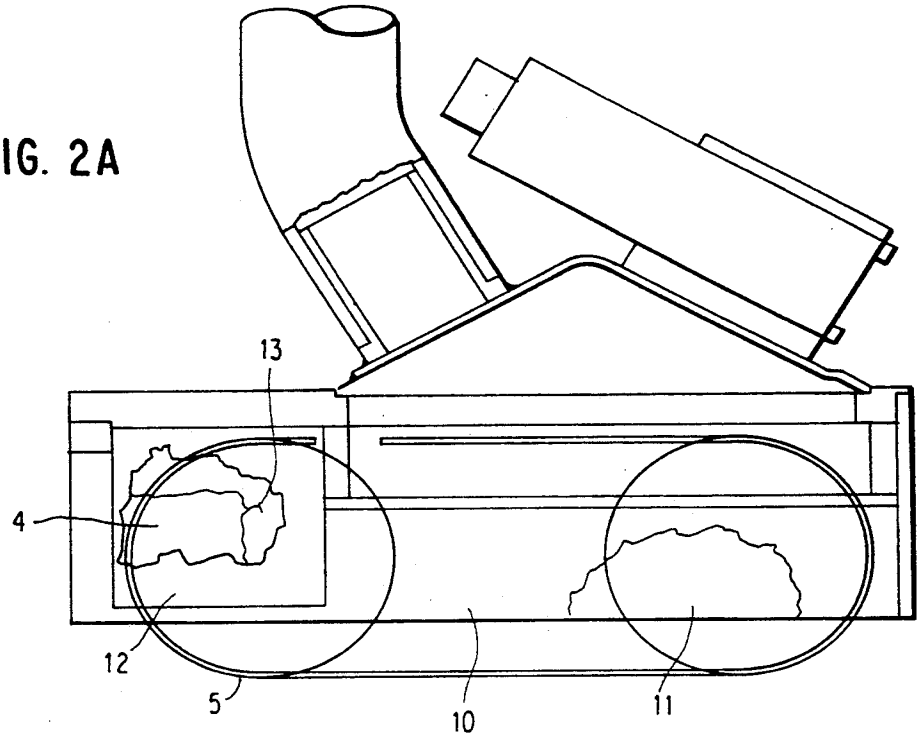
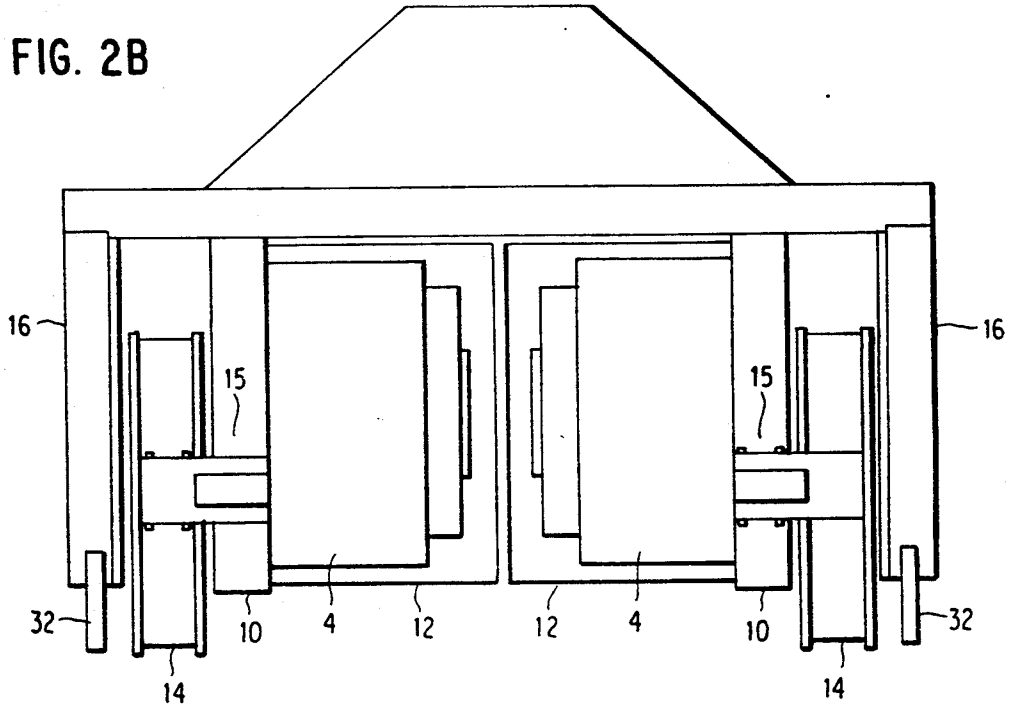


FIG. 2B



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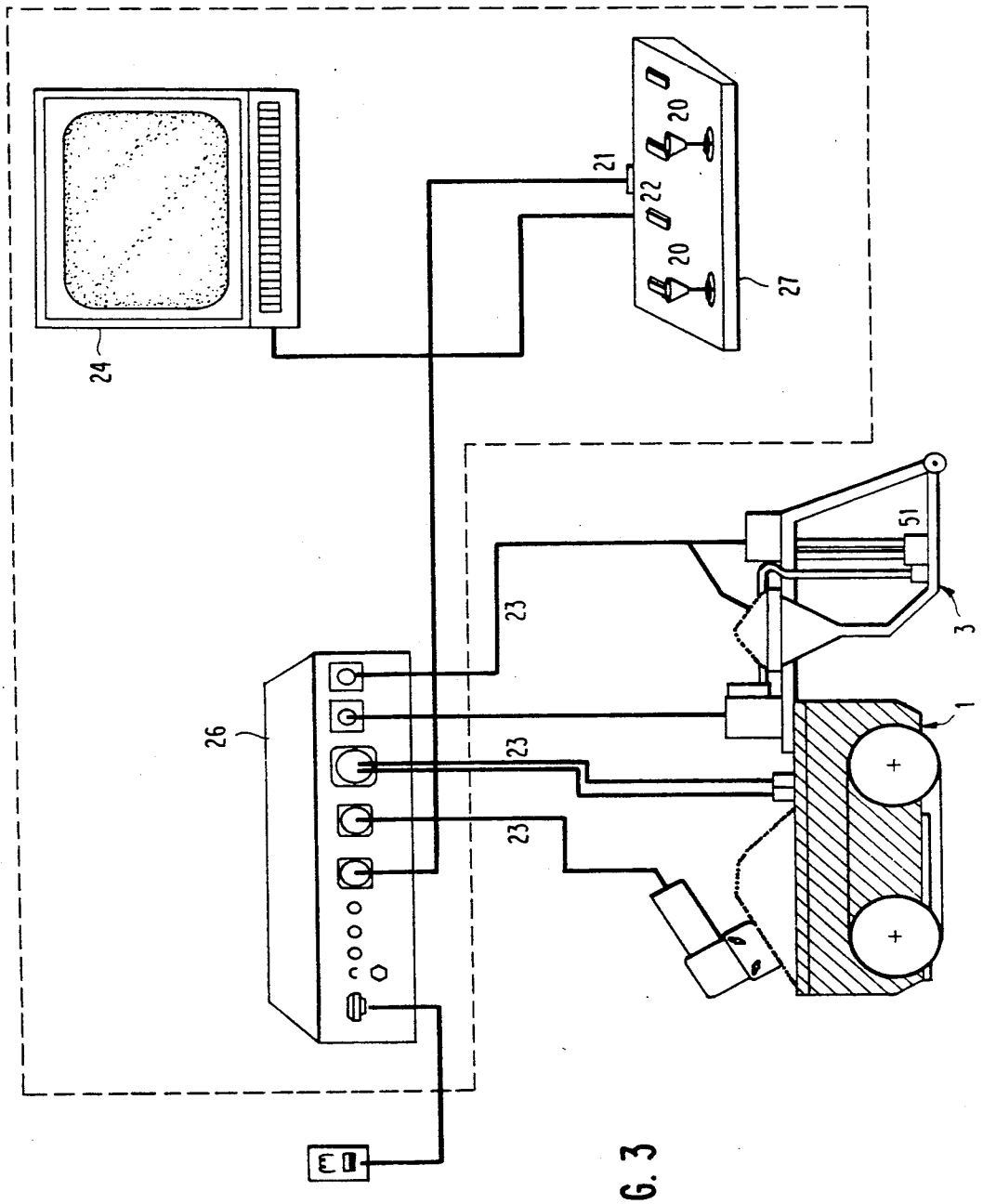

FIG. 3

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FIG. 4A

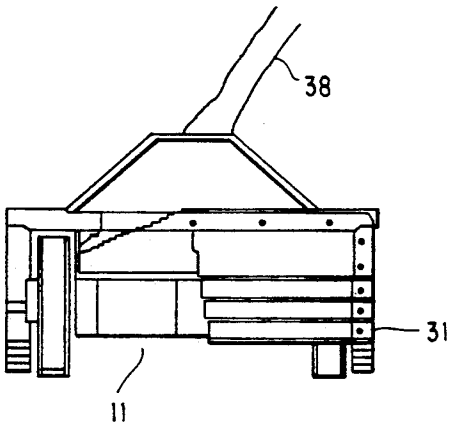

FIG. 4B

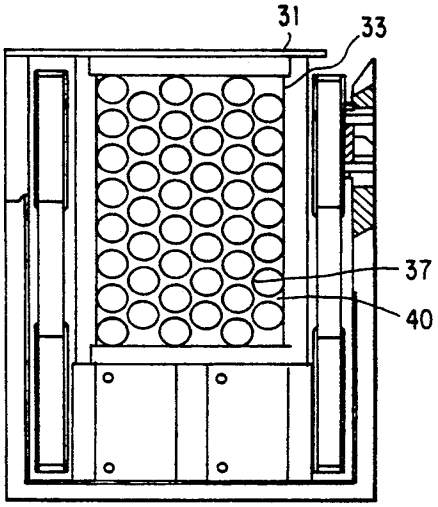

FIG. 4D

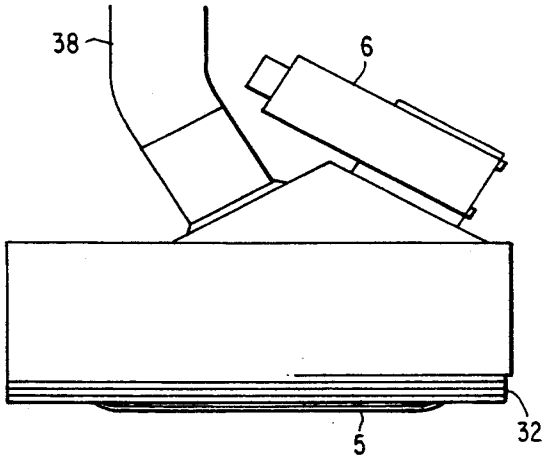

FIG. 4C

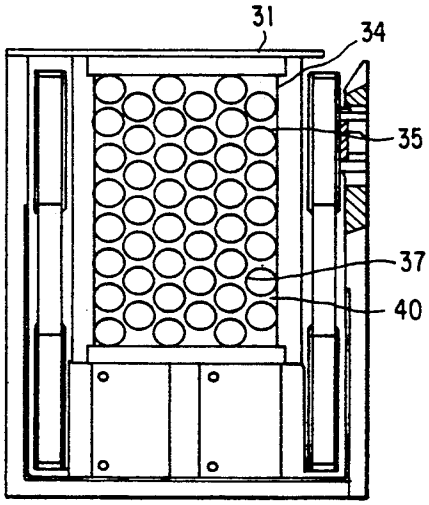

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FIG. 5A

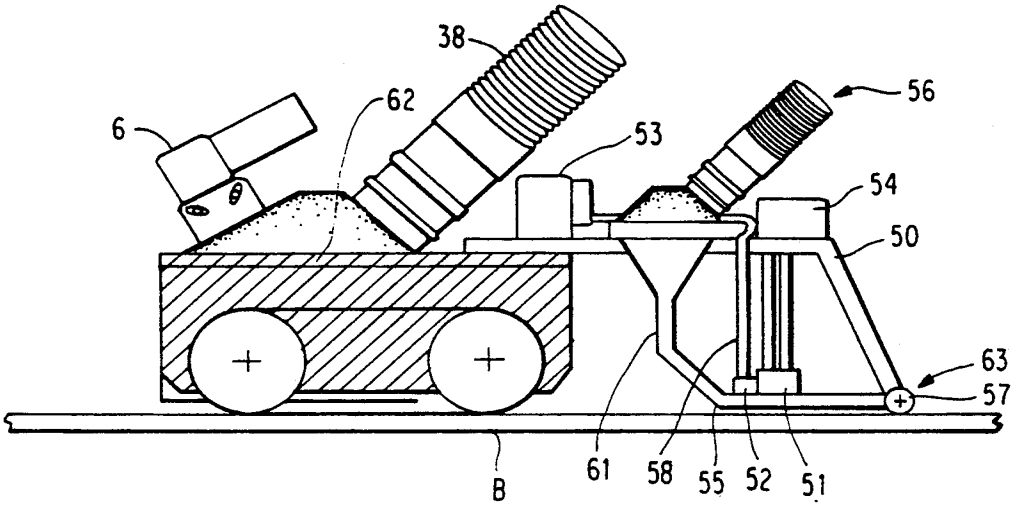

FIG. 5B

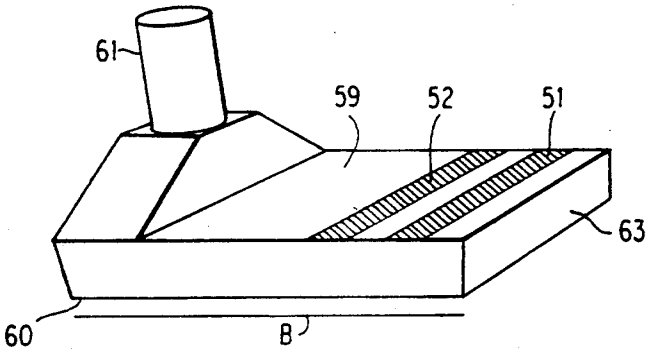

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FIG. 6A

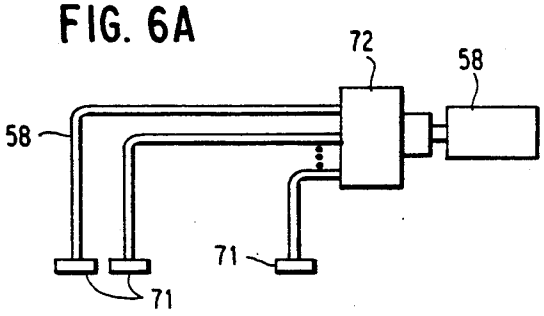

FIG. 6B

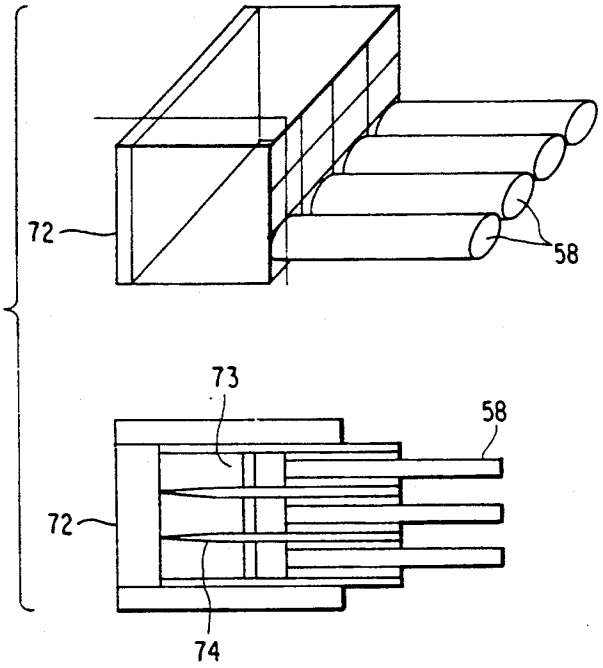

FIG. 7A

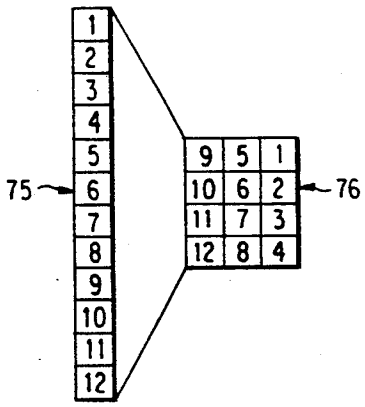

FIG. 7B

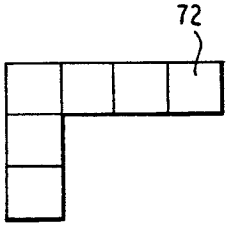

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FIG. 8A

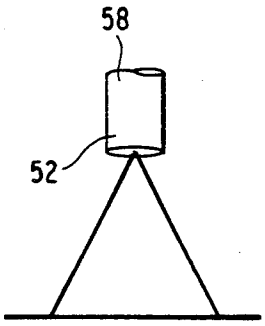

FIG. 8B

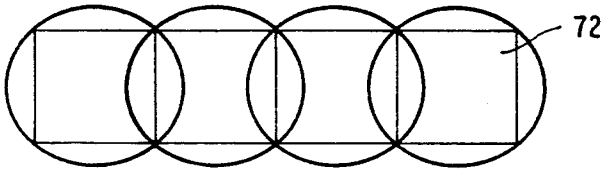

FIG. 9

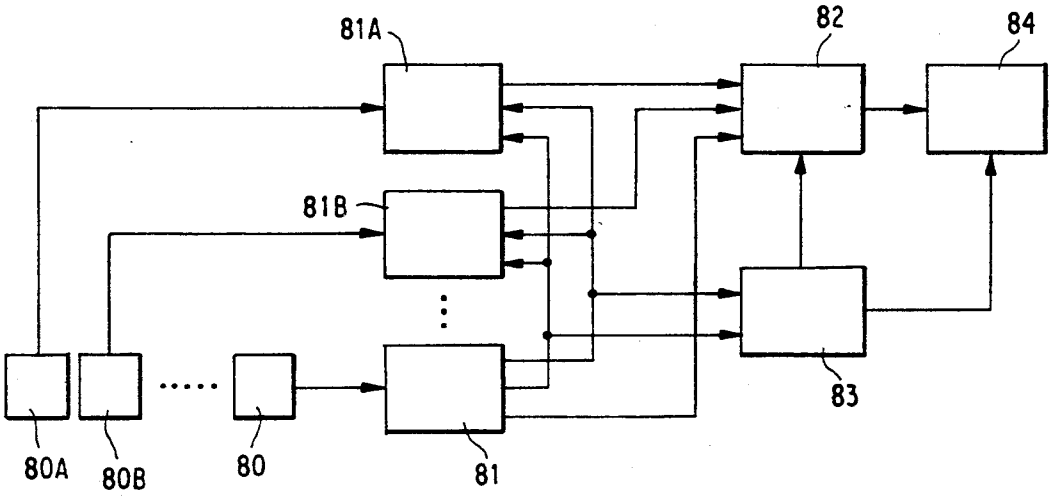

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FIG. 10A

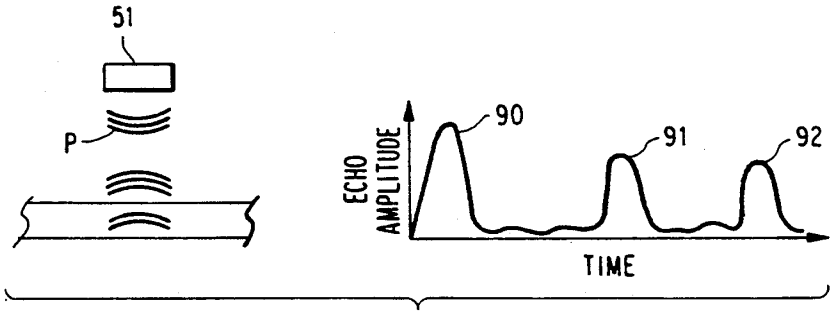

FIG. 10B

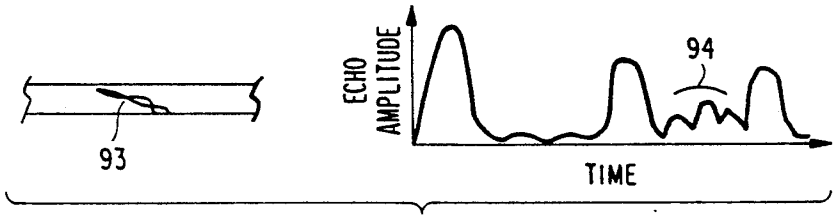

FIG. 10C

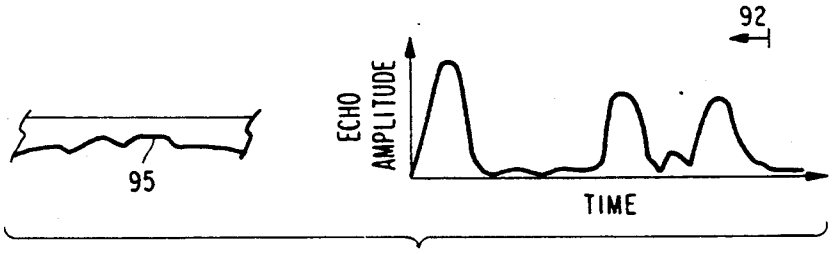

FIG. 10D

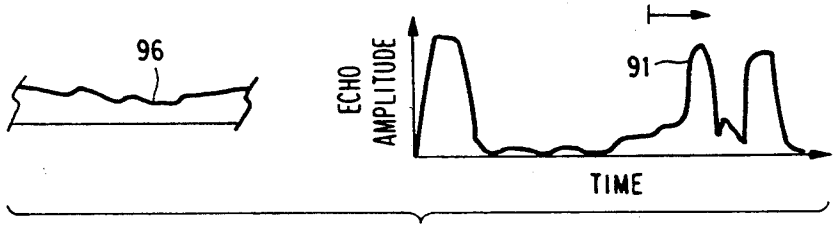

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FIG. 11A

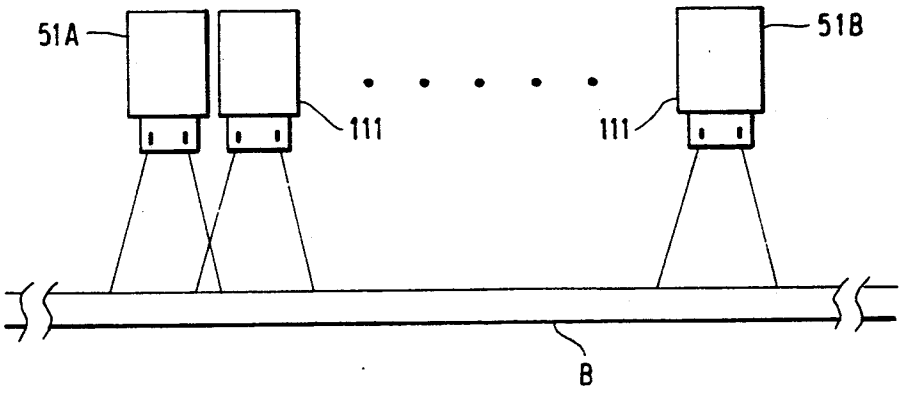
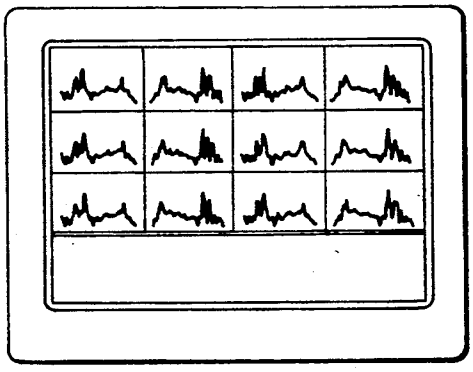


FIG. 11B



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SCAVENGER SUBMERSIBLE VISUAL AND ACOUSTICAL TANK INSPECTION SYSTEM AND METHOD

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a method and apparatus for cleaning and inspecting the bottom surfaces of fluid reservoirs, such as storage tanks, pools, sumps, and ponds, without first draining them. More particularly, the invention relates to a remote controlled, submersible vehicle which removes sediment from reservoir surfaces by a scrubbing and/or vacuuming process and simultaneously provides video and/or acoustic inspection of the freshly cleaned surface.

In recent years, environmental and industrial safety concerns have focussed attention on the need to inspect fluid handling facilities for signs of corrosion and structural defects. The use of fluid reservoirs to store fuels, chemicals, waste, and radioactive effluents is common in many industries, particularly the chemical and nuclear power industries. In addition, some fluid reservoirs are involved in the active processing of liquids. These reservoirs are subject to additional stresses since liquids often move through them at elevated temperatures and high velocities. When used for either purpose, the volume and nature of the liquids involved make these reservoirs potential sources of widespread toxic and radioactive contamination. As a result, monitoring their structural integrity is a primary concern of government and industry alike. The consequences of failing to detect structural by the media and in court proceedings before the regulatory agencies.

Inspection of liquid reservoirs is no simple matter since entire systems often must be shutdown to gain access to them. Even where the reservoir is not a part of an active processing system, inspection is impeded by the stored liquid and the inevitable buildup of sediments on the reservoir surfaces. In addition, the suspension of sediment in the fluid itself impedes inspection since these particles reduce visibility and scatter signals which may be used to remotely examine the surfaces. Thus, suspended particles will significantly reduce the resolution of video or acoustic images, limiting the features that can be detected.

The most obvious solution to the difficulties imposed by suspended particles and sediment buildup is to drain and clean the reservoir prior to inspection. However, there are significant problems with this approach. First, operation time is lost as systems which depend upon the reservoir are shut down during the cleaning and inspecting procedure. Second, manpower is tied up by these procedures. Finally, where toxic chemicals or radioactive waste are implicated, personnel are exposed to dangerous conditions. For example, in the nuclear power industry radioactive sediment collects in water filled cooling pools. This water provides shielding against radiation and prevents the escape of radioactive particles. Draining these pools to clean and examine their surfaces removes this shielding, exposing personnel to high radiation levels. In addition, if the sediment dries it is susceptible to wind borne dispersion, increasing the dangers to other on-site personnel and the surrounding communities.

Remote controlled, submersible vehicles have been used in various industries to remove sediment from undrained storage tanks. While the use of these vehicles addresses the dangers and economic costs associated with draining reservoirs for cleaning, the contemporaneous inspection of the reservoir surface for damage or defects is not known to have been practiced. As discussed in connection with the description of the present invention, cleaning and inspection procedures are interrelated and it is more efficient to deal with them concurrently.

Sedimentation is a continuous process, proceeding even as the deposited materials are removed. Thus, fresh sediment will accumulate in the interval between cleaning the surface and inspecting it. Minimizing this interval is one key to obtaining accurate inspection data. On the other hand, the contemporaneous cleaning and inspection of surfaces creates a new problem since scrubbing a surface agitates deposited sediment, thereby increasing the concentration of sediment particles suspended in the liquid. As a result, the scattering problem described earlier may be exacerbated when surface cleaning and inspection are carried out in a one step process.

In addition to the problems created by solid sediments, the suspension of non-miscible liquids creates difficulties in certain storage environments. For example, where oil-based liquids are stored, accumulated moisture may also be present, suspended in the liquid. The consequent inhomogeneity of the liquid leads to the same signal scattering and resolution problems discussed above. The quality and resolution of the images necessary to accurately inspect liquid reservoirs is determined by the size of the features which indicate the presence of structural defects and corrosion. Unfortunately, these features may be as fine as hairline cracks, which are easily obscured by small amounts of sediment or missed in low resolution images. Thus, any image degradation could hinder the timely discovery of structural defects and result in contamination with toxic or radioactive material. Certain features, such as corrosion on the external surface of tanks, grain boundary corrosion, or subtle wear effects, cannot be detected visually under the best of circumstances. In these instances, ultrasonic inspection methods are necessary. Ultrasonic inspection can detect variations in reservoir wall thickness due to corrosion on either the inside or outside wall surface as well as structural defects within the reservoir walls. However, ultrasonic inspection requires the detection of small changes between incident and reflected signals. Consequently, the technique is equally sensitive to the accumulation of sediments on reservoir surfaces and the scattering of signals by suspended particles.

Accordingly, it is a primary object of the present invention to facilitate the cleaning and inspection of a reservoir surface without draining the reservoir of its contents.

It is also an object of the present invention to remove sediment from a reservoir bottom by breaking it up mechanically and vacuuming it away.

It is a further object of the present invention to filter the suspension of sediment and reservoir fluid and return the filtered fluid to the reservoir.

Yet another object of this invention is to minimize the time between surface cleaning and surface inspection, during which sediment can continue to deposit.

A further object of the present invention is to provide a liquid volume free of suspended particles through which optical and ultrasonic inspection signals can pass unscattered.

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SUMMARY OF THE INVENTION

In accordance with the foregoing objects, the present invention is a method and apparatus involving a remotely operated, tracked, submersible vehicle comprising a system which mechanically loosens and vacuums deposited sediment from a reservoir surface and an inspection system capable of collecting and transmitting video or ultrasonic images of the freshly cleaned surface. In particular, the present invention utilizes a system to remove reservoir fluid containing suspended sediment from an inspection volume and to supply clean fluid to the inspection volume and, more particularly, a system to continuously remove and filter reservoir fluid having suspended particles from the inspection volume and to supply the inspection volume with reservoir fluid which has been filtered of suspended particles or liquids and thereby minimize the degradation of inspection signals. Furthermore, the present invention utilizes a positioning system to locate the vehicle as it moves across the reservoir surface.

The invention may be operated interactively with an operator following the vehicle motion using the positioning system, a forward looking video camera, or direct observation. Alternatively, the vehicle may operate autonomously by pre-programming an on-board or remote microprocessor.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1**. is a schematic overview showing the cleaning/inspection apparatus of the present invention in a reservoir along with its external remote control, filtering, and positioning systems.

FIG. **2A**. is a side view of the robotic vehicle including cutaway views of the sealed motor compartment and the scrubbing/vacuuming compartment.

FIG. **2B**. is a cutaway view of the motor compartment from the rear of the robotic vehicle, showing the location of the tread motors, drive wheels, and axles.

FIG. **3**. is a schematic view of the remote control center with connections between user console, power supply, video display, inspection system and robotic vehicle indicated.

FIG. **4A**. is a front view of the robotic vehicle, indicating the location of the scrubbing/vacuuming compartment and front gate.

FIG. **4B**. is a bottom view of the robotic vehicle indicating the location of the rotating brush scrubbing mechanism and the vacuum inlet.

FIG. **4C**. is the same as FIG. **4B**. with the rotating brush replaced by a hydrolaser scrubbing mechanism.

FIG. **5A**. is a view of the inspection system, including the optical and ultrasonic inspection systems, the plenum, and the associated electronics.

FIG. **5B**. is a detailed view of the plenum.

FIGS. **6A** and **6B**. provide views of one embodiment of the optical inspection system, detailing the fiber optic system connecting the sensor lenses to the CCD camera.

FIGS. **7A** and **7B**. indicate one way to map the linear sensor array is onto the CCD board.

FIGS. **8A** and **8B**. indicate the orientation and location of the fiber optic/lens elements with respect to the surface and the fields of view of the individual elements.

FIG. **9** is a diagram of an alternative embodiment of the optical inspection system which uses an array of **12** separate CCD cameras to image the surface directly.

FIG. **10**. illustrates the echo signals to be expected for an intact wall section, a section containing an inclusion or crack, a section corroded from the outide, and a section corroded from the inside.

FIG. **11A**. is a view of the transducer array for doing acoustic inspections.

FIG. **11B**. represents one mode of displaying the signals from the transducers on a video monitor.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings, FIG. **1** shows a plan view of a typical liquid reservoir, R, having bottom and side surfaces and filled with liquid, L, that defines a liquid surface, S. Within the reservoir, R, and below the surface, S, is a submersible vehicle **1** having a cleaning system **2**, an inspection system **3**, a propulsion system **4**, including motor driven treads **5**, and a navigation system, including a camera **6**. Physically connected to or in communication with the vehicle but outside of the reservoir, is positioning system **7**, a remote control system **8**, and a system for filtering reservoir liquids and returning them to the reservoir **9**.

In the preferred embodiment, all vehicle operations are directed from the remote control system **8**. Thus, vehicle speed and direction, surface cleaning and inspection, and reservoir fluid processing operations may be regulated from the control system **8**. It also receives and processes information from the external positioning system **7**, the inspection system **3**, and the navigation camera **6**. The remote control system can provide video display of all inspection data and, in particular, it can correlate and store information on reservoir surface features as a function of vehicle position. As would be understood by one of ordinary skill in the art, many of these functions need not be performed at the remote control system but could be performed on-board the vehicle, using microprocessors, storage media, and customized programming.

The propulsion system **4** is operative to move the vehicle across the reservoir bottom surface, which may have a variety of accumulated contaminants and may have variations in height and surface orientation. Preferably, the vehicle has a low center of gravity and is made of corrosion and impact resistant materials that can be sealed to contain on-board electronics, motors, actuators, and the like. For example, the body may be constructed of ½" ultra high molecular weight polyethylene (OHWM), 300 series stainless steel, and Delrin. Conventional joint and interface sealing materials may be used.

Referring to FIGS. **2A** and **2B**, the submersible robotic vehicle is shown having a base chassis **10**, a scrubbing/vacuuming compartment **11**, and a sealed compartment **12** which houses the propulsion motors **4** and electronics **13**. The vehicle chassis **10** is supported on two treads **5** which provide traction for forward and reverse motions, climbing over small surface structures or obstructions, and steering. Preferably, the treads **5** are made of rubber and each is separately driven by a reversible, stall-protected motor **4**. The treads are enclosed by an Outer wall **16** which also supports a rubber skirt **32** that extends almost to the surface. The drive wheels **14** for the treads are connected to the two drive motors **4** by sealed axles **15**. Because the motors provide a significant part of the vehicle mass, particularly when batteries are not used as the energy source, they are located to provide a low center of gravity to the vehi-

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cle. Together, the motors provide adequate thrust to propel the vehicle at speeds sufficient to promote effective cleaning and inspection of the reservoir surface without agitating the sediment. The motors are separately operable in forward and reverse directions, and at various speeds to promote steerability. Ordinarily, vehicle speeds of up to 1 ft/s would be acceptable.

FIG. 3 illustrates an embodiment of the remote control system 8. The system is operator controlled via a user console 27 consisting of two joysticks 20, video input and output ports 21 and power switches 22 for the various subsystems. From the console, the operator can maneuver the robotic vehicle, adjust the vehicle speed, regulate the surface scrubbing and vacuuming operations, and activate the inspection system 3. Communication between the control system and the various systems of the robotic vehicle is accomplished by power and control lines 23. Alternatively, when a power/control tether is not desirable, power could be provided by batteries and control could be provided by radio command signals, broadcast from a remotely located transmitter to an on-board receiver. Also, as previously noted, an on-board microprocessor would allow the operator to pre-program certain vehicle functions for automatic operation.

Video signals are provided by navigation camera 6 and optical sensors 52, and time/amplitude signals are provided by ultrasonic transducers 51. These video and amplitude/time signals may be displayed on the video terminal 24. Signals from the forward looking navigation camera 6 provide the operator with a broad, though possibly occluded view of the uncleaned reservoir surface in front of the vehicle, allowing him to adjust the vehicle speed and direction accordingly. Video signals from the optical sensors 52 provide close up views of the freshly scrubbed and vacuumed surface. Finally, signals from the ultrasonic transducers 51 provide the operator with an amplitude/time display which can be analyzed for surface irregularities by conventional techniques. The video and ultrasonic inspection signals may also be stored for later analysis, as discussed below.

In the preferred embodiment, a power supply 26 is connected to the user console 27. It provides 12 V power for the vehicle drive motors 4 and the external pump (not shown) in addition to supplying power for operation of the navigation camera 6 and the inspection system 3, including the CCD camera 53 and the ultrasonic transducers 51.

Referring to FIG. 4A, the scrubbing/vacuum compartment 11 is disposed on the front underside of the robotic vehicle 1. The compartment 11 is shown in FIGS. 4B and 4C having a scrubbing mechanism 33, 34 to dislodge sediment from surfaces which may have a variety of irregularities. The sediment is mixed with fluid by the scrubbing action and pumped through a vacuum opening 37 in the top of the scrubbing/vacuuming compartment 11. A flexible pipe 38 transports the fluid/sediment mixture to a filtering system 9 which is located outside the reservoir as indicated in FIG. 1.

A gate 31 at the front of the vehicle, may be adjusted to provide the minimum aperture necessary to accommodate the sludge level in the reservoir. As seen in FIG. 2B, the flexible rubber bottom skirt 32 is located along either side of the vehicle, descending from the outer tread covering 16 almost to the bottom of the vehicle treads 5. The rubber skirt 32 automatically throttles the vacuum and the pressure differential provides additional traction for the robotic vehicle 1. By enclosing the scrubbing/vacuuming operation beneath the robotic vehicle 1, a steady inward movement of fluid is created. This design is effective to prevent movement of dislodged sediment into the fluid surrounding the vehicle 1, thus minimizing any deterioration in visibility.

One embodiment of the scrubbing mechanism, illustrated in the underside view of FIG. 4B, utilizes a rotating brush 33 to break up deposited sediment. The brush may be driven by a geared connection to the propulsion motor 4 or a separate motor may be provided for it. An alternative embodiment of the scrubbing mechanism is the hydrolaser illustrated in FIG. 4C, which utilizes high velocity jets of filtered reservoir fluid to break up deposited sediment. The embodiment shown consists of a manifold of four nozzles 34 mounted to a face plate 34a on the front of the vehicle body 17. The nozzles 34 can be selected to accommodate different spray widths and delivery pressures up to 3000 psi. These would be particularly suitable for highly irregular surfaces. A combination of brushes and hydrolasers, or other dislodging/scrubbing mechanisms may also be used.

The vacuum inlet 37 is located in the top surface of the robotic vehicle and connected by flexible pipe 38 to an external pump (not shown). While a pump may be located on the vehicle 1 within the purview of the present invention, the added weight and vibration that would result may not be desirable. In the preferred embodiment, the pump is capable of moving up to 300 gallons of sediment and fluid per minute through a 2–3" diameter flexible pipe 38 which connects it to the vehicle.

As noted above, turbulence in the reservoir fluid is minimized by arranging the scrubbing mechanism to direct the fluid/sediment suspension into the vacuum inlet 37. The inlet is covered by a screen 40 made of hard, corrosion resistant material. Variable mesh sizes may be used to regulate the sludge flow rate and the maximum size of objects taken into the filter system.

Placement of the inspection system 3, which is illustrated in FIGS. 5A and 5B, is based on the requirement that the interval between surface cleaning and surface inspection be minimized. This may be accomplished by locating the inspection system so that the robotic vehicle's forward motion brings the freshly cleaned surface into the inspection sensor's field of view immediately after the sediment has been removed from it. For example, at a robotic vehicle velocity of 1 ft/s, a sensor array positioned 1 ft. behind the vacuum inlet views a surface that has been scrubbed and vacuumed only one second earlier. Larger separations yield correspondingly longer intervals between surface preparation and inspection. A linear array of sensors with overlapping fields of view, a total width comparable to that of the robotic vehicle, and an orientation perpendicular to the vehicle's direction of motion, allows for cleaning and inspection of the same swath of surface in a single pass.

FIG. 5A illustrates the preferred embodiment of the inspection system 3. A framework 50, provides support for the optical sensors 52, ultrasonic sensors 51, electronics 53, 54, the plenum 55, and plenum fluid supply system 56. The framework 50 is made of lightweight, corrosion resistant material. Attachment to the robotic vehicle 1 may be made by an articulated connection 62, allowing the vehicle to move over uneven terrain. Rollers, skids, or the like 57 may be used to support the rear of the framework 50. The CCD camera, electronics,

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and light source **53** are mounted on the framework **50**, immediately behind the articulated connection **62**. Fiber optics **58** transmit the image from the optical sensor lenses **52** to the camera **53**. The ultrasonic transducer electronics **54** are located behind the articulated connection **62**, directly above the transducer array **51**. All electronics are packaged in corrosion-resistant, lightweight materials. The clear fluid supply pipe **56** for the plenum **55** is mounted on top of the framework **50**, immediately behind the articulated connection **62**. The pipe **56** materials and diameter are selected in accordance with a variety of parameters including the desired flow rate, maximum hydrostatic head which must be overcome, fluid drag per foot of pipe, and the characteristics of the pump. Clear fluid is provided by filtering suspended materials from the contents of the tank.

The plenum **55** is a structure substantially enclosing a volume between the inspection sensors **51**, **52** and the bottom reservoir surface B, through which filtered reservoir fluid is continuously passed. The plenum **55** provides a volume in which signal scattering from suspended particles or fluids is minimized. The positive pressure created by the continuous fluid flow prevents unfiltered fluid outside the plenum from entering it and clouding the volume with suspended particles.

In the embodiment illustrated in FIG. **5B**, the plenum **55** comprises the volume bounded on top by the surface **59** on which the optical sensors **52** and acoustical sensors **51** are mounted. The plenum sides are bounded by rubber skirts **60** which extend from the surface **59** almost to the reservoir surface B. Fluid enters the volume through an inlet **61** at the forward end and is discharged at the open rear of the volume **63**. The fluid is drawn from the contents of the tank, filtered if necessary, and pumped through the plenum **55** at a rate sufficient to provide the volume with steady stream of filtered fluid. For example, a $12''\times8''\times2''$ volume would require approximately 50 gallons per minute to flush the 192 in^3 space once every second.

The optical inspection system which consists of lenses **52**, fiber optics connections **58**, a CCD interface **72**, and the attendant electronics **53**, transmits video images of the surface to the control center video monitor **24** (FIG. **3**) for immediate analysis and/or storage for subsequent analysis. The present invention contemplates using an array of lenses arranged to image a section of the surface comparable in width to the swath cleaned by the scrubbing/vacuuming system.

One embodiment of the optical system is illustrated in FIG. **6A**. Commercially available fiber optic elements **58** transmit surface images from the sensor lenses **52** to a CCD interface **72**. As illustrated in FIG. **6B**, a second set of lenses **73** and baffles **74** may be used to focus the individual images onto the CCD **72**.

One possible mapping configuration of the sensor images onto the CCD interface **72** is illustrated in FIG. **7A**, where a linear array **75** of twelve sensor lenses **52** is mapped onto a 3×4 array of CCD sections **76**. As shown in FIG. **7B**, a 256×256 pixel CCD board **72** may be subdivided into a 4×4 array of sixteen equal areas. Mapping images from the twelve lenses **52** onto a 3×4 subset of the CCD sections **76** provides each sensor with 64×64 pixel array.

As illustrated in FIG. **8A**, the lenses **52** are preferably arranged with their optic axes perpendicular to the surface B to be inspected. In the illustrated configuration, the lenses **52** are preferably located 2" above the surface B, but other lens/surface distances are possible, provided that lens focal lengths are adjusted appropriately. With the lenses **52** spaced at 1" intervals and each lens imaging a 1.5" dia. area, as illustrated in FIG. **8B**, images from adjacent lenses overlap with each lens corresponding to a 1 in^2 area. This arrangement allows the operator to view a $12''\times1''$ swath of the surface.

An alternative embodiment of the optical system is illustrated in FIG. **9**. Twelve low resolution (64×64 pixel) CCD cameras **80** are arranged as illustrated for the fiber optic/lens case in FIGS. **8A** and **8B**. Here, however, CCD cameras directly image the surface rather than depending on the fiber optic/lens arrangement of the embodiment described above. The output of each camera is sent to a corresponding sample & hold circuit **81**. The sample & hold outputs are then sequentially transferred to an appropriate location in the video memory **82**. For example, a 30 frame per second image would require a clock **83**, operating at 1.62 MHz ($30\times64\times64\times12+10\%$ for overhead), to trigger the transfer of the sample & hold outputs.

The video image can be processed by conventional techniques, such as contrast enhancement, edge detection, or pixel averaging, and stored for later review. The video system may also be used in conjunction with a mouse, allowing the operator to mark the location of a surface feature and store it for future reference.

Illumination for video inspection is provided by a single high intensity bulb projected into a fiber-optic bundle which carries the light between the optics electronics **53** and the optical sensors **52**. One illumination fiber-optic is provided for each optical sensor **52**. Illumination is preferably provided at an angle with respect to the surface normal, to enhance contrast and visibility of surface defects.

Not all defects can be detected by an optical inspection system, even under the best of circumstances. Such defects include grain boundary corrosion, cracks, inclusions, and decreased material thickness due to erosion from below the tank bottom. However, these defects may be detected using existing ultrasonic inspection techniques. In addition, an ultrasonic inspection system may be used to confirm the results obtained with an optical system.

The applicable ultrasonic technique is illustrated in FIG. **10**. An ultrasonic transducer **51** emits a pulse P and detects the echoes created when the pulse is reflected from various surfaces. The time interval between detection of the echoes indicates the distances separating the reflecting surfaces. Thus, FIG. **10A** shows the echo response from a fully intact reservoir wall. A single outgoing pulse **90** gives rise to two reflected pulses, one from the near, inner wall **91** and one from the far, outer wall **92**. The time interval between the detected echoes multiplied by the pulse propagation velocity in the wall material is equal to the wall thickness. The case where a defect is present within the wall is illustrated in FIG. **10B**. There, the internal crack **93** provides additional reflecting surfaces and, consequently, additional echoes **94** are detected between the echoes corresponding to reflections from the near (inner) wall **91** and the far (outer) wall **92**. FIG. **10C** and **10D** illustrate the echo patterns to be expected from a wall that has been corroded on its exterior **95** and interior **96** surfaces, respectively.

One embodiment of the acoustic detection system is illustrated in FIG. **11A**. The geometry of the system parallels that of the optical system to facilitate a comparison of the optical and acoustic images of a surface

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region. In the illustrated embodiment, the system consists of a linear array of twelve ultrasonic transducers **51**. Baffles **111** on each transducer **51** are used to image a 1.5" diameter area of the surface, B. At a transducer separation of 1" and with the array oriented perpendicular to the direction of travel, this arrangement provides sufficient overlap to cover a 1" by 12" swath of surface. The transducers may be triggered sequentially and their outputs displayed in twelve separate amplitude-time segments on a video monitor, as illustrated in FIG. **11**B. In this way, a 12"×1" swath of surface, comparable to that imaged by the lens array shown in FIGS. **7** and **8**, may be acoustically imaged for analysis. The transducer characteristics are determined by the resolution necessary to detect defect features. Thus, a wavelength of 0.0156" (1/64") provides sufficient resolution to detect features of comparable size. Assuming a transmission velocity of 20,000 ft./s in steel, this wavelength corresponds to a transducer frequency of 15.4 MHz. At 100 MHz bandwidth, the signal rise time is 10.6 nanoseconds, which is reasonable relative to the 0.53 microseconds necessary to produce an 8 cycle pulse. The roundtrip travel time of a pulse is approximately 76 microseconds, assuming a 1" thick steel tank. The transducers can therefore be triggered by 0.1 Msec clock. A complete sweep of the twelve transducer array requires approximately 1.2 Msec. At 4"/s velocity, the propulsion system moves only 0.005" in the time necessary for a single sweep, leading to negligible skewing.

The external positioning system of the present invention may be either an acoustic or optical triangulation system. It is provided so that defects observed with the acoustic or optical inspection systems may be located precisely within the reservoir. In addition, the present invention may be used in a variety of situations where visual positioning of the submersible vehicle may not be possible using either the navigation camera or direct observation. The navigation system provides an alternative means for following the vehicles motion across the reservoir surface.

It should be understood that the foregoing disclosure relates only to a preferred embodiment of the invention. The present invention is intended to cover all changes and modifications which fall within the spirit and scope of the invention.

I claim:

1. An apparatus for the preparation and inspection of a submerged surface of a fluid reservoir, said apparatus comprising:

means for moving the apparatus within a fluid in a direction of travel over an area of the submerged surface to be inspected;

cleaning means for preparing said area for inspection comprising means for removing deposited sediment from the submerged surface and means for irrigating the cleaned surface with a stream of clean fluid; and

inspection means for examining said prepared surface through said clean fluid.

2. The surface preparation and inspection apparatus of claim **1** further comprising movement and inspection control means, said control means being responsive to at least one of pre-programmed control and direct control from a remote location.

3. The surface preparation and inspection apparatus of claim **2** wherein said means for removing deposited sediment comprises means for sucking fluid containing suspended sediment, means for filtering said fluid to produce clean fluid and means for providing said clean fluid to said irrigating means.

4. The surface preparation and inspection apparatus of claim **2** wherein said inspection means is operatively disposed immediately after said cleaning means along said direction of travel.

5. An apparatus for preparing and inspecting the submerged surface of a fluid reservoir, said apparatus comprising:

a chassis means, sized and shaped to provide an optimally low center of gravity and defining at least a front and an underside of said apparatus;

propulsion means operative to provide movement to said apparatus and being mounted on said chassis means, said propulsion means comprising two independently controllable motor and track means;

a scrubbing/vacuuming compartment disposed at said front, underside of said chassis means and comprising:

scrubbing means designed to mechanically break up sediment on the surface beneath said apparatus; and

vacuuming means to remove sediment and sediment-containing fluid from beneath said apparatus, resulting in a freshly cleaned surface; and

inspection means located immediately behind the scrubbing/vacuuming means with respect to the direction of apparatus travel and operative to inspect said freshly cleaned surface.

6. An apparatus for preparing and inspecting a submerged reservoir surface as claimed in claim **5** further comprising a filtering system communicating with said scrubbing/vacuuming compartment and operative to filter sediment from fluid, said filtering system comprising:

means to remove fluid and suspended sediment from the scrubbing/vacuuming compartment;

means to filter the sediment from the reservoir fluid and return clean fluid to the reservoir proximate to said inspection means.

7. An apparatus for preparing and inspecting a submerged reservoir surface as claimed in claim **5** wherein said apparatus is operated from a remote control command center, said apparatus further comprising command receiving means for receiving operational commands and controlling at least one means comprised in said apparatus.

8. An apparatus for preparing and inspecting a submerged reservoir surface as claimed in claim **5** wherein said inspection means comprises:

means to continually irrigate said freshly cleaned surface by flowing clear fluid into the volume between the inspection means and said freshly cleaned surface; and

at least one of optical sensors and ultrasonic sensors operative to image a portion of said freshly cleaned surface.

9. An apparatus claimed in claim **8** wherein said optical and ultrasonic sensors comprise arrays generally disposed perpendicular to the direction of apparatus travel and oriented to image a surface section of width comparable to said chassis width.

10. An apparatus claimed in claim **9** wherein said scrubbing means comprises a rotating cylindrical brush disposed in said scrubbing/vacuuming compartment.

11. An apparatus claimed in claim **10** wherein said scrubbing means comprises a nozzle means, disposed in the scrubbing/vacuuming compartment and aimed at

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the surface beneath the apparatus, to provide at least one high velocity jet of fluid.

12. An apparatus claimed in claim **6** wherein said chassis means comprises a first and a second chassis joined by an articulated connection, said inspection means being disposed on said second chassis and said scrubbling/vacuuming department being disposed on said first chassis.

13. A method for preparing and inspecting a fluid reservoir surface coated with sediment comprising:

scrubbing a section of said surface to loosen said sediment and removing the loosened sediment to prepare a freshly cleaned surface;

interposing a clean fluid flow between said freshly cleaned surface and an inspection means; and

inspecting said surface through said clean fluid flow with said inspection means.

14. The method for preparing and inspecting a fluid reservoir surface claimed in claim **13** wherein the fluid containing loosened sediment is removed from the reservoir, filtered, and returned as said clean fluid flow.

15. The method of claim **13** wherein said scrubbing step is performed by at least one of mechanical brushing and fluid sprayering.

16. The method of claim **13** wherein said step of inspecting is performed by at least one of optical inspection and acoustic inspection.

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(54) **SUBMERSIBLE POOL CLEANER WITH INTEGRAL RECHARGEABLE BATTERY**

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(52) **U.S. Cl.** **15/1.7**

(57) **ABSTRACT**

A submersible robotic pool cleaner is provided with an integral sealed rechargeable battery and an inductive charging assembly, a first portion of which is mounted in the pool cleaner housing and during the charging, receives a second separate portion that is connected by a cable to a conventional power source. The pump motor drive shaft is treated with a specialized anti-friction lubricant composition to minimize frictional energy losses where the shaft contacts the seal(s) and any shaft bearing(s), to maximize efficiency and minimize the power consumption of the pump motor assembly and permit the pool cleaner to completely traverse the surfaces to be cleaned within the fully-charged power capacity of the battery.

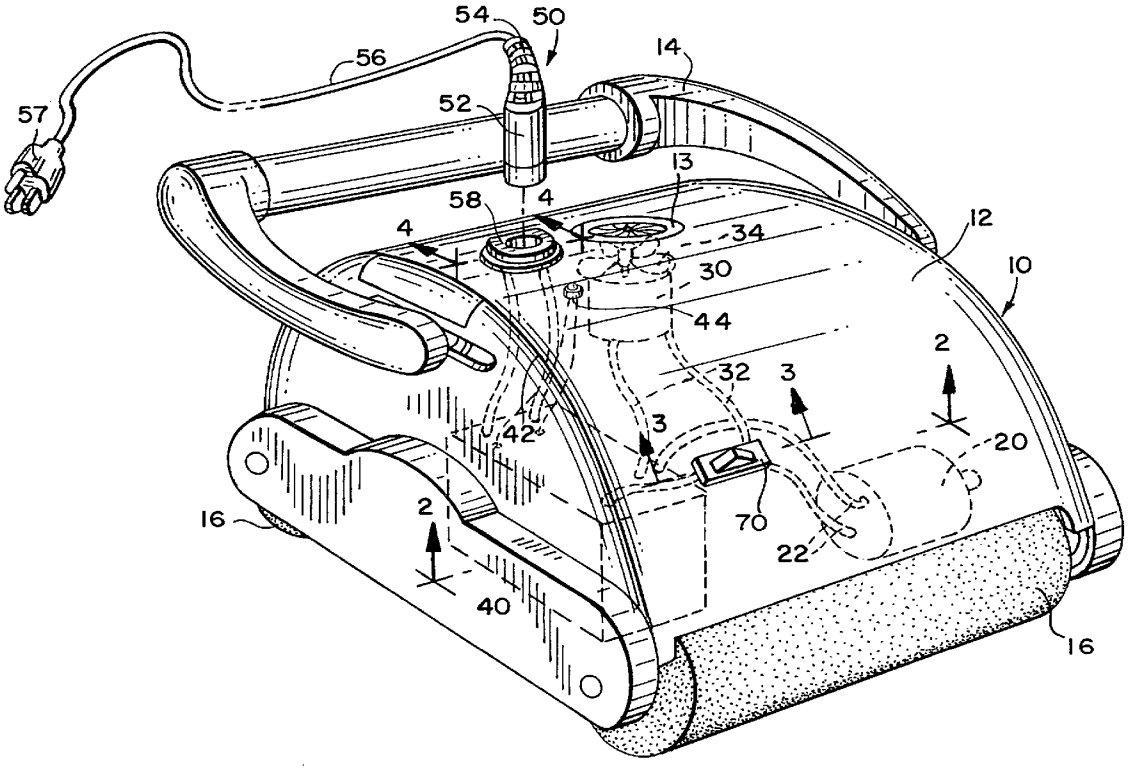

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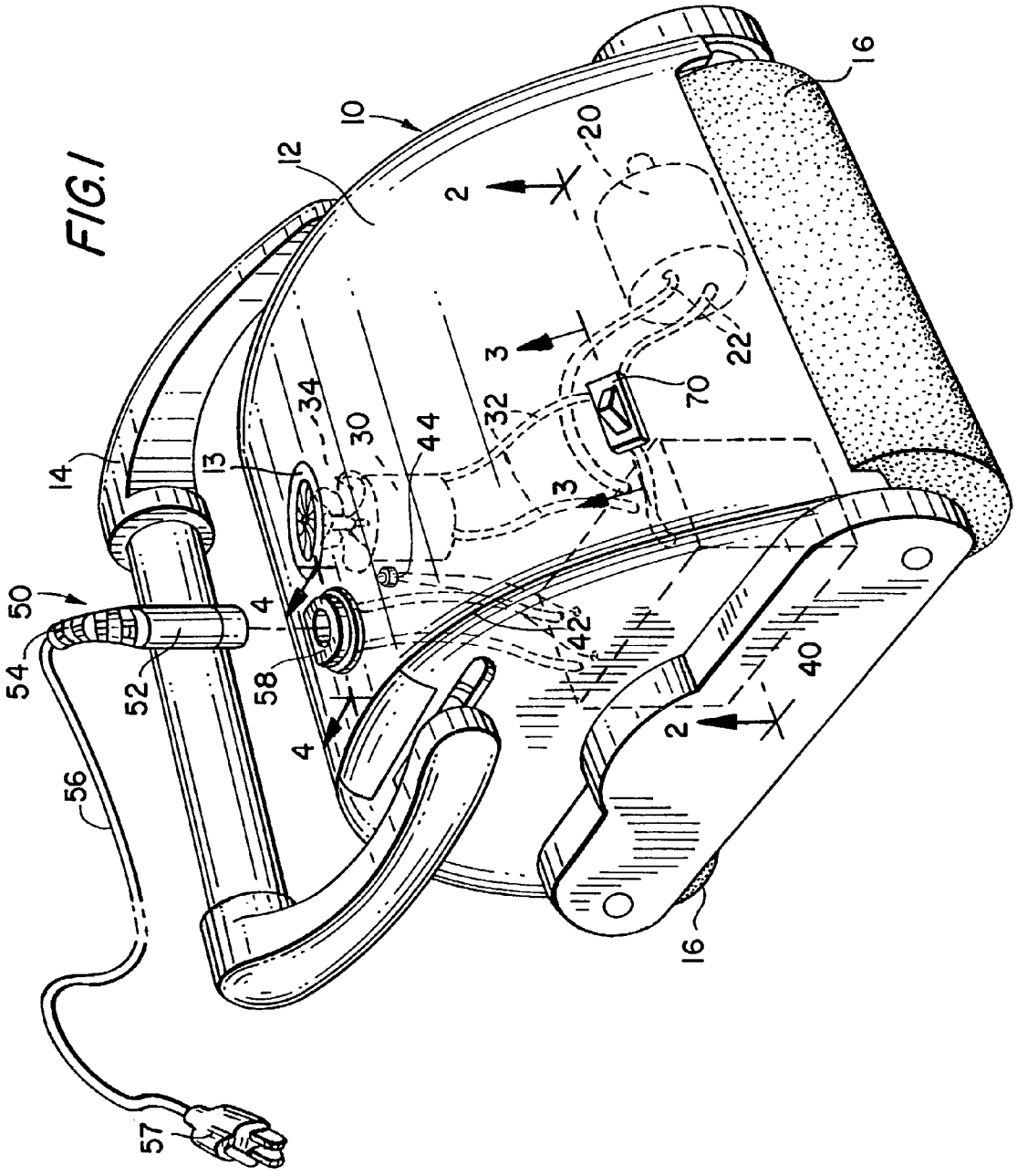
FIG. 1



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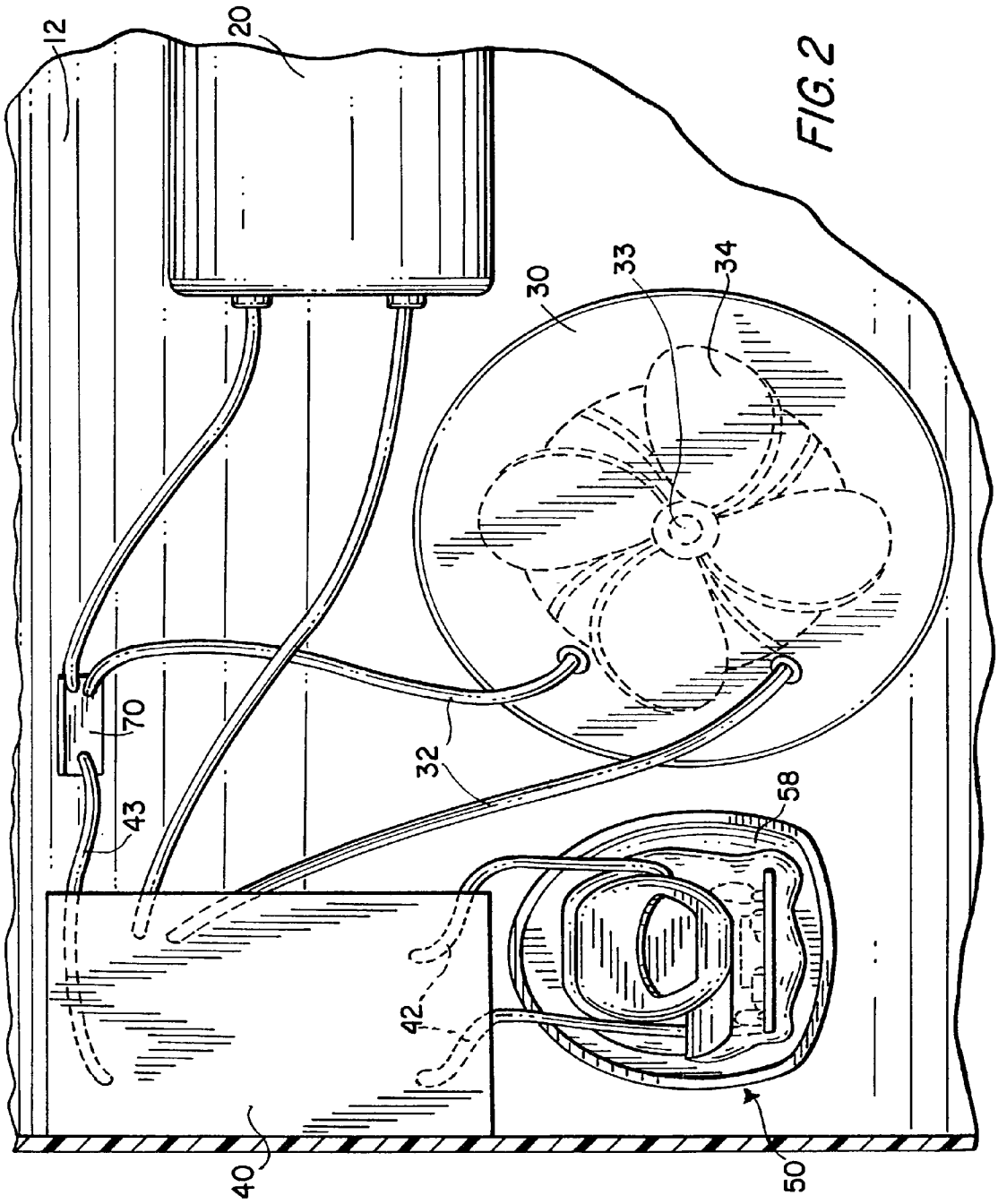

FIG. 2

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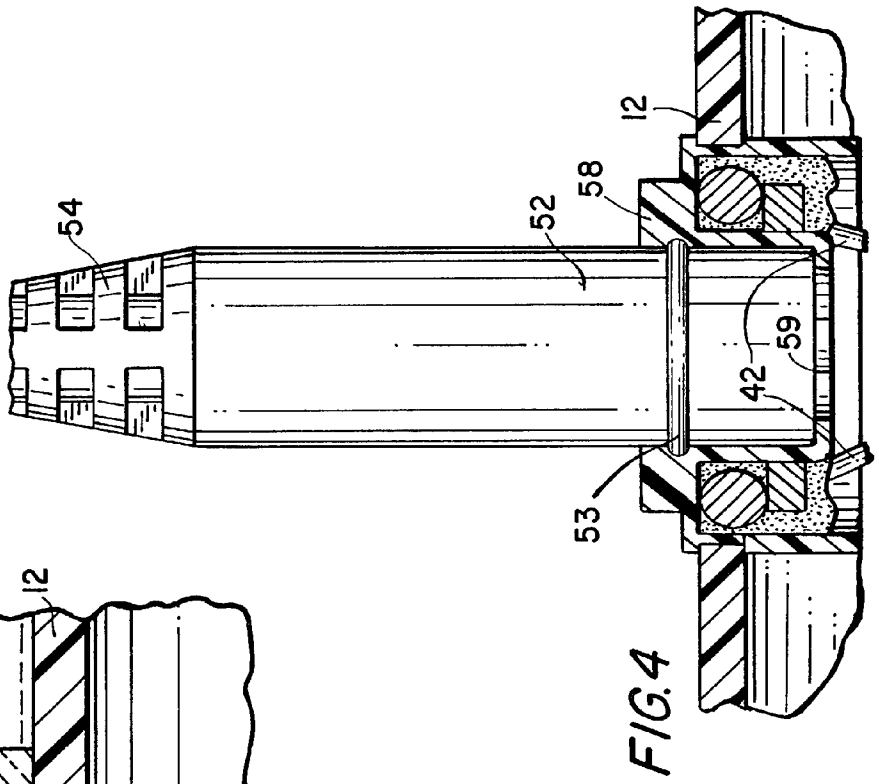

FIG.4

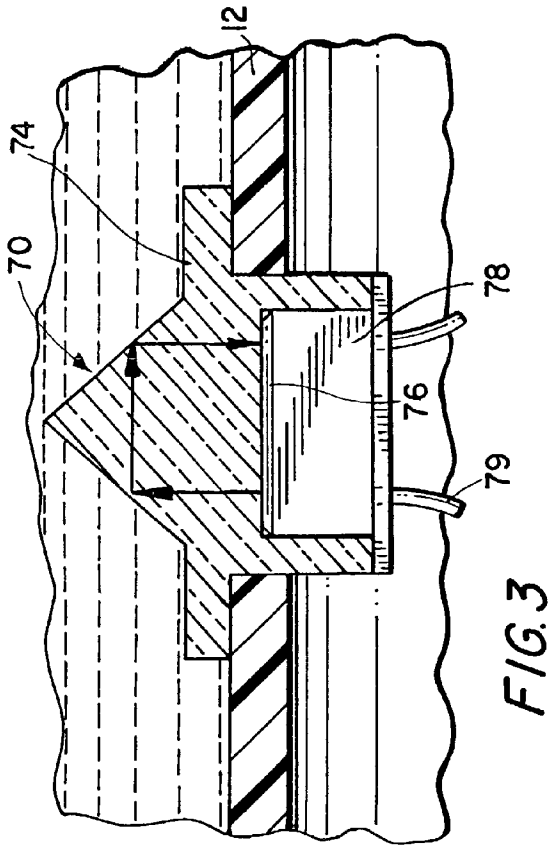

FIG.3

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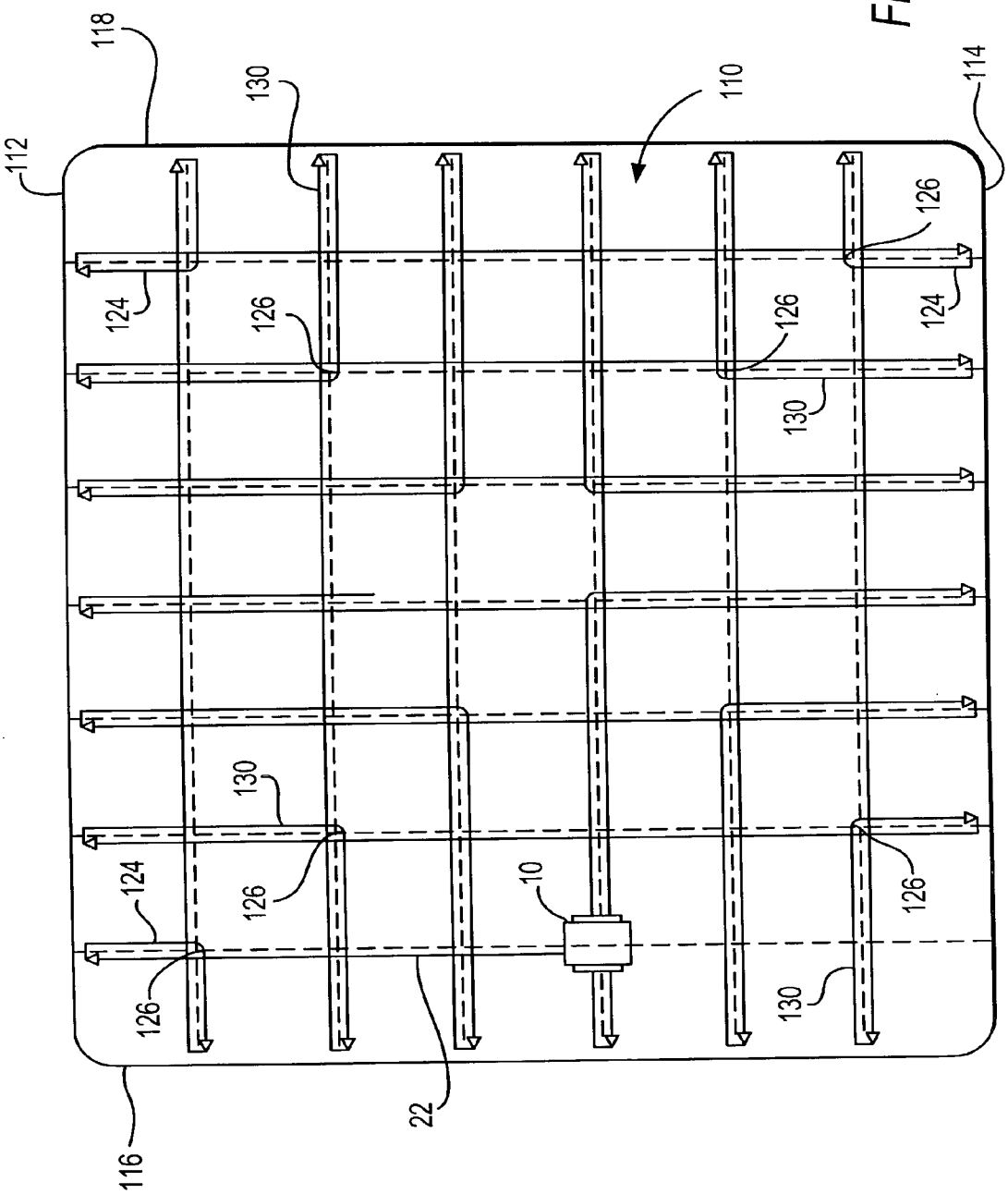
FIG. 5



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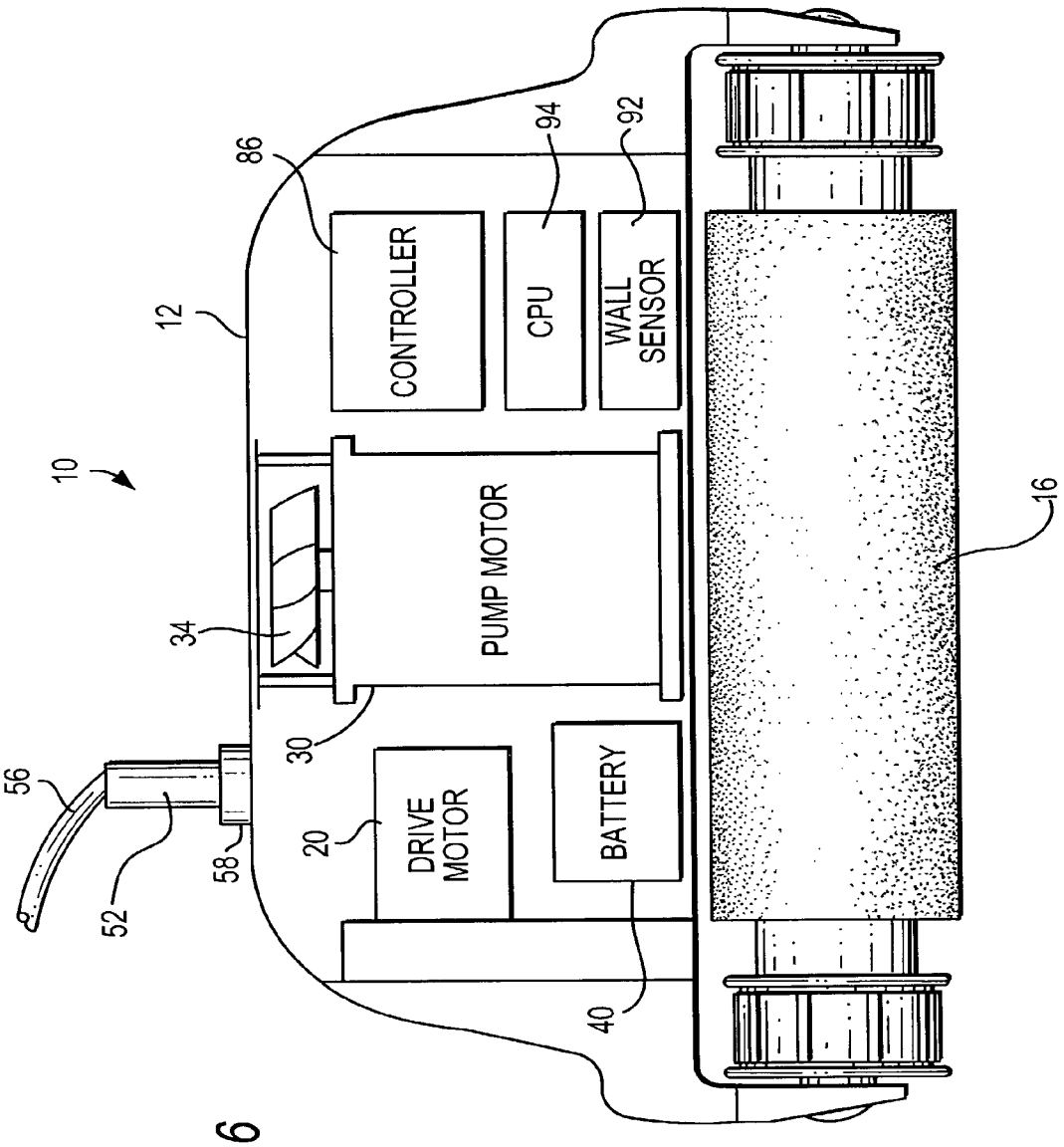

FIG. 6

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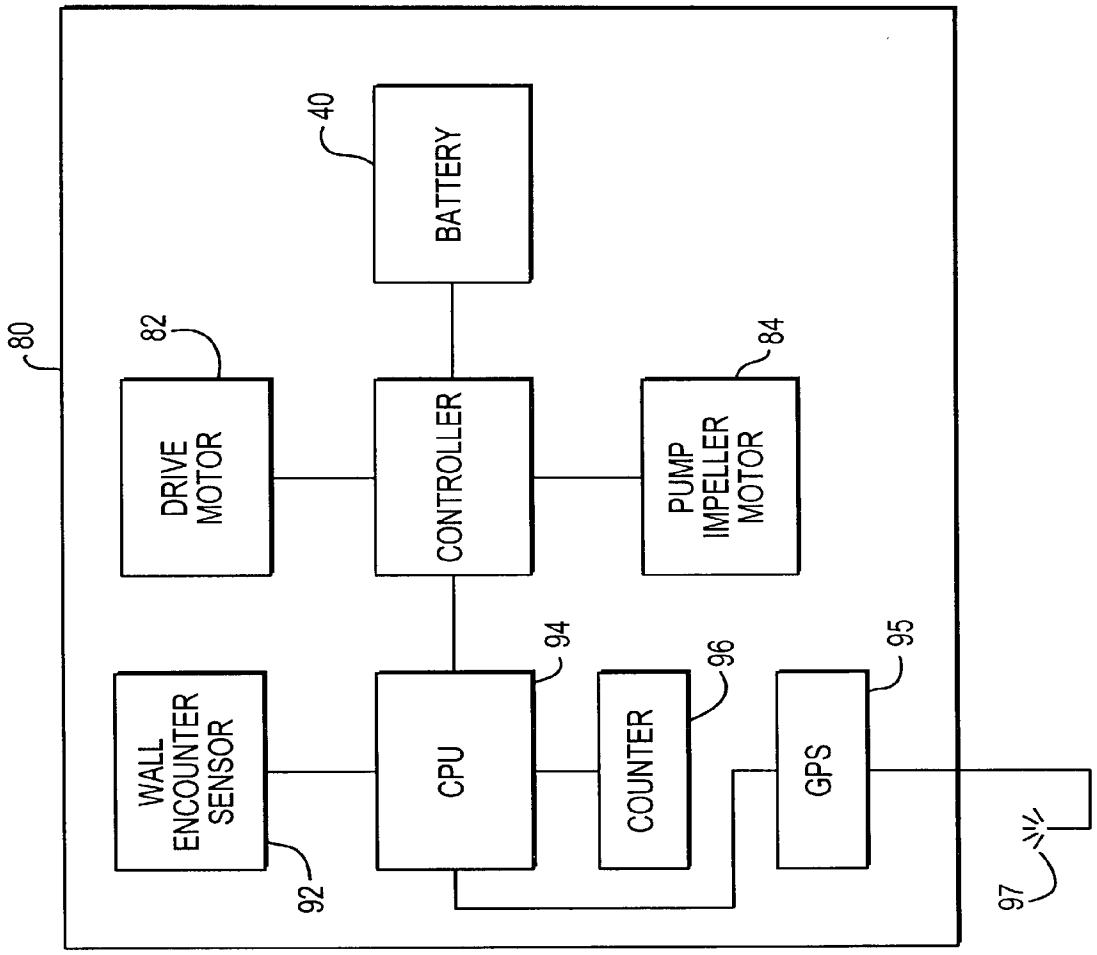

FIG. 7

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SUBMERSIBLE POOL CLEANER WITH INTEGRAL RECHARGEABLE BATTERY

FIELD OF THE INVENTION

[0001] This invention relates to robotic, self-propelled submersible pool and tank cleaners.

BACKGROUND OF THE INVENTION

[0002] Conventional robotic pool cleaners are powered by electric drive motors and/or water pumps that receive power from a power cord or cable that is attached to a low-voltage power source outside of the pool. The use of a battery or batteries as a power source has also been proposed. For example, a rechargeable battery in a waterproof or water-resistant floating case having a power cable extending to the submerged pool cleaner has the advantage of eliminating or substantially reducing problems associated with twisting of the power cable which occurs with a remote stationary power supply unit as the pool cleaner traverses the bottom of the pool in its cleaning pattern.

[0003] Although the inclusion of one or more batteries in the submersible pool cleaner housing has been proposed, the limitations of battery life and power consumption have prevented the realization of a practical commercial pool cleaner having an integral battery as the sole source of power that is required for cleaning a residential swimming pool. As used herein, the term "integral battery" means a battery that is secured to the moving pool cleaner, preferably on the interior of the housing, and is to be distinguished from a battery that is tethered to the moving pool cleaner as by a power cable extending away from the pool cleaner to a floating battery housing, or an otherwise remotely positioned battery.

[0004] As previously proposed, an integral battery lacks sufficient power to complete cleaning patterns known to have been disclosed or used by the prior art. Furthermore, while a floating battery has some apparent advantages, battery power is required to overcome hydrodynamic forces resulting from moving the battery housing through the water by the tethering power cord.

[0005] A robotic pool cleaner utilizes one water pump assembly to draw water through an internal filter. The pool cleaner can also have at least one drive motor that is utilized to move the cleaner across the surface(s) to be cleaned. Typically, the drive motor that is linked through mechanical drive means has a relatively lower power consumption, as compared to the power consumed by the pump motor.

[0006] The motion of the pool cleaner can be directed from the motor through a drive train to a generally cylindrical cleaning brush which contacts the surface of the pool to be cleaned or to a rotating axle that causes the movement of one or more wheels or endless tracks which support the pool cleaner. A jet of water can also be discharged from a port at approximately a right angle to the surface over which the pool cleaner is moving in order to maintain the pool cleaner, which is conventionally of nearly neutral buoyancy, in the appropriate orientation for cleaning.

[0007] As will be understood by one of ordinary skill in the art, the pool cleaner can also be powered by a jet of water that is alternatively discharged in opposing directions that are generally parallel to the surface being cleaned to cause the cleaner to move first in one direction and then in the opposite direction. With this arrangement, it is possible to eliminate the drive motor and drive assembly, thereby reducing the overall power consumption of the pool cleaner.

[0008] It is also well known in the art to provide the pool cleaner with a preprogrammed microprocessor and electronic control device, which can include a controller and memory device that is wired to one or more electronic and/or electromechanical switches, sensors and the like, in order to insure that the pool cleaner follows a pattern that provides for the cleaning of the entire bottom surface of the pool. In some cases, the programmed movement is entirely random and can take account of pools of different sizes and shapes. Other pool cleaner control devices are based upon the initial orientation of the cleaner after it encounters a sidewall of a rectilinear pool having no obstacles or accessories that might impede or trap the pool cleaner, or otherwise interfere with a regular transverse repetitive movement that is designed to pass the cleaner over the entire bottom surface of the pool.

[0009] It is therefore an object of the present invention to provide an improved swimming pool cleaner having an integral battery that is capable of cleaning an entire swimming pool without recharging.

[0010] It is a further object of the invention to provide a robotic swimming pool cleaner having an integral battery and no external wires or connections leading to accessories outside of the pool.

[0011] Another object of the invention is to provide an automatic program controlled robotic pool cleaner that is powered by an integral battery that is simple and economical in its construction and which can complete the cleaning of the bottom surface of the residential pools without interruption or recharging of the integral battery during the cleaning operation.

[0012] It is a further object of the invention to provide an improved programmed electronic integrated circuit device that provides for an efficient pattern of movement for a pool cleaner having an integral battery during the cleaning of the bottom surface of a swimming pool.

SUMMARY OF THE INVENTION

[0013] The above objects and other benefits and advantages are achieved by a pool cleaner of the present invention that comprises a rechargeable integral battery that is connected to (1) a water pump associated with a cleaning filter; and (2) drive means for advancing the pool cleaner. In order to provide for the power requirements, the water pump seals and related impeller assembly and bearings operate at a high efficiency, i.e., with a low power loss to friction. A highly efficient water pump assembly is necessary to ensure sufficient electrical power from the integral battery to accomplish the cleaning of a relatively large pool.

[0014] In accordance with the method and apparatus of the present invention, it has been found that the power requirements of the water pump assembly can be reduced from an average of about 4.5 amps to about 1.0 amp. This reduction in the pump motor power requirement is directly attributable to the reduction of frictional forces on the pump drive shaft by the seals and/or bearings. The effect of reducing the frictional forces is that a smaller battery having the neces-

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sary power storage capacity can be integrated into the construction and operation of the pool cleaner.

[0015] The reduction in friction losses is achieved by coating and treating the drive shaft of the pump assembly with a friction-reducing compound of the type that is commercially available for use in automotive crankcase applications.

[0016] The sealed rechargeable battery is preferably a 12-volt lead-acid or lithium type that is rated for at least four ampere-hours of service.

[0017] In order to avoid any potential hazards, the battery is also connected to an inductive recharging circuit which itself is sealed and fitted with an inductive charging element. The employment of an inductive charging circuit eliminates the need for any exposed metallic conductors, which adds to the overall safety of the pool cleaner and its charging accessory. Although charging would not customarily be undertaken while the unit is in the water, in the event that the inductive charging element is mated in the charging position and the pool cleaner inadvertently pushed into the water, no shock hazard would arise.

[0018] In a preferred embodiment, an induction coil is utilized in the inductive charging circuit. In this embodiment, the inductive charging unit comprises a port and separate power element.

[0019] The inductive charging port is preferably located in an aperture in the pool cleaner housing. The sealed toroidal element is fixed in the housing aperture at a location that provides a convenient position to receive the mating inductive electrical element. The mating of the two elements can include a friction fit between the plastic surfaces of the respective elements, e.g., an O-ring, alone or in combination with a positive locking engagement, such as a lug and channel, or the like.

[0020] In a further preferred embodiment of the invention, the impeller attached to the pump drive motor is in the form of a propeller which provides a relatively large volumetric water flow at a relatively low pressure and requires less power consumption than other well-known alternative types of impellers, such as centrifugal and turbine pumps.

[0021] The electrical circuit is provided with a switch, either automatic or manual, to isolate the battery during charging and when the cleaner is not in use. A further preferred embodiment of the invention provides for an automatic shut-off of the power supply when the pool cleaner is removed from the water. A sensor and switch circuit are provided that interrupt the power supply from the battery. The sensor and switch can include a float mechanism, a circuit element that is non-conductive when not immersed in, or in contact with water, or a light sensing element that is mounted on the exterior of the housing and is actuated to interrupt the battery power circuit when the sensor detects the relatively brighter ambient light when the unit is removed from the water.

[0022] A sealed, waterproof rechargeable battery suitable for use in the improved pool cleaner of this invention can be purchased from the Panasonic Corporation and is identified as model LCR 12V4BP. Other suitable commercial equivalents are readily available from Panasonic and other manufacturers.

[0023] As will be understood by one of ordinary skill in the art, the electric pump motor and drive motor(s) are sealed in waterproof housings to which the electrical conductors are attached. The drive shaft is passed through the aperture of a shaft seal that typically has a torroidal spring that applies the radial sealing force on the axle. In a typical pool cleaner, it has been found that the power consumption during operation of the sealed pump motor assembly is in excess of 4.0 amperes/hour.

[0024] In order to obtain the maximum reduction in frictional forces using the anti-friction composition and lubricant, the water pump motor drive shaft is treated in at least those portions that contact the pump seals, and preferably any other contact or bearing surfaces that support the pump shaft. As a practical matter, it is most efficient from a production standpoint to treat substantially the entire surface of the pump shaft prior to its assembly.

[0025] As used herein, the term "lubricated shaft" means a pump or drive motor shaft that has been lubricated to substantially reduce the frictional forces as compared to a shaft that has not been so lubricated.

[0026] One product that has been found suitable for use in the practice of the invention is sold under the trademark REVERUP. Information on the purchase of this product is available on the Internet at www.rev_er_up.com.data.htm. Another product that is suitable for use in the invention is sold as "Nilsen's Oil Fortifier". Other suitable products are sole in retail automotive supply stores as high efficiency crankcase lubricant additives. Such additives can include tetrafluoroethylene (TFE), fluorocarbon polymers and/or fluorinated ethylenepropylene (FEP) resins and like products that are known to significantly reduce the coefficient of friction between moving surfaces.

[0027] The method of treatment is as follows:

[0028] 1. the pump motor shaft is heated to about 40° C.;

[0029] 2. the lubricant composition is applied as a liquid;

[0030] 3. the shaft is heated to a temperature of about 80° C.; and

[0031] 4. the shaft is allowed to cool to ambient temperature prior to its assembly in the pump motor housing seal(s).

[0032] Optionally, the drive motor shaft can be similarly treated with the anti-friction lubricant composition to further reduce the overall power consumption. However, the drive motor typically requires about one ampere-hour of power, which is a relatively low requirement.

[0033] It is to be understood from the above description that more than one battery, as well as more than one drive motor and/or pump motor can be utilized in the method and apparatus of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034] The invention will be further described below and with reference to the drawings in which:

[0035] **FIG. 1** is a top, front perspective view, partly in phantom, illustrating one preferred embodiment of the invention;

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[0036] **FIG. 2** is an enlarged interior view, partly in section, of a portion of the pool cleaner of **FIG. 1**;

[0037] **FIG. 3** is an enlarged cross-sectional side view of the light sensor switch shown in **FIG. 1**; and

[0038] **FIG. 4** is a side view, partly in section, illustrating the induction charging assembly on the mated configuration for charging the pool cleaner battery.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0039] With reference to **FIG. 1, a** pool cleaner referred to generally as **10** includes an exterior housing **12** fitted with a pump outlet **13** and carrying handle **14**. Rotating supports **16**, in the form of cylindrical cleaning rollers, support and move the pool cleaner across the bottom or side wall surfaces of the pool to be cleaned. A sealed electric drive motor **20** is connected to drive means **16** through a power train (not shown). Drive motor electrical leads **22** are connected to battery **40**.

[0040] With continuing reference to **FIG. 1, a** sealed electric pump motor is connected to a propeller type impeller through drive shaft **33**. The pump and its impeller are mounted in axial alignment with the exhaust port **13** mounted in housing **12**.

[0041] The pool cleaner housing **12** also encloses a filter medium through which the water is drawn from the underside of the cleaner and discharged by the movement of impeller **34** through the discharge port **13**. Other various types of water pumps and/or impellers that have been utilized in prior art pool cleaner, the preferred impeller for use in the present invention is of the propeller type. It has been found that this type of impeller provides the most efficient force for moving the desired large volume of water through the pool cleaner filter to provide an effective cleaning. Other types of impellers, e.g., turbines, create a higher pressure discharge, move to a relatively smaller volume and consume more power.

[0042] During the assembly of the pump motor in its waterproof housing, the shaft is treated as described above with the friction-reducing lubricant either along its entire length or at those positions which contact the seals. If the shaft is mounted in bearings outside of the motor housing, that portion of the shaft is also preferably treated with the friction-reducing lubricant. This treatment has the effect of substantially reducing the power consumption of the pump motor. In operational tests, the power consumption was reduced by as much as about 75%, so that the water pump's power consumption was reduced from about four amps to about one amp.

[0043] As will be apparent to one of ordinary skill in the art, the significant reduction in power consumption resulting from the practice of the invention extends the operating time of the pool cleaner by almost four times. The power consumption of the drive motor is relatively much less than the power consumed by the water pump when operated under conventional prior art conditions and without the treatment of the water pump drive shaft with the friction-reducing lubricant. However, the invention comprehends the use of a lubricated shaft to minimize frictional losses.

[0044] A further beneficial effect of this reduction in power consumption is to permit the installation of a battery in the interior of a pool cleaner housing that is within the parameters of size and weight that will permit the pool cleaner to be lifted, moved and stored much in the same way as a cleaner of the prior art which receives its power from an external source, i.e., a conventional electric current supply. The size and weight of the battery must also be considered in maintaining the negative, but near-neutral buoyancy of the cleaner.

[0045] With continuing reference to **FIG. 1**, there is also shown an inductive charging assembly **50** that comprises an inductive recharging circuit that includes elements that are sealed and waterproof, and that operate at a relatively low voltage. An inductive charging port **58** is securely mounted through an opening in housing **12**. The port includes a pair of electrical conductors **59** that enter the sealed battery case **40** and are secured to the battery charging circuit (not shown).

[0046] A separate power charging element **52** mates with charging port **58** in the charging configuration. Sealed charging element **52** is connected through a power cable **56** to a conventional electrical plug **57**. In a preferred embodiment, the charging element **52** includes a flexible and wear-resistant collar **54** to preclude damage and the loss of the water-tight seal with power cord **56**. The charging element **52** or the port **58** can be provided with a plurality of frictional ribs, an O-ring, or other construction to maintain proper alignment and a secure fit between these members during charging.

[0047] During battery charging, the pool cleaner is preferably removed from the water and placed away from the pool. However, as will be appreciated by one of ordinary skill in the art, the inductive charging assembly provides a means for recharging the battery that avoids the need for any exposed metal conductors that might lead to an electrical shock or other injury in the event that the pool cleaner is accidently or inadvertently placed in the pool during charging. In fact, the inductive element **52** can be handled even when the plug **57** is in a power socket.

[0048] The materials of construction of the charging port **58** and mating charging element **50** are preferably selected from the class of impact-resistant, non-conducting polymers that are resistant to UV radiation and chemicals commonly used in treating the water in the pool.

[0049] In a particularly preferred embodiment, the pool cleaner is also provided with a light-emitting indicator that is visible during the battery charging to provide information on the condition of the battery's charge. In an especially preferred embodiment, the indicator **44** is a light-emitting diode or similar device mounted on the external surface of the housing **12** or otherwise positioned adjacent an aperture in the housing that will permit the user to determine when the battery is fully charged. Leads **45** extend to the battery **40**. In an alternative embodiment, a manual or automatic shutoff switch can be provided in the circuit between the external power source and the battery to discontinue the charging current to induction element **50** when the battery has reached the desired level of charge.

[0050] As will also be understood by one of ordinary skill in the art, the particular arrangement of the drive motor, battery, pump motor, switch and their associated electrical conductors can be varied. Although the preferred embodi-

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ment of the invention positions the battery on the interior of the housing in order to minimize turbulence and other hydrodynamic frictional effects, the battery can be secured in a position which is external to, but attached securely in a fixed position to the housing **12**. For example, the housing, typically formed of molded plastic, can be provided with an integral external receptacle or brackets (not shown) for receiving the battery. In any event, it will be understood from the definition provided above, that the battery is an integral part of the pool cleaner whether mounted on the exterior or interior of the housing.

[**0051**] As best shown in **FIG. 2**, switch **70**, mounted in housing **12**, is connected on one side to the battery and at the other side of the switch separate leads extend to the drive motor and pump motor.

[**0052**] In a particularly preferred embodiment, as illustrated in **FIG. 3**, the switch **70** includes an optical sensor in housing **74** that receives ambient light that is transmitted to a photovoltaic element **76** that is in turn linked to the electronic switching device in housing **78**. When the pool cleaner is submerged, the ambient light is at a relatively low level and the switch is in the open position allowing power to pass through conductor **79** to the pump and drive motors. When the pool cleaner is removed from the water, the ambient light increases and the photovoltaic layer responds by sending a signal to open the switch and terminate the power transmitted to the two motors.

[**0053**] In a further preferred embodiment, the switch **70** can include a light-emitting source in element **78**, which light is reflected internally in the sensor housing **74** to a photovoltaic receiving surface **76**. While the pool cleaner and sensor are submerged, the optical reflectivity within the sensor is such that the switch is maintained in the closed position and power flows from the battery to the respective motors. When the sensor is removed from the water, the reflectivity is reduced and the light emitted escapes from the housing and the switch circuit is opened so that power flow is discontinued.

[**0054**] Various other types of switches, including a simple manual toggle switch, can be installed to permit the user to turn the motors on and off. A float switch can also be employed, so that when the pool cleaner is removed from the water, the buoyant portion of the switch changes position and the circuit is opened, thereby terminating the power flow from the battery to the motors.

[**0055**] Referring now to **FIG. 4**, the inductive charging element **52** is shown positioned in the annular chamber of port **58** for receiving the charging current that is directed to the battery. The underside of the port member is provided with leads **42** which, as best seen in **FIG. 2**, are connected to the charging circuit of the battery **40**. The charging element **52** can optionally be provided with an o-ring **53** to assure a secure and stable fit in the annulus **59** during charging.

[**0056**] In order to maximize the capability of the robotic cleaner to cover the entire bottom surface of the pool to be cleaned, the unit is provided with a microprocessor that has been programmed to direct the cleaner in a particularly efficient pattern of movements. The programming and installation of microprocessors and controllers is well known in the art.

[**0057**] In a particularly preferred embodiment, the on-board microprocessor is programmed with an algorithm that results in the following cleaning pattern:

[**0058**] 1. Following initiation, the unit traverses the pool to encounter a wall, after which it reverses to cross to the opposite side wall.

[**0059**] 2. After each crossing, the unit reverses, travelling a predetermined distance back along the same path.

[**0060**] 3. When the predetermined distance is reached, the unit turns a predetermined angle, which can be about 90°, and advances to reach a side wall.

[**0061**] 4. Thereafter, the unit reverses and traverses the bottom to the opposite side wall.

[**0062**] The pattern of returning a predetermined distance along the most recent path and then stopping to turn a predetermined angle is repeated. The counter records the number of contacts with the side walls. After a predetermined number of such side wall contacts have been recorded, the predetermined distance of the reverse leg travel is altered and the routine is continued until the entire bottom area of the pool is contacted and cleaned.

[**0063**] An example of this preferred programmed pattern is schematically illustrated in **FIG. 5**. In order to more clearly depict the cleaning pattern, parallel lines are used to illustrate the reverse leg portion. However, it will be understood that the actual path followed by the unit will overlap along the dashed lines. The lines with the arrowheads represent the direction of travel of the unit. The angle of rotation illustrated is 90°.

[**0064**] In a particularly preferred embodiment of the present invention, a novel algorithm that we have developed is incorporated into a microprocessor controller that directs the automated pool cleaner in its cleaning pattern. The novel cleaning pattern is the subject of co-pending patent application entitled "Pool Cleaning Method and Apparatus" filed Jul. 29, 2002 naming Porat and Fridman as inventors, and the disclosure of this co-pending application is incorporated herein in its entirety by reference.

[**0065**] In its broadest construction, the improved method is practiced in accordance with the step-wise procedure that follows.

[**0066**] In this embodiment of the invention's apparatus and method for cleaning the surfaces of a pool, an automated cleaner capable of reversing movement and turning is utilized. The unit is initially placed at an arbitrary location on the bottom of pool **110**, and the method comprises moving the cleaner in a forward direction until it encounters an upright pool wall **112**, reversing the robot until it is a predetermined distance **124** from the wall **112**, turning it through a predetermined angle **126** that is less than 180°, and preferably 90° for a rectilinear pool, and continuing to move it until it again encounters an upright wall **116**, and then repeating those steps until the unit has encountered upright walls e.g., **118**, **112**, **114**, **118** a predetermined number of times, at which point the predetermined distance is changed e.g. to **130**. All of the previous steps are repeated again until a substantial area of the pool floor **110** has been covered. In a preferred embodiment, a rectangular pool is cleaned by

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setting the turning angle to 90° and the number of turns before changing the predetermined distance from **125** to **130** is seven.

[**0067**] In another aspect of the invention, the robot has a propeller-type impeller driven in a horizontal plane, and the robot is turned by interrupting motive force to the impeller a plurality of times during a predetermined period to impart a sideways directed bias momentum to the robot.

[**0068**] A schematic illustration of the arrangement of elements in the interior of the pool cleaner housing is shown in **FIG. 6**. The particular position of the controller **86** and central processing unit (CPU) **94** of the microprocessor **80** is not critical. Likewise, the location of the wall sensor **92**, schematically illustrated in **FIG. 6**, will be understood by one of ordinary skill in the art to be comprised of one or more components located with transmitting/receiving elements located at either end of the unit. Such sensors can be mechanical or electromechanical, but are preferably electronic, e.g., infrared transmitters which receive signals reflected from the pool's side walls. The cleaner can also include a ground position system (GPS) **95** with floating antenna **97** for use in gathering data on the location and way points as the unit traverses the bottom of the pool.

[**0069**] A schematic circuit diagram is illustrated in **FIG. 7**. Again, the arrangement of elements is merely illustrative and not to scale. The electronic elements, including the microprocessor CPU **94**, controller **86**, counter **96**, and wall counter **96** and sensor **92** are preferably incorporated into a unitary waterproof housing or assembly for ease and economy of installation and replacement, should that become necessary.

[**0070**] Also shown in **FIG. 7** is a global positioning system or "GPS" unit **95** that is also in communication with the CPU and controller. The utilization of GPS units with marine and aircraft navigational systems is well known in the art. It is within the skill of the art to integrate the control of the pool cleaning unit based on the algorithm with a starting set of coordinates provided by the GPS unit. For example, the pool cleaner can be manually positioned at one corner of the pool as prescribed by the operating instructions and the GPS coordinate entered into the controller memory. The unit can then be taken to a different location along the pool, e.g., the diagonally opposite corner of a rectangular pool and those GPS coordinates entered. The program will then have sufficient information to determine an appropriate path for the unit to follow in order to clean substantially the entire bottom of the pool.

[**0071**] The entry of the coordinates can be in the way of a manual push button or other similar entry device based on a programming sequence provided to the user in a user's manual. A separate hand-held device that communicates with the controller, as by IR signals or conductor wires, can be also utilized. The unit will also have to be provided with a floating antenna wire for receiving the GPS signals, or they can be transmitted through a receiver in the power supply. Once the unit is positioned on the bottom surface of the pool and activated, the algorithm that now includes the GPS coordinates can accurately direct the movement, turning and distance changes necessary to cover the entire bottom surface of the pool in an efficient cleaning pattern.

[**0072**] Alternate algorithms are provided for round, oval or other shaped pools. In a preferred embodiment the microprocessor is provided with a plurality of algorithms and a display or manual switch is provided to permit the seller or user to select the optimum program for the pool to be cleaned.

[**0073**] While the invention has been described with reference to the specific embodiments set forth above and in the drawings forming a part of this application, modifications and variations will be apparent to those skilled in the art that will fall within the scope of the claims that follow.

I claim:

1. A self-propelled, submersible pool cleaner comprising:

a) an integral sealed rechargeable battery;

b) a sealed water pump motor electrically connected to said battery, said motor having a shaft on which is mounted an impeller; and

c) a first portion of an inductive charging assembly electrically connected to said battery, said first portion of the inductive charging assembly being permanently affixed to said pool cleaner, said first portion of the inductive charging assembly having an aperture for receiving a second portion of the inductive charging assembly in mating relation, whereby said battery is recharged by the mating of the first and second portions of the inductive charging assembly and when said second portion is connected to an external power supply.

2. The pool cleaner of claim 1, wherein the battery produces a voltage in the range of from 6 volts to 12 volts.

3. The pool cleaner of claim 1, wherein the battery is connected to the pump motor through a switch.

4. The pool cleaner of claim 1, wherein the pump impeller is a propeller.

5. The pool cleaner of claim 1, wherein the pump motor operates on twelve volts.

6. The pool cleaner of claim 1, which further comprises a housing, wherein the battery is positioned inside of the housing.

7. The pool cleaner of claim 6, which further comprises a switch mounted on said housing, whereby the power from the battery can be interrupted when the switch is moved to an off position.

8. The pool cleaner of claim 7, wherein the switch is a light-sensitive optical switch for interrupting the power to the pump and drive motors.

9. The pool cleaner of claim 7, wherein the switch is a toggle switch.

10. The pool cleaner of claim 1, which further comprises a drive motor electrically connected to the battery for propelling the pool cleaner.

11. A battery-powered submersible pool cleaner comprising a pool cleaner housing, an integral rechargeable battery secured to said housing and an inductive charging assembly, at least one portion of which is secured to said housing and electrically connected to the battery.

12. The pool cleaner of claim 11 that further includes an integral water pump and which is moved by the discharge of water from the water pump.

13. The pool cleaner of claim 11 that includes a programmed microprocessor and controller and which is programmed to move in a generally rectilinear path over the bottom surface of a pool or tank.

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14. The pool cleaner of claim 11 in which a second portion of the inductive charging assembly is received in mating relation in a recess of the portion connected to the battery.

15. The pool cleaner of claim 14 in which the second portion includes a power cable and is of waterproof construction.

16. A method for improving the efficiency of an electric motor contained in a waterproof motor housing having at least one drive shaft extending through a waterproof seal in said motor housing, the method comprising the steps of heating the drive shaft to a temperature of about 40°; applying a liquid automotive crankcase antifriction lubricant additive to the shaft; heating the coated shaft to a temperature of about 80° C.; cooling the shaft to ambient temperature; assembling the drive shaft to the motor; and placing the seal on the drive shaft.

17. The method of claim 16, wherein the lubricant composition is a polymeric material.

18. The method of claim 16, wherein the liquid lubricant composition is applied to the portion of the shaft in contact with the seal.

19. The method of claim 16, wherein the drive shaft is stainless steel.

20. A method of improving the overall operating efficiency of an electric motor-powered assembly, the assembly comprising an electric motor, a drive shaft connected to the motor, a driven unit connected to the drive shaft and one or more contact units through which the drive shaft passes axially, the contact units selected from the group consisting of seals bearings and journals, the method comprising the steps of: heating the drive shaft to a temperature of about 40°; applying a liquid automotive crankcase antifriction lubricant additive to the shaft; heating the coated shaft to a temperature of about 80° C.; cooling the shaft to ambient temperature; assembling the drive shaft to the motor; and placing the seal on the drive shaft.

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(54) **ACTIVATION SYSTEM FOR A ROBOTIC VEHICLE**

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(57) **ABSTRACT**

The invention relates to an activation system (**1**) for a robotic vehicle (**2**), comprising at least one external camera (**8**) configured for generating image data of a work area (**3**) and of at least one robotic vehicle (**2**), and comprising at least one external logic unit (**10**) configured for determining the position of the at least one robotic vehicle (**2**) based on the image data generated by the camera (**8**), and comprising an external transmission unit (**15**, **20**) configured for transmitting driving instructions, and comprising a receiving unit (**16**, **21**) configured for receiving the driving instructions, and further comprising a controller (**18**) for activating drive means of at least one robotic vehicle (**2**) based on the driving instructions.

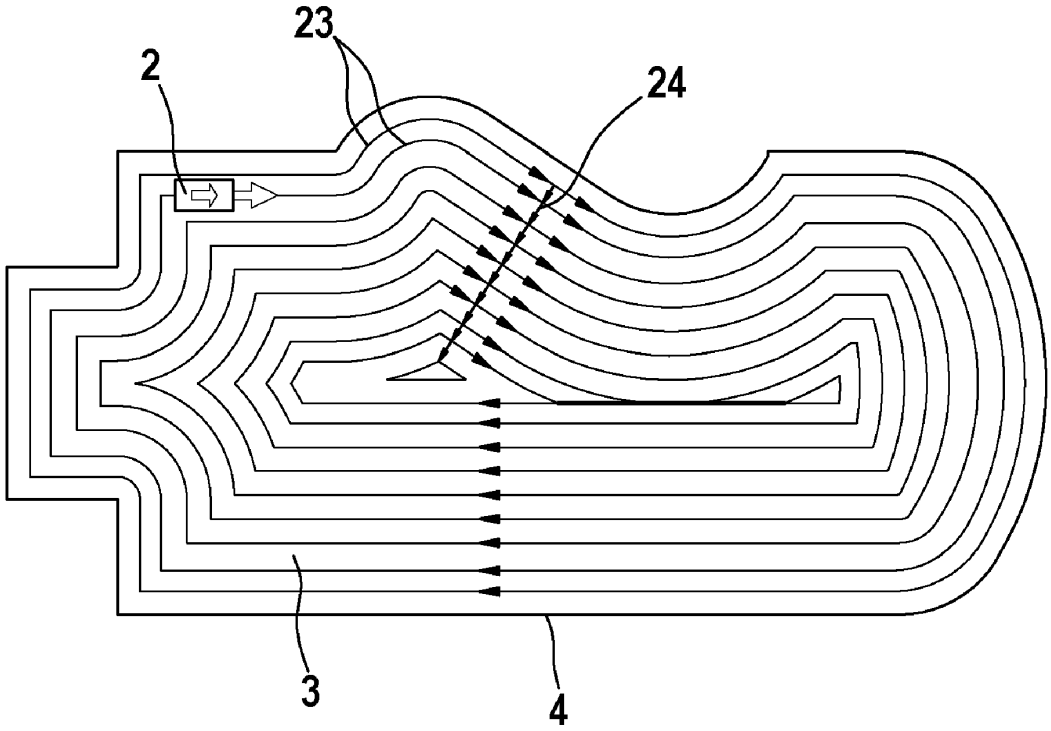

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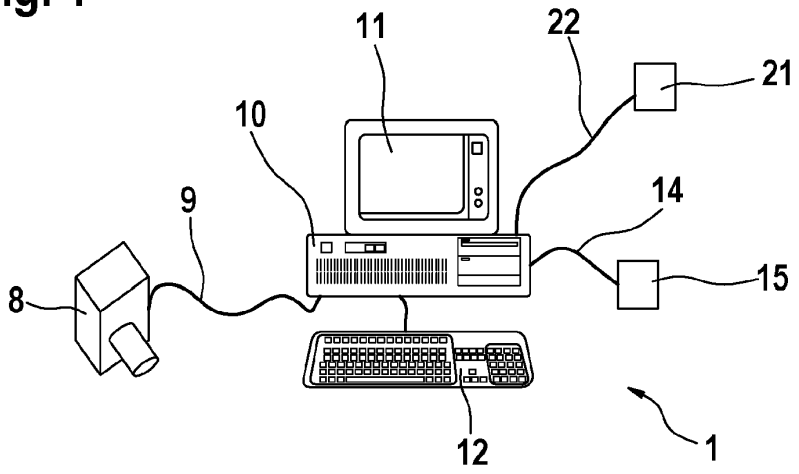
Fig. 1



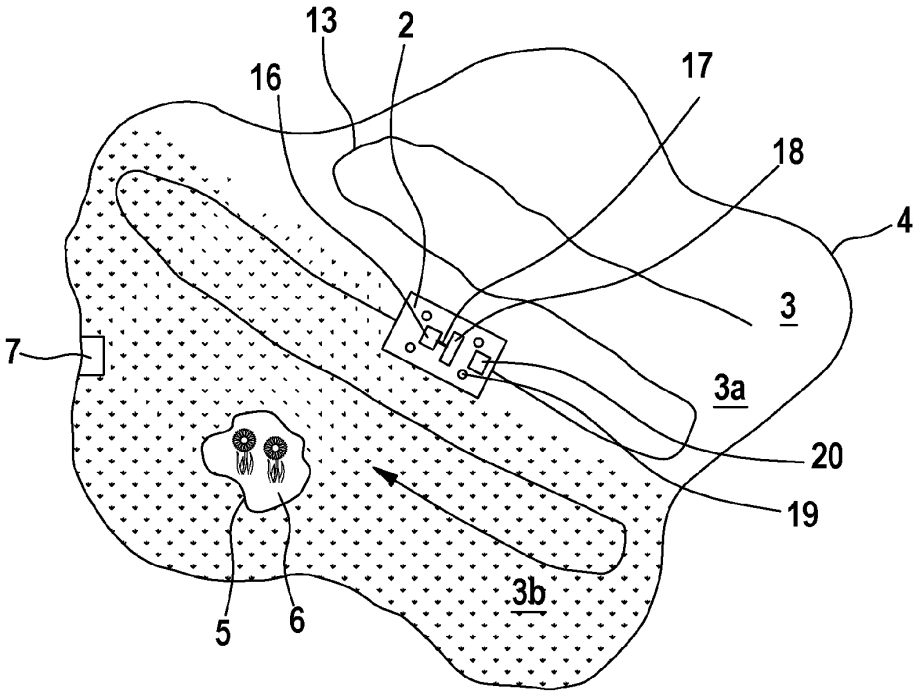


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Fig. 2

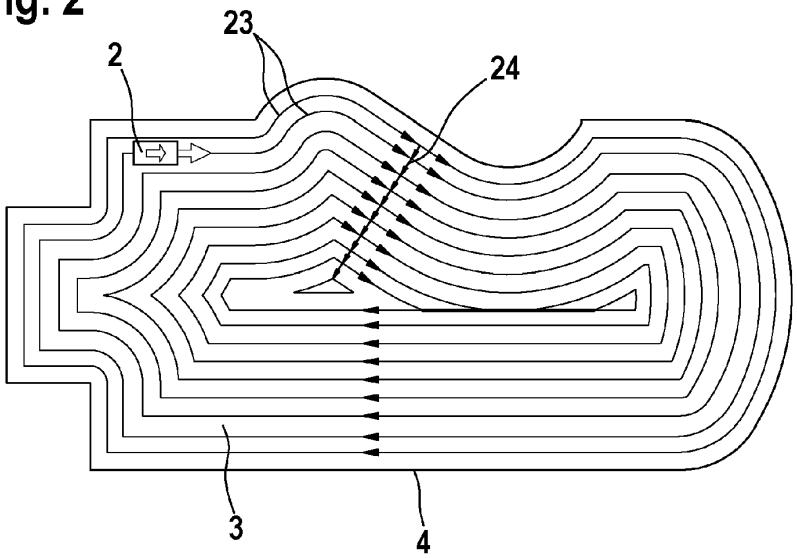
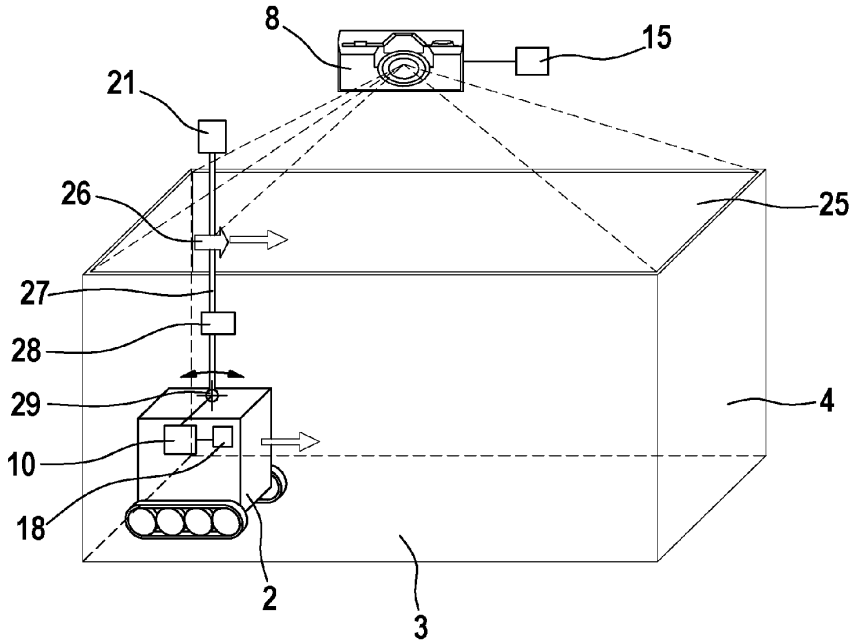


Fig. 3



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ACTIVATION SYSTEM FOR A ROBOTIC VEHICLE

STATE OF THE ART

[0001] The invention relates to an activation system for a robotic vehicle.

[0002] Activation systems are known for autonomous lawnmowers, which comprise a live conductor that is buried at the external border of the work area (lawn). Corresponding sensors on the lawnmower detect if the external border is driven over and as a result a control unit causes a turning maneuver of the lawnmower. It is also complex to install the known activation systems and they only allow a coincidental navigation. Marker-based lawnmower robotic vehicles are for example described in EP 55 04 73 B1 and U.S. Pat. No. 6,984, 952 B2.

[0003] An improved activation system for autonomous lawnmowers is known from GB 2 277 152 A1. The known activation system comprises a number of landmarks, which are distanced from each other and which border a work area (lawn). The autonomous lawnmower communicates actively with the landmarks in order to determine its position and to calculate a driving route based on these position data with the aid of a logic unit.

[0004] In particular at irregularly outlined lawnmowers a number of landmarks is required. It is furthermore a disadvantage that the lawnmower (robotic vehicle) has a complex construction due to the provision of a logic unit for calculating the driving route and is therefore interference-prone.

[0005] It is known from EP 1 704 766 A1 to equip a lawnmower with infrared sensors for analyzing the immediate surroundings of the lawnmower and to activate the lawnmower with the aid of an internal logic unit based on the sensor data. A global position detection is not possible with the known activation system and therefore it is not possible to ensure that a complete mowing of the lawn takes place.

[0006] Robotic vehicles are known from EP 1 041 220 A2, EP 1 302 611 A2, WO 2005/045162 A1, EP 1 022 411 A2, US 2004 007 4524 A1, WO 2004/019295 A1, EP 1 489 249 A2, EP 6 596 03 A1, ES 2 074 401 A1, ER 2 685 374 A1, JP 2005/257441 A, EP 1 500 83 A1 as well as KR 2004/101953 A, which carry out a change of direction by a defined angle after detecting a wall contact and then continue their movement linearly. The disadvantage of these robotic vehicles is that the robotic vehicles are controlled by a sheer coincidental navigation, so that it is not possible to drive along an optimized work area path. A complete driving along is not guaranteed for random surface and takes correspondingly long.

[0007] Robotic vehicles are known from FR 2 781 243 A1, U.S. Pat. No. 556,937 A and U.S. Pat. No. 59,743,447 A1, whose control unit carries out an automatic trajectory correction for following a path that has been previously programmed by an operator. The programming of the path is complex and mostly requires the support of an expert.

DISCLOSURE OF THE INVENTION

Technical Task

[0008] The invention is based on the task to suggest an alternative activation system for robotic vehicles, which allows the use of comparably simply constructed robotic vehicles.

Technical Solution

[0009] This task is solved by the characteristics of claim **1**. Advantageous improvements of the invention are stated in the sub-claims. All combinations of at least two characteristics that are stated in the description, the claims and/or figures also fall within the scope of the invention.

[0010] The invention is based on the idea to provide at least one camera that is arranged outside the robotic vehicle for detecting the work area as well as the robotic vehicle. The camera is preferably arranged above the work area, so that a section of the work area can be detected that is as big as possible with the camera, preferably a digital video camera. If the work area is contoured in such a way that it cannot be completely detected by a single camera it is advantageous to provide at least a second external camera, which means one that is arranged outside the robotic vehicle. It is furthermore possible to arrange the at least one camera pivoted and to arrange it with the aid of the logic unit in such a way that it follows the movement of the robotic vehicle. The camera or the cameras generates/generate image data, which is transferred to the logic unit. The logic unit can thereby be a part of the camera or be arranged as a separate component with a distance to a camera, whereby the transfer of the image data can for example take place over a data cable and/or a radio interface. A personal computer, a PDA or a mobile phone can for example serve as logic unit. The logic unit determines the position of the robotic vehicle on the work area based on the image data and calculates driving instructions for the robotic vehicle based on the determined position for proceeding on the work area. It falls thereby within the scope of the invention that the image data that is generated by the at least one external camera is revised either in the logic unit or in front of the logic unit, in particular filtered or reviewed in a different way. The driving instructions that are calculated by the logic unit are transmitted over a transmitting unit that is connected in a signal-conducting way with the logic unit and received by a receiving unit that is arranged at the robotic vehicle. The receiving unit of the robotic vehicle is on the other hand connected to a simply constructed control unit in a signal-conducting unit, which is arranged at the robotic vehicle and which activates the drive means of the robotic vehicle according to the received driving instructions. The drive means are thereby construed in such a way that the robotic vehicle can be driven and steered by them. The activation system according to the invention has essential advantages compared to the known activation systems. Because wide areas can be detected with the aid of the at least one camera it is usually sufficient to provide only one camera. By all means usually less cameras than landmarks have to be used in an activation system that is known from the state of the art. A further advantage of the activation system according to the invention is that the robotic vehicle can be construed simply because the logic unit, which preferably creates a digital map of the work area, is arranged outside of the robotic vehicle. This causes on the other hand that the robotic vehicle can be produced less interference-prone and cheaper. Therefore the entire activation system according to the invention is less interference-prone, since it is possible to arrange the logic unit in an area that is mostly protected from external environmental influences, for example within a house or under a roofing. If a usual personal computer is for example used as logic unit only a corresponding program has to be installed on it, which is able to process the image data that is generated by the at least one camera and to detect the position of the robotic vehicle based on this data and to calculate corresponding driving instructions, which are then transmitted by the transmitting unit, for example a WLAN-transmitting unit, to the receiving

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unit of the robotic vehicle. A further essential advantage of the activation system according to the invention is that close range sensors at the robotic vehicle can be waived. But for a fine tuning such sensors can be provided optionally.

[0011] An internal logic unit can also be provided in addition or as an alternative to the provision of an external logic unit, thus a logic unit, which is a component of the robotic vehicle, or which is arranged in or at it. Preferably the logic unit is thereby arranged in a moisture-sealed housing. Assuming that an internal logic unit is provided the image data that is detected by the digital camera and the external transmitting unit has to be transmitted to the internal receiving unit at the robotic unit, which is connected in a signal-conducting way to the internal logic unit, which on the other hand evaluates the image data and determines corresponding driving instructions for the control unit, which then activates the driving means correspondingly. It is thereby possible that the logic unit and the control unit are put together in one component. Alternatively the logic unit and the control unit are connected with each other in a signal-conducting way. The camera is preferably a color digital camera.

[0012] As an improvement of the invention it is advantageously provided that the external logic unit is construed in such a way that it detects the internal and/or external border of the work area based on the image data of the at least one camera. The external logic unit can for example calculate the borders with the aid of contrast differences between adjoining image points. The external logic unit is construed in such a way that the determined border of the work area flows into the calculation of the driving instructions, in particular in such a way that the robotic vehicle does not exceed the borders, thus does not leave the work area.

[0013] It is advantageously provided according to an improvement of the invention that the logic unit additionally or alternatively detects static and/or moved, which means temporary obstacles within the work area and considers them when calculating the driving instructions for the robotic vehicle, in particular in such a way that the robotic vehicle does not collide with the obstacles, thus changes the driving direction or stops.

[0014] For optimizing the driving path of the robotic vehicle it is advantageous if the external logic unit detects the orientation of the robotic vehicle from the image data and considers this information when calculating the driving instructions, for example in such a way that at first a rotation takes place before the robotic vehicle is directed into a linear direction.

[0015] It is particularly advantageous if the external logic unit considers further data when calculating the driving instructions. It is advantageous if the logic unit considers for example weather data, which is especially retrieved over the internet or a weather station that belongs to the activation system. The external logic unit can thereby for example be construed in such a way that the robotic vehicle drives into a parking position for example a garage in the case of precipitations and/or too high wind forces. Additionally or alternatively the logic unit can for example consider time data and/or date data, for example from the internet or a clock that belongs to the activation system, for example in such a way that the robotic vehicle does only proceed on the work area at certain times and/or only at certain days, in particular during weekdays.

[0016] One embodiment is particularly advantageous, at which the logic unit detects differently conditioned sections of the work area, for example a mowed or a not mowed section of the work area based on the image data and then considers this information when calculating the driving instructions, in particular in such a way that the robotic vehicle does only or preferably move on one of those sections, in particular the not mowed lawn section.

[0017] One embodiment is particularly advantageous, at which the borders of the work area can be determined manually, in particular in such a way that the borders that are detected automatically by the logic unit are reworked. The logic unit is therefore preferably equipped with a corresponding input unit and/or a corresponding visualizing unit for displaying the work area or the borders of the work area. Preferably obstacles and/or external or internal borders can be manually pre-determined or removed or driving patterns, meaning driving strategies, can be provided or driving strategies that are suggested by the logic unit can be reworked.

[0018] As an improvement of the invention it is advantageously provided that the logic unit is construed in such a way that the driving instructions are calculated in such a way that the work area is driven along according to a certain driving pattern, which means a certain driving strategy. Thereby a time-optimized and therefore energy-consumption-optimized driving along the work area can be realized and/or the complete driving along the work area, for example on parallel and/or overlapping tracks. The last embodiment is particularly advantageous if the robotic vehicle is a autonomous lawnmower. It is possible that the logic unit suggests different driving patterns and an operator can select an individually preferred driving strategy over an input unit. The input unit can preferably revise and/or determine areas within the work area (internal border) that should be omitted, which means not driven along. It is also possible that the logic unit is provided with new driving strategies, which can for example be read or taken from the internet or a data carrier, in particular in exchange for fees.

[0019] Preferably a bidirectional communication connection exists between the logic unit and the robotic vehicle. This embodiment enables that the robotic vehicle sends status information to the logic unit, which considers them when calculating the driving instructions. After detecting a low accumulator load status the logic unit can for example activate the robotic vehicle in such a way that it docks into a charging station. For optimizing the navigation/guiding of the robotic vehicle it is advantageous if the robotic vehicle determines odometry data and/or the environmental character with corresponding sensors, for example with the aid of IR-sensors, and transfers this data with the aid of a transmitting unit to a receiving unit that is connected with the logic unit.

[0020] In one embodiment the lawnmower can disclose the takeover of control over the driving navigation over the communication connection, for example if near-field sensors at the vehicle detect an obstacle. For increasing the data security it is advantageous to use known security mechanisms (for example communication protocols with a checksum, handshaking etc.).

[0021] It is advantageous to equip the communication with a so-called watchdog. Normally the data transfer takes preferable place cyclically. If the data transfer stays away for a defined time range or if no valid data is transferred in a defined time range the system goes into a secure status (the robotic vehicle stops for example).

[0022] One embodiment is preferred, at which the logic unit detects the position and/or orientation of the robotic

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vehicle only with the aid of the distinctive shape and/or color of the robotic vehicle and if necessary follows the movement. In order to optimize the position and/or orientation detection it is however advantageous to place marks at the robotic vehicle, for example LEDs in a suitable arrangement, in order to simplify the identification of the robotic vehicle and therefore the position and/or orientation determination.

[0023] The robotic vehicle can be implemented in different configurations. The robotic vehicle can for example be implemented as a snow cleaning vehicle, as leaf collecting vehicle, as grass collecting vehicle, thatching vehicle, or as weeding vehicle etc. One embodiment is preferred, at which the robotic vehicle is implemented as a lawnmower with a mower. Another embodiment is especially preferred, at which the logic unit does not only calculate the driving instructions for the robotic vehicle based on image data but additionally generates a starting instruction and/or stopping instruction for a tool of the robotic vehicle based on image data, whereby the starting instruction or the stopping instruction is transmitted to the receiving unit of the robotic vehicle with the aid of the transmitting unit and correspondingly converted by the transmitting unit. In order to save electric energy it is thus for example possible that a mower is only operated in the case that the robotic vehicle is moving on a not mowed section of the work area. The mower can also be switched off if an obstacle, in particular a moved obstacle, is detected by the logic unit in the area of the robotic vehicle.

[0024] As an improvement of the invention it is advantageously provided that the internal or external logic unit automatically calculates a trajectory for the robotic vehicle based on the image data that is in particular continuously determined by the external camera. This trajectory is preferably calculated or generated in such a way that the entire work area or a default and/or by an operator pre-defined section of the work area is at least almost completely driven along, preferably without driving along one surface section several times. The last limitation or driving optimization does not apply conclusively for the last driving route or the last track section of the trajectory, in particular not if the diameter of the work area cannot be divided integrally by the path widths or track widths of the paths or tracks that have to be driven along.

[0025] One embodiment is particularly advantageous, at which the trajectory for the robotic vehicle is calculated in such a way that it drives along the work area circularly clockwise and/or counter-clockwise, which means in rounds. One embodiment is thereby preferred, at which the trajectory is calculated in such a way that the robotic vehicle constantly drives either clockwise or counter-clockwise. But one embodiment can also be realized, at which it is switched between a clockwise driving along the work area and a counter-clockwise driving. The trajectory calculation preferably takes place with the assistance of the image processing operation erosion, in particular with a gradually increased or reduced erosion filter mask (for example circular or rectangular masks for round or rectangular forms). In other words circular lanes that are oriented at the external and/or internal border are calculated, whereby the diameters of the lanes that have to be driven along become gradually bigger or gradually smaller by increasing or reducing the erosion filter mask depending on whether one begins with the driving in the work area on the inside or outside. In other words, it is switched after driving along one track by the robotic vehicle to the next adjoining track that is adjusted to the external or internal border or border contour. The adjoining driving tracks are thereby usually not (exactly) parallel, but their topology (shape) changes in the style of the adjoining driving track.

[0026] As an improvement of the invention it is advantageously provided that the logic unit calculates the driving instructions depending on distance information that is determined from the image data of the camera, due to which the control unit activates the drive means, in such a way that the robotic vehicle drives along the work area in several rounds, which means ring tracks, whereby the round contours are oriented at the internal or external border contour. The contours of the ring tracks approach thereby the contour of the external or internal border in an increased or reduced scale. While one round is driven, which means while the robotic vehicle drives along a ring track, the control unit activates the drive means depending on the driving instructions that have been calculated by the logic unit in such a way that the robotic vehicle observes approximately one constant, round-specific distance (depending on topologic changes by the erosion) to the internal or external border. After the end of a round, thus after a ring has been driven along by the robotic vehicle, preferably completely, the robotic vehicle shifts to an adjoining bigger or smaller ring or to a bigger or smaller round, whereby the contour of this ring or ring track is also adjusted to the contour of the external or internal border due to observing the approximately constant distance, or it corresponds with this contour in a changed scale and with topological changes, contingent on the use of the image processing operation erosion. In this adjoining round a changed approximately constant distance to the border contour is maintained.

[0027] Particularly advantageous is an embodiment, at which the width of the ring track corresponds at least approximately with the width of the robotic vehicle transversely to the driving direction or the width of a working element of the robotic vehicle, for example the width of a cutting knife or a cleaning device, so that the entire work area can be completely "worked off" preferably without driving across one surface section several times.

[0028] One embodiment of the activation system is particularly preferred, at which the robotic vehicle is construed as pool-robotic vehicle, thus in particular as filter vehicle and/or cleaning or purifying vehicle. Such pool robotic vehicles drive in particular on the bottom of a pool, which then creates the work area.

[0029] In order for the digital camera, which is constructed above the pool, the swimming bath etc. and which is in particular construed as color camera, to be able to distinguish the robotic vehicle from the environment, in particular from the blue and reflecting water surface, it is provided as an improvement of the invention that the robotic vehicle is equipped with a swimmer, which swims on the water surface. It is for example possible to carry the swimmer along on a rod, in particular a telescope rod that is pivoted. The swimmer is preferably movable relative to and along the longitudinal direction of the rod.

[0030] In order to ensure that the rod remains vertical despite the flexible arrangement even at a forward movement of the robotic vehicle, a further swimmer is provided below the swimmer, which is firmly connected to the rod and which provides sufficient lift to widen the rod vertically.

[0031] In particular when the color of the swimmer (preferably red) differs from the color of the water surface (usually blue) the logic unit can determine the exact position of the swimmer and therefore of the robotic vehicle with the aid of the image data that is delivered by the camera. Additionally or

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alternatively a form matching based on an edge detection and/or color segmentation can be carried out. The communication between an external logic unit and the control unit takes preferably place by radio devices, whereby a corresponding receiver can be provided for the swimmer at a guiding rod. Alternatively it is also possible to connect the logic unit and the sensor unit over a cable connection in a signal-conducting way. It is also possible that the camera communicates over a cable a radio with a logic unit that is construed as internal logic unit.

[0032] One embodiment of the swimmer is particularly advantageous, at which its width, which means its range transversely to the driving direction corresponds at least approximately with the width of the robotic vehicle or the width of a work element, for example a cleaning device, etc. In particular at such an embodiment a calibration is not required.

SHORT DESCRIPTION OF THE DRAWINGS

[0033] Further advantages, characteristics and details of the invention arise from the following description of preferred embodiments as well as with the aid of the drawings, which show in:

[0034] FIG. **1** an activation system for a robotic vehicle in a schematic illustration,

[0035] FIG. **2** a trajectory that is automatically calculated by the logic unit, and

[0036] FIG. **3** a schematic illustration of an activation system for a robotic vehicle that is construed as pool robotic vehicle.

EMBODIMENTS OF THE INVENTION

[0037] FIG. **1** schematically shows an activation system **1** for a robotic vehicle **2** that is construed as lawnmower. The robotic vehicle **2** comprises not shown drive means, in particular a drive motor and a steering device for steering the robotic vehicle **2** or two drive units, which both together create a differential drive. In the shown embodiment the drive motor is construed as electric motor, which is operated with the aid of an accumulator that is also not shown.

[0038] The robotic vehicle **2** is located on a work area **3** (lawn) with an external border **4**. A static obstacle **6**, in the present embodiment a flowerbed, is located within this work area **3** within an internal border **5**.

[0039] A charging station **7** is located at the edges within the work area **3** for charging the accumulator of the robotic vehicle **2**.

[0040] The entire work area **3** is optically detected by a camera **8**, which is construed as digital video camera and which is located outside and above the work area **3**. The camera **8** can for example be mounted at a gable etc. If necessary several cameras **8** can be provided. The camera **8** is connected over a data cable **9** with a logic unit **9** that is construed as personal computer. Image data is transferred over the data cable **9** from the camera **8** to the logic unit **10**. Instead of a data cable **9** a radio connection can also be provided.

[0041] The logic unit **10** can alternatively also be integrated in the camera or in the robotic vehicle **2**.

[0042] The logic unit **10** comprises a visualizing unit **11** (screen) for visualizing the image data, thus the robotic vehicle **2** as well as the work area **3**, in particular the external border **4**, the internal border **5** and the static obstacle **6**.

[0043] The logic unit **10** is furthermore connected to an input unit **12**, with which it can be selected from default driving strategies and driving strategies can be created or adjusted for the robotic vehicle **2**. Furthermore omitted areas within the work area **3** can be determined over the input unit **12** and external and internal borders **4**, **5** can be defined or changed.

[0044] The logic unit **10** calculates driving instructions for the robotic vehicle **2** based on the image data and any further data or parameter, which are for example entered over the input unit **11** or fed in over a data carrier or the internet. The driving instructions are thereby preferably calculated in such a way that the robotic vehicle **2** drives along the work area **3** in a certain driving strategy—in the present case a meander-shaped driving strategy with tracks **13** that are parallel to each other and overlap each other in certain areas. The driving instructions are calculated in such a way that the external border **4** as well as the internal border **5** are not driven over, thus the robotic vehicle **2** remains within the work area **3**. Besides the static obstacle **6** also temporarily occurring obstacles are detected and driven around with the aid of corresponding driving instructions. One driving instructions can also be to stop the robotic vehicle **2** (temporarily).

[0045] The logic unit **10** or a computer program that is installed on it is furthermore construed in such a way that differently conditioned sections (mowed/not mowed) **3***a*, **3***b* are detected and the driving instructions are calculated in such a way that preferably the not mowed section **3***b* is driven along.

[0046] In order for the robotic vehicle **2** to able to react to the driving instructions that have been calculated by the logic unit **10**, the logic unit **10** is connected in this embodiment with a transmitting unit **15** over a further data cable **14**, with which the driving instructions are transmitted to a receiving unit **16** at the robotic vehicle **2**. The receiving unit **16** is connected to a control unit **18** over a further data cable **17**, whereby the control unit **18** controls the not further shown drive means of the robotic vehicle **2** based on the driving instructions that have been received by the receiving unit **16** in such a way, that the robotic vehicle **2** follows the calculated tracks **13** and when detecting a certain obstacle **6** it avoids it or reacts by other means.

[0047] For an improved position detection of the robotic vehicle **2** it is helpful to apply marks **19** (in this embodiment LEDs), which make it more simple for the logic unit **10** to detect the position and/or orientation of the robotic vehicle **2** as well as to track its movement.

[0048] The robotic vehicle **2** comprises in the shown embodiment a transmitting unit **20** besides the receiving unit **16**, whereby the receiving unit **16** and the transmitting unit **20** can also be construed as combined receiving- and transmitting unit. With the aid of the transmitting unit **20** the robotic vehicle **2** transmits status information of the robotic vehicle **2** to an external receiving unit **21**, which is connected to the logic unit **10** over a data cable **22**. The external receiving unit **21** as well as the external transmitting unit **15** can also be construed as combined transmitting- and receiving unit. The status information that is transferred over the data cable **22** from to the logic unit **10** is considered by the logic unit **10** when calculating the driving instructions for the robotic vehicle **2**, for example in such a way that the robotic vehicle **2** drives directly to the charging station **7** and docks into it when detecting a low accumulator load status.

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[0049] Besides the driving instructions the logic unit can create a start instruction and/or a stop instruction for the not further shown mower of the robotic vehicle **2**, whereby these instructions are transmitted to a receiving unit **16** over the external transmitting unit **15** and correspondingly converted by the control unit **18**. Thus a stop instruction is for example send out to the mower when detecting a temporary obstacle, also when the robotic vehicle **2** drives over the not mowed section **3***a* of the work area **3**.

[0050] FIG. **2** shows a possible trajectory for the robotic vehicle **2**, which is automatically calculated by the logic unit **10** based on the distance information to the external border **4** of the work area **3** that is determined by the image data of the camera **8**. The control unit **18** controls the drive means of the robotic vehicle **2** depending on these driving instructions, which means depending on the constantly determined distance information to the external border. The shown trajectory has been determined by the logic unit **10** with the aid of the image processing operation erosion with a gradually increased erosion filter mask (for example circular mask for round and rectangular for rectangular contours). As it can be seen in FIG. **2** almost the entire work area **3**, except the innermost area, can be driven along in such a way that the same surface area is not driven along several times. A connecting line **24** (radial line) is shown besides the at least approximately parallel rounds **23** or ring tracks, whose diameter becomes smaller externally, and whose contours are adjusted to the contours of the external border **4**. After driving each round **23** the robotic vehicle **2** arrives at the (virtual) connecting line **24**. The arriving at this connecting line **24** can be determined with the aid of the above arranged camera **8**, which continuously detects the position of the swimmer. When arriving at the connecting line **24** the robotic vehicle **2** shifts to an adjoining approximately parallel round **23** or ring track that lies radially further inside.

[0051] FIG. **3** shows an automatic activation system **1** for a robotic vehicle **2** that is construed as a pool-robot. The robotic vehicle **2** comprises not shown drive means, in particular a drive motor and a steering device for steering the robotic vehicle **2**, or like in the previous embodiment, two drive units, which both together create a differential drive. The drive motor is construed in the embodiment as electric motor, which is operated with the aid of an also not shown accumulator.

[0052] The robotic vehicle **2** is located on a work area **3**, which is created by a pool bottom. The external border **4** of the work area **3** is created by the surrounding pool walls.

[0053] For an optical detection of the robotic vehicle **2** or a swimmer **26** that is swimming on the water surface **25**, which is carried along with the robotic vehicle **2** when driving along the work area **3** over a guiding rod **27** that is flexibly connected with the robotic vehicle **2**, a camera **8** is provided, which is construed as a color digital camera and which is arranged above the water surface **25**. Since the camera can be pivoted by a link **29** relative to the robotic vehicle, a further swimmer **28** is provided below the swimmer **26** that is adjustable relatively to the guiding rod **27**, which is firmly connected to the guiding rod **22** and adjusts it vertically.

[0054] The camera **8** is connected with the transmitting unit **15** in a signal-conducting manner, over which image data is transmitted to a receiving unit **21**, which is attached at the guiding rod **27**, and which is connected with a logic unit **10** within the robotic vehicle **2** in a signal-conducting manner. The logic unit **10** is connected in a signal-conducting way with a control unit **18**, which controls the not shown drive means. Additionally further transmitting- and receiving units can be provided for the communication, analogous to the embodiment according to FIG. **1**. It is furthermore possible to construe the logic unit **10** not as internal logic unit **10** that is directly assigned to the robotic vehicle **2** like in the embodiment according to FIG. **1**, but as an external logic unit **10**, which is connected in a signal-conducting way with the digital camera **8**, whereby the data transferring mechanism functions preferably as in the embodiment according to FIG. **1**.

[0055] The swimmer **26** that is only indicated by an arrow has preferably a width (expansion transversely to the driving direction of the robotic vehicle **2**), which corresponds with the width of the robotic vehicle **2**. Thereby no camera calibration is required and the robotic vehicle can even be correctly positioned in the external areas further away from the CAM despite perspective deformation/illustration. If the mark width on the swimmer or the width of the swimmer itself corresponds with the track width the perspective of the camera (deformation, perspective illustration) does not matter, because the camera can always compare the external borders of the marker or the swimmer with adjoining tracks and keep the robotic vehicle distanced.

[0056] The logic unit **10** preferably calculates a trajectory that is construed analogously to FIG. **2**, whereby the individual rounds or ring tracks then provide a mainly rectangular contour in the shown embodiment according to FIG. **3**, thus a contour, which is adjusted to the rectangular contour of the external border **4**.

1. Activation system for a robotic vehicle,
- with at least one external camera, which is configured for generating image data of a work area as well as at least one robotic vehicle, and
- with at least one, preferable external, logic unit, which is configured for determining the position of the at least one robotic vehicle and for calculating driving instructions for the at least one robotic vehicle based on the image data that has been generated by the camera,
- with an external transmitting unit, which is configured for transmitting the driving instructions and/or for transmitting the image data, and
- with a control unit that is configured for activating drive means of at least one robotic vehicle based on the driving data.

2. The activation system according to claim **1**, wherein the external logic unit is configured in such a way that it detects the borders of the work area and calculates the driving instructions in such a way that a robotic vehicle does not leave the work area.

3. The activation system according to claim **1** the external logic unit is configured in such a way that it detects static and/or moved obstacles in a work area and calculates the driving instructions in such a way that a robotic vehicle does not collide with the obstacles.

4. The activation system according to claim **1**, wherein, in that the external logic unit is configured in such a way that it detects the orientation of a robotic vehicle and considers it when calculating the driving instructions.

5. The activation system according to claim **1**, wherein, in that the external logic unit considers weather data and/or time data when calculating the driving instructions.

6. The activation system according to claim **1**, wherein the external logic unit is configured in such a way that it detects

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differently conditioned sections of the work area and considers them when calculating the driving instructions.

7. The activation system according to claim **1**, wherein the external unit is assigned to an input unit for a manual determining and/or changing of borders of the work area and/or obstacles and/or driving patterns and/or a visualizing unit for visualizing the image data and/or the obstacles and/or the driving patterns.

8. The activation system according to claim **1**, wherein the logic unit is configured in such a way, that it calculates the driving instructions in such a way that the work area is driven along by the robotic vehicle according to a certain, in particular selectable and/or readable driving pattern, especially on parallel tracks and/or on overlapping tracks.

9. The activation system according to claim **1**, wherein a transmitting unit, arranged at a robotic vehicle, for transmitting status data, in particular odometry data/or accumulator load status data, and an external receiving unit, connected with the external logic unit, for receiving the status data, are provided.

10. The activation system according to claim **9** wherein the logic unit considers the status data when calculating the driving instructions.

11. The activation system according to claim **1**, wherein the system comprises at least one robotic vehicle, in particular a robotic vehicle with drive means.

12. The activation system according to claim **11**, wherein the at least one receiving unit is arranged at the robotic vehicle.

13. The activation system according to claim **11**, wherein the at least one control unit is arranged at the robotic vehicle.

14. The activation system according to claim **11**, wherein at least one mark, in particular a LED, is provided at the robotic vehicle for a simplified determination of the position and/or orientation of the robotic vehicle.

15. The activation system according to claim **11**, wherein the robotic vehicle is a gardening tool, in particular for a surface treatment near the ground, preferably a lawnmower with a mower, or a leaf collecting vehicle, or a grass collecting vehicle, or a mobile watering facility, or a thatching vehicle, or a weeding vehicle, or a snow cleaning vehicle, or a seed distributing vehicle, or a fertilizing vehicle, or a harvesting vehicle, or in that the robotic vehicle is a cleaning or supervising robot, in particular for supermarkets, airports or train stations or such alike.

16. The activation system according to claim **1**, wherein the logic unit creates a starting instruction and a stopping instruction for a tool, in particular a mower, of a robotic vehicle based on the image stat.

17. The activation system according claim **1**, wherein the logic unit calculates a trajectory of a robotic vehicle depending on the image data that is provided by the camera, preferably in such a way that the entire work area or a pre-determined or pre-determinable section of the work area, is driven along at least almost completely, in particular in such a way, that no surface section is driven along several times.

18. The activation system according to claim **1**, wherein, in that the logic unit calculates a trajectory that runs clockwise or contra-clockwise by the image procession operation erosion.

19. The activation system according to claim **11**, wherein the logic unit is controls drive means in such a way that a robotic vehicle drives along the work area in several, in particular oriented at the internal or external border of the work area, rounds, whereby the robotic vehicle maintains a round-specific distance to the external or internal border during each round, whereby the distance that is determined by erosion is increased or reduced with every round by a measure of length that is determined by an erosion filter mask.

20. The activation system according to claim **19** wherein the defined measure of length corresponds at least approximately with the width of the robotic vehicle or at least approximately with the width of a working element of the robotic vehicle.

21. The activation system according to claim **11**, wherein the robotic vehicle is a pool robotic vehicle, and in that the robotic vehicle is connected to a swimmer that is detected by the camera and swims above the robotic vehicle.

22. The activation system according to claim **21** wherein the width of the swimmer corresponds with the width of the robotic vehicle and/or the width of a working element of the robotic vehicle, in particular the width of a filter unit and/or a suction unit and/or a cleaning unit.

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(54) Programmable remote control system for a vehicle

Programmierbare Fernsteuerung für ein Fahrzeug

Système de commande à distance programmable pour un véhicule

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Description

The present invention refers to an improved remote control system for a vehicle, which is capable of being easily programmed according to the actual requirements.

The term "vehicle" is used here to actually mean any type of controlled self-moving or self-propelled apparatus that is capable of being used to household, commercial or industrial purposes.

Remote control systems for vehicles are widely known in the art. The most simple ones among them include for instance a toy motor-car provided with a driving and steering servosystem which is radio-controlled, ie. remotely controlled by radio signals in a manual manner. The most advanced systems are on the other hand programmable in a fully automatic manner and, therefore, they do not require any operator to continuously ensure a supervision of the vehicle. This is for instance the case of a robot for industrial uses, which is adapted to be remotely controlled for travelling along relatively complex paths or routes according to a scheme that will have been pre-determined in accordance with the characteristics of the area in which the vehicle is due to operate.

For example, WO-A-87 01216 discloses a navigation system for detecting the position and controlling the movement of an automatically guided vehicle carrying a source of light to which a detector is responsive. A signal processing unit has memory means in which path control information corresponding to the path of the vehicle is stored, and comparator means adapted to compare the path control information stored in the memory means with positional information produced by the system, in order, when the path control information and the positional information differ, to emit control signals for the movement of the vehicle. As a result, the vehicle is automatically and accurately controlled to follow a predetermined path.

However, all these automatic systems require an undesirably complex and rather unflexible programming of the route which the vehicle is requested to cover, so that they do not appear to be fit for use in operational areas that are different from the one for which they have been originally programmed.

It is therefore a main purpose of the present invention to provide a programmable remote control system for a vehicle, which is simple and easily adaptable to the characteristics of different operational areas.

It is a further purpose of the present invention to provide a remote control system of the afore mentioned type which is capable of being set and programmed in an easy, flexible and substantially precise manner even by substantially unskilled persons.

It is a further purpose of the present invention to provide a remote control system of the afore mentioned kind, which is capable of enabling the vehicle to be continuously and effectively controlled so as to ensure a correct displacement of the same vehicle within its predetermined operational area.

According to the present invention, all such aims are reached in a programmable remote control system for a vehicle, which includes the characteristics as recited in the appended claims.

The characteristics, features and advantages of the present invention will anyway become more apparent from the following description that is given by way of non-limiting example with reference to the accompanying drawings, in which:

- Figure 1 is a schematical view of a preferred embodiment of the remote control system according to the present invention;
- Figure 2 is a schematical view of a detail of the system illustrated in Figure 1; and
- Figure 3 is a flow-chart illustrating the general operation of the system appearing in Figure 1, with various selectable operational options;
- Figure 4 is a flow-chart illustrating in a more detailed manner the operation of the system for the guidance of the vehicle;
- Figure 5 is a flow-chart illustrating in a more detailed manner the operation of the system for controlling the position and locating the vehicle.

Referring in particular to Figure 1, it can be noticed that the system according to the present invention mainly comprises at least an artificial vision apparatus, such as a television camera 1, adapted to continuously sweep and pick-up the images of a given operational area 2 in which at least a vehicle 3 provided with own propulsion means, such as an electric motor, and own steering means is able to move around in a controlled manner. Said vehicle 3 can for instance be an industrial-type vacuum cleaner, a lawn mower, a robot or the like, and can be of a type that is capable of moving forward at different speeds, as well as moving backward and turning to the left and to the right in a controlled manner, wherein said propelling means and steering means are of a per se known kind, so that they will not be shown here for reasons of greater simplicity.

The operational area 2 can for instance be constituted by a rectangular or square place with the sides measuring approx. 10 m, while the television camera 1 can be situated in a position at a height of a few meters above the floor.

The television camera 1 can be of a type having a spectrum that extends to include infrared, such as for instance a television camera of the charge-coupled or CCD type marketed by WATEC under the model designation of TIN 304 R.

The output 4 of the television camera 1 uses an im-

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age signal, ie. a video signal representative of the area 2 and the vehicle 3, to drive a control unit that preferably comprises a personal computer 5. The latter can for instance be a AST 486 PREMMIA personal computer associated to command means such as a keyboard 6 and/or a so-called "mouse" 7, and comprises an output 8 that drives a remote-control transmitter 9.

Said transmitter 9 is adapted to remotely control, preferably by means of radio waves, a corresponding receiver 10 which is provided on the vehicle 3 and which is in turn adapted to control, in a substantially per se knwon manner, said propelling and steering means of said vehicle.

The remote control apparatus itself can for instance be of the FUTABA type, mod. F14.

The remote control system according to the present invention is in an advantageous manner of the closed-loop type, with the possibility of continuously monitoring and controlling, in the manner that will be described in greater detail farther on, the actual position of the vehicle 3 within the operational area 2. In particular, the television camera 1 acts as a feed-back means for the whole system.

To the control unit 5 there is associated at least a monitor 11 , which is adapted to display an image (Figure 2) that corresponds to the operational area 3 being picked up by the television camera 1, along with possible information needed for programming commands to be performed or carried out by the vehicle 3.

In a per sè known manner, the personal computer 5 comprises an acquisition and processing board for video signals in digital form, as well as a so-called library software which, although not covered by the present invention, enables the system to be managed and the images to be processed by the personal computer in the manner that will be described farther on. For example, said video-signal acquisition and processing board comprises a board of the Frame Grabber type, mod. DT2867, as marketed by DATA TRANSLATION, whereas the output 8 of the control unit 5 is included in a digital output board as marketed by NATIONAL INSTRUMENT under the model designation DI024.

Two combinable programmes can be set on the personal computer for the operation of the system. In particular, a so-called range-setting or range-calibrating programme is set, through the keyboard 6 and/or the mouse 7, with the data concerning the ratio of the performance capabilities of the vehicle 3 (eg. the steering or turning radius) to the dimensions of the operational area 2. In a preferred manner, said range-calibrating programme also comprises data concerning the mesh pitch or size of a reference grid 12 (Figure 2) which is displayed on the monitor 11 as superimposed on the view of the operational area. In accordance with these data, the software of the personal computer 5, through appropriate metric transformations, will automatically adapt the dimensions of the image displayed on the monitor 11 to the dimensions of the real image, ie. the operational area 2 viewed by the television camera 1. The data of the range-calibrating programme are then stored in the personal computer 5 in view of their utilization as a reference by an operational programme. The range-calibrating programme shall only be changed in the case that some "geometric" variation occurs or takes place in the operational area, such as for instance a displacement of the television camera 1 to a different siting, a change of the operational area 2, etc.

The operational programme uses the stored data of the afore mentioned range-calibrating programme to enable the image picked up by the television camera 1 to be correspondingly displayed on the monitor 11, as well as so-called moving zones, possible forbidden zones and, if needed, a parking zone to be defined, as this will be better explained farther on.

In a preferred manner, as shown in Figure 3, the range-calibrating programme and the operational programme can be set directly into a single combined programme. In any case, the system's software can be of any appropriate type fitting the particular purpose, is within the capabilities and the knowledge of those skilled in the art, and departs from the scope of the present invention, as already pointed out. It is quite apparent that setting the range-calibrating programme and the operational programme can be quite simply and readily performed, through the keyboard 6 and/or the mouse 7, even by substantially unskilled persons, who will in fact be only required to be able to operate an ordinary personal computer.

As far as the operational programme is concerned, the operator, through the keyboard 6 and/or the mouse 7, defines and stores the contours of at least a moving zone 20, which comprises at least a portion of the operational area 2 and within which the vehicle 3 is to move. As shown in Figure 2, said contours of the moving zone 20 are displayed on the monitor 11.

Similarly, the operator can define and store the contours of one or several forbidden zones 21, ie. zones through which the remotely controlled vehicle 3 is not allowed to pass. Said forbidden zones 21 are included in the moving zones 20. If the operational area 2 is for instance a garden monitored by the television camera 1, and the vehicle 3 comprises a lawn mower, the moving zone 20 represents at least a portion of the garden in which the vehicle 3 has to move while avoiding forbidden zones 21 that may be represented by trees, flower-beds and the like included within said moving zone 20.

Similarly to the moving zone 20 and the forbidden zones 21, the operator can further define also a parking zone P, which is also included in the moving zone 20 and preferably corresponds to a mesh of the grid 12. Also said parking zone P is correspondingly displayed on the monitor 11 in an accordingly coded manner.

The moving zone 20 and the forbidden zones 21 can be changed at discrete levels, corresponding to meshes of the grid 12. The latter can of course be or not

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be displayed on the monitor 11, depending on the relevant command imparted by the operator.

Once the range-calibrating programme and the operational programme have been set in the above described manner, the operator can act on the keyboard 6 to selectively start the operation of the system with a "random" movement of the vehicle 3, in accordance with the data stored in the personal computer 5. The output 8 of the control unit 5 drives thereupon the transmitter 9 with a driving signal, which is coded in a per sè known manner, according to the operational programme that has been set (Figures 3 and 4). The driving signal is transmitted by the transmitter 9 to the receiver 10 of the vehicle 3, which, when at rest, is preferably located in the parking zone P. Thereupon, said vehicle 3 moves out of the parking zone P and automatically follows such a route as to enable the same vehicle to substantially "scan" the moving zone 20 (through repeated actuation of its steering members) and move eventually back into the parking zone P, where the vehicle comes preferably to a standstill with a given orientation, according to the geometric characteristics (as set in the combined programme) of both the zone P and the moving zone 20.

When moving along its route, the vehicle 3 is caused to "bounce" in advance against the contours of the moving zone 20 and against the contours of the forbidden zones 21. In other words, that is, the vehicle 3 is guided so as to avoid moving beyond the contours of the above cited zones 20 and 21.

For a correct operation, the vehicle 3 is provided with coded optical recognition means, comprising for instance a lamp 13 or a similar light source, which is caused to uninterruptedly blink by the control unit 5 through the remote control 9, 10. Therefore, the video signal generated by the television camera 1 contains also a coded information that drives the personal computer with corresponding data concerning the actual instant position of the vehicle 3 within the operational area 2.

With reference also to Figure 5, the control unit 5 preferably uses the following procedure to effectively locate the actual position of the vehicle 3:

- the personal computer 5 acquires from the television camera 1 a video image with the lamp 13 off; it then issues the command for the same lamp to light up;

- the personal computer 5 acquires from the television camera 1 an image with the lamp 3 on; it then issues a command for the same lamp to turn off.

Such an operation continues in a cyclic manner and, using a *per sè* known technique, the personal computer 5 repeatedly performs a subtraction between the two above cited subsequent images, in a pixel-by-pixel manner, thereby obtaining a completely black digital image with a bright spot in correspondence of the lamp 13 and, as a consequence, of the vehicle 3. Such a resulting image is preferably displayed on the monitor 11 together with the area 2 and the zones 20, 21 and P.

In a manner which is generally known to those skilled in the art, the personal computer 5 is capable of automatically determine by calculation the geometric coordinates of the bright spot on the screen of the monitor corresponding to the instant position of the vehicle 3 within the operational area 2. As a result, the output 8 of the control unit 5 is able to continuously drive the vehicle 3 with error commands, through the remote control 9, 10, so as to perform the pre-set operational programme in a correct manner and with an adequate level of accuracy.

Claims

1. Programmable remote control system for a vehicle (3) equipped with own propelling and steering means that are adapted to be controlled by means of remote control means (9, 10), said system comprising artificial vision means (1) adapted to pick up the images of an operational area (2), in which said vehicle is situated, and to drive with a corresponding video signal a computerized control unit (5) provided with command means (6, 7) for inputting and setting an operational programme according to which said control unit is capable of driving said remote control means and, as a result, controlling the movement of said vehicle (3), the latter being provided with coded optical recognition means (13) which the control unit (5) is adapted to detect so as to determine the instant position thereof and drive the vehicle with corresponding error signals, according to the operational programme, **characterized in that** the control unit (5) is arranged to store in the operational programme at least a moving zone (20) within which said vehicle (3) is controlled to move with a random movement, so as to substantially scan said moving zone (20).

2. Programmable remote control system according to claim 1, **characterized in that** the control unit (5) is arranged to store in the operational programme at least a forbidden zone (21) which the vehicle is controlled to avoid during its random movement in said moving zone (20).

3. Programmable remote control system according to claim 1, **characterized in that** the control unit (5) is arranged to store in the operational programme a parking zone (P) in which said vehicle (3) is controlled to stay at the end of its random movement in said moving zone (20).

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Patentansprüche

1. Programmierbare Fernsteuerung für ein Fahrzeug (3), welches mit eigenen Antriebs- und Steuereinrichtungen versehen ist, die so gestaltet sind, daß sie mittels der Fernsteuerung (9, 10) betätigt werden können, wobei das System eine technische Erfassungseinrichtung (1) umfaßt, welche in der Lage ist, die Ansicht eines Arbeitsbereiches (2) zu erfassen, innerhalb welchem sich das Fahrzeug befindet, und mit einem entsprechenden Videosignal eine computergestützte Steuereinrichtung (5) zu betreiben, die mit Befehlseinrichtungen (6, 7) zur Eingabe und zum Abspeichern eines Funktionsprogrammes versehen ist, mit welchem die Steuereinrichtung in der Lage ist, die Fernsteuerung zu betreiben, und dadurch die Bewegung des Fahrzeuges (3) zu steuern, wobei letzteres mit einer codierten optischen Signaleinrichtung (13) ausgestattet ist, welche von der Steuereinrichtung (5) erkannt werden kann, so daß sie die augenblickliche Position von diesem ermitteln und das Fahrzeug durch Fehlersignale steuern kann, die durch Vergleich mit dem Funktionsprogramm ermittelt werden, **dadurch gekennzeichnet,** daß die Steuereinrichtung (5) so gestaltet ist, daß sie im Funktionsprogramm zumindest einen Bewegungsbereich (20) speichert, in welchem das Fahrzeug (3) mit einer beliebigen Bewegung gesteuert bewegt wird, so daß es im wesentlichen den Bewegungsbereich (20) abfährt.

2. Programmierbare Fernsteuerung nach Anspruch 1, **dadurch gekennzeichnet,** daß die Steuereinrichtung (5) so gestaltet ist, daß sie im Funktionsprogramm zumindest einen unerlaubten Bereich (21) speichert, welchen das Fahrzeug bei seiner beliebigen Bewegung im Bewegungsbereich (20) gesteuert meidet.

3. Programmierbare Fernsteuerung nach Anspruch 1, **dadurch gekennzeichnet,** daß die Steuereinrichtung (5) so gestaltet ist, daß sie im Funktionsprogramm einen Parkbereich (P) speichert, in welchem das Fahrzeug (3) am Ende seiner beliebigen Bewegung im Bewegungsbereich (20) gesteuert verweilt.

Revendications

1. Système de commande à distance programmable pour un véhicule (**3**) équipé de ses propres moyens de propulsion et de direction qui sont adaptés pour être commandés par des moyens de commande à distance (**9, 10**), ledit système comprenant des moyens de vision artificielle (**1**) adaptés pour prélever les images d'une zone opérationnelle (**2**) dans laquelle est situé ledit véhicule, et pour entraîner avec un signal vidéo correspondant une unité de commande informatisée (**5**), munie de moyens de commande (**6, 7**) pour entrer et définir un programme opérationnel selon lequel ladite unité de commande est capable d'entraîner lesdits moyens de commande à distance et, en conséquence, de contrôler le mouvement dudit véhicule (**3**), ce dernier étant muni de moyens de reconnaissance optique codés (**13**) que l'unité de commande (**5**) est adapté à détecter, afin de déterminer la position instantanée de celui-ci et d'entraîner le véhicule avec des signaux d'erreur correspondants, selon le programme opérationnel, caractérisé en ce que l'unité de commande (**5**) est agencée pour mémoriser dans le programme opérationnel au moins une zone de déplacement (**20**) dans laquelle ledit véhicule (**3**) est contrôlé à se déplacer avec un mouvement aléatoire, de manière à balayer sensiblement ladite zone de déplacement (**20**).

2. Système de commande à distance programmable selon la revendication 1, caractérisé en ce que l'unité de commande (**5**) est agencée pour mémoriser dans le programme opérationnel au moins une zone interdite (**21**) que le véhicule est contrôlé à éviter pendant son mouvement aléatoire dans ladite zone de déplacement **(20).**

3. Système de commande à distance programmable selon la revendication 1, caractérisé en ce que l'unité de commande (**5**) est agencée pour mémoriser dans le programme opérationnel une zone de stationnement (**P**) dans laquelle ledit véhicule (**3**) est contrôlé pour rester au terme de son mouvement aléatoire dans ladite zone de déplacement (**20**).

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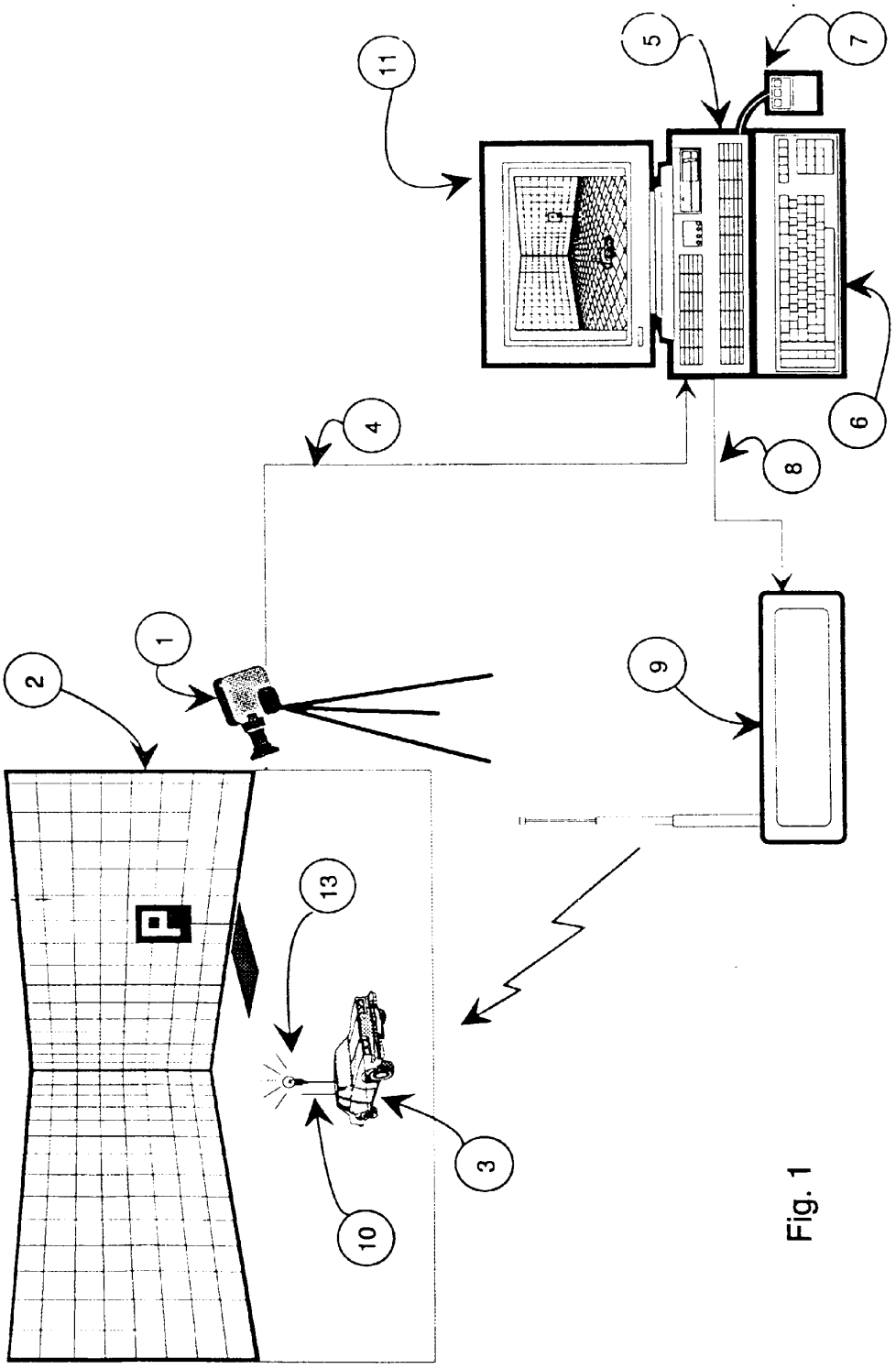

Fig. 1

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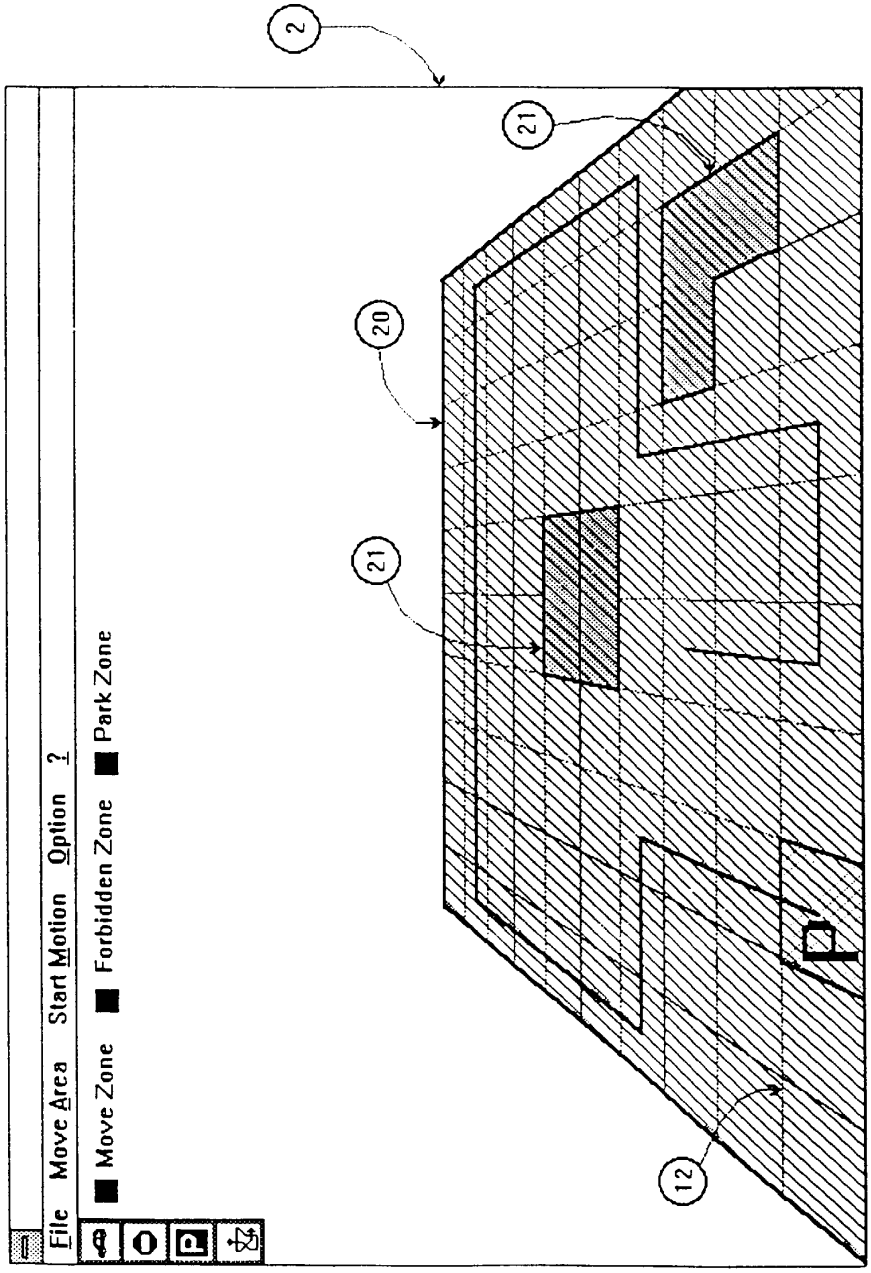

Fig. 2

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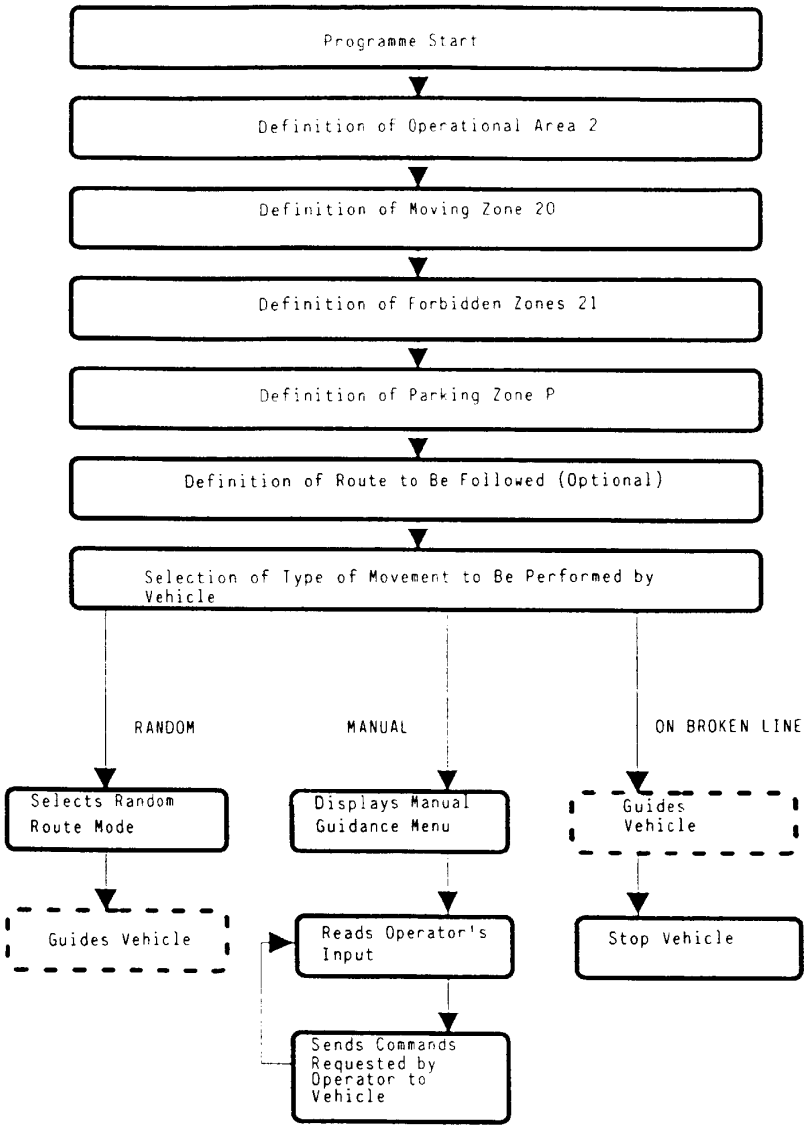

Fig. 3

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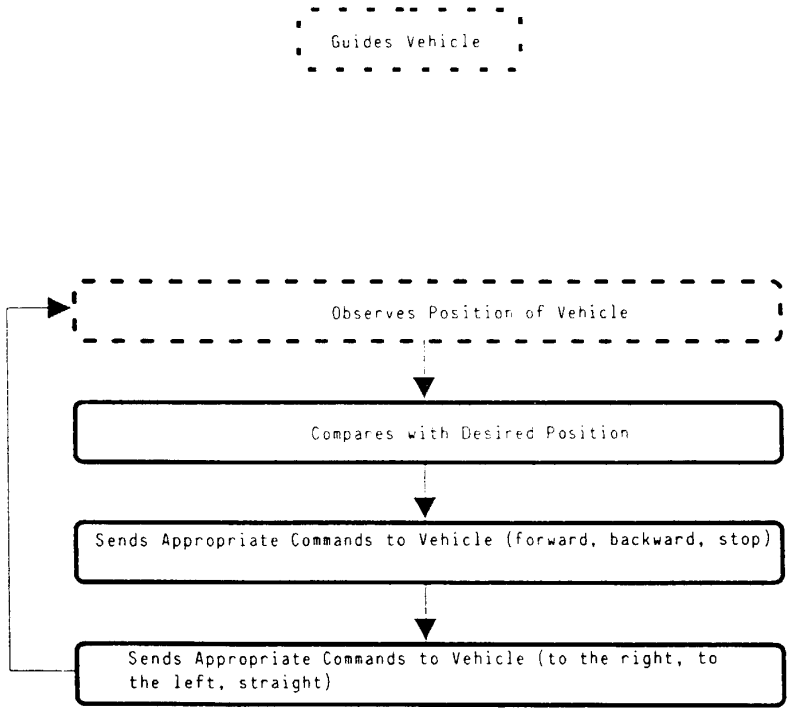

Fig. 4

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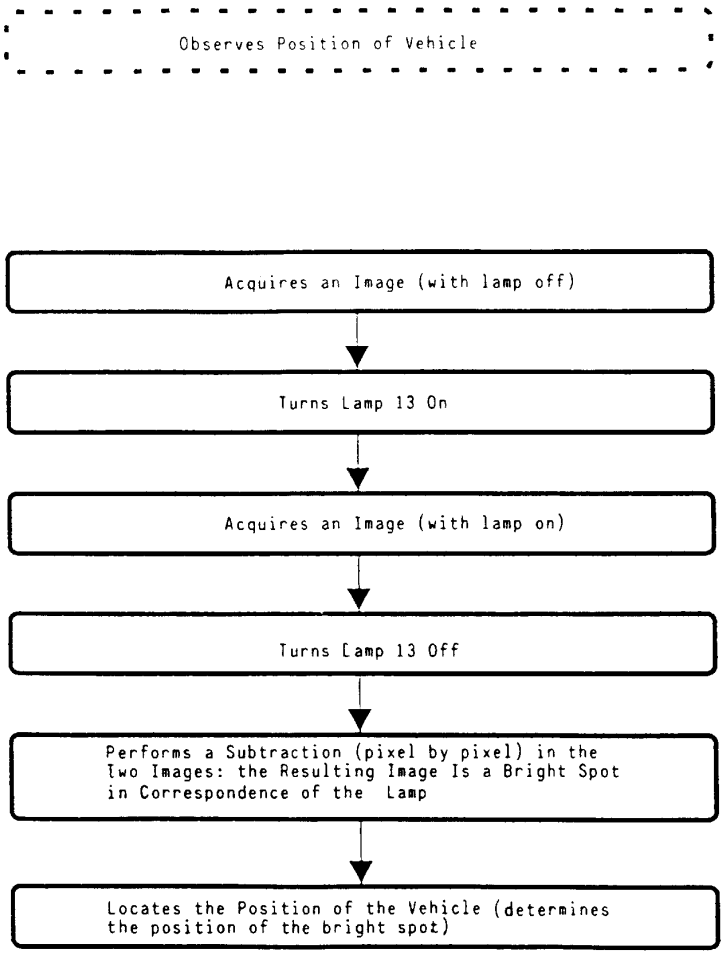

Fig. 5

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(54) Device for cleaning of water tanks

Vorrichtung zur Reinigung von Wasserbehältern

Dispositif de nettoyage de réservoirs d'eau

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US-A- 5 093 949
US-A- 5 205 174
US-A- 5 253 812
US-A- 5 363 935

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Description

[0001] The present invention relates to a device comprising a remotely controlled machine for cleaning of inner surfaces, preferably in drinking water tanks, comprising electrically powered crawler tracks, brushes and a pump unit that discharges sludge and particles via a hose into a sludge container outside the tank, a video camera, spot-lights and a control unit.

[0002] Existing devices of similar types have various disadvantages.

The apparatus according to US 5,093,949 has a programmed action pattern which provides that the surface to be cleaned is known and without obstacles. The sucked up material is filtered and delivered to a sludge-collecting tank on a vehicle outside the water tank. The device also comprises another vehicle with a hydraulic power supply. If obstacles like columns, steps or the like are present, the device must be controlled manually to overpower the programmed pattern. The position of the device is determined by checking length and angle of tether line. There are no devices like sonars and video cameras to facilitate navigation and checkout of the result of the cleaning.

[0003] The cleaning apparatus described in US 3,753,265 is provided with a number of mercury switches which are activated when the device hits an obstacle and an external logic circuit controls the heading of the device in an uncontrolled way whereby parts of the bottom surface can be left uncleaned. One version does not have any logic but is operated manually. This vehicle is also without devices for remote control without visual contact from the operator. The sucked up water is filtered in an internal filter, which gives the device a very poor cleaning capacity as the filter in a short time will be stowed by mud and particles.

Consequently it is not suitable for large tanks with relatively thick layers of sludge and fine grained sediments. The device is provided with only one rotating brush.

[0004] The device according to US 4,304,022 is also operating with a filter arranged on the vehicle itself. The filter has to be emptied and cleaned as often as the filter get stowed at removing of fine grained sediment and particles.

This apparatus also lacks devices like sonar or video camera for safe and exact navigation.

[0005] US 5,205,174 discloses an apparatus mainly designed for inspection purposes. It has only a fixed, forward directed video camera for navigation purposes. This is not sufficient for navigating the machine for thorough cleaning a water tank with a complicated inner structure.

[0006] FR 2 416 808 discloses a machine designed for inspection and transportation purposes. It is equipped with two forward directed video cameras one of which is rotatable a limited angle in a vertical plane. This is not either sufficient for navigating a machine for thorough cleaning a water tank with a complicated inner structure.

[0007] It obvious that the devices described above lack possibility for convenient and safe navigation in large, deep tanks with obstacles of various kinds and with relatively deep layers of sludge and particles on the bottom and the walls. The quality of the cleaning will then be jeopardised.

[0008] The object with the present invention is to eliminate the above mentioned disadvantages with known devices and provide a machine provided with equipment that can locate and visualise obstacles in a water tank and facilitate for an operator to unimpededly navigate between the obstacles in tanks of complicated design and even climb vertical walls. The water distribution shall proceed without disturbances during the cleaning operation.

[0009] This object is achieved with a device according to the invention which is characterised in that the machine has a sonar unit that produces signals representing echoes from the bottom and from obstacles in the surroundings of the machine, said signals being visualised on a presentation unit in a control unit, and in that a video camera is remotely controlled and can be directed to identify the obstacles by an operator by means of the visualised sonar echo on the presentation unit to facilitate safe and exact navigation in the water tank for effective cleaning .

[0010] The device will now be described more in detail with reference to the attached drawing on which

Fig 1 shows a schematic side view of the device in a water tank, a collection tank and a control unit outside the tank.

[0011] A machine 1 has a framework 2 on which a preferably electrical power unit 3 is mounted. Centrally on the framework a pump unit 4 is mounted the outlet 5 of which, via a hose 6, leads the sucked sludge and particles to a container 7 located outside the water tank. The container can be placed on the ground or on a trailer. The sucked up material can also be lead to a sewer nearby.

On top of the framework 2 there are two spotlights 14 and 15 and a video camera 17.

The camera 17 can be operated from a control unit 16 and the image is presented on a monitor 20. A sonar unit 21 is connected via a signal line 22 to the control unit 16 to show the operator echoes from the bottom and the surroundings on a presentation unit 23. By means of the information from the video image and the sonar echo the operator can control the vehicle with high precision even if there are obstacles present, for instance plumbing or the like. To manoeuvre vertically, for instance due to steps in the bottom surface or at launching or lifting up, two blowable ballast tanks 24 and 25 on the top of the framework can be filled or emptied.

[0012] The advantage with a device of the described type is that it is not necessary to engage divers and expose them to risks at work in complicated under-water structures. The device is easily operated by one single

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operator and the working time is drastically reduced compared to older methods or use of devices that cannot be operated by means of images from the bottom or wall profile or from obstacles consisting of columns, plumbing etc. The whole cleaning operation can be followed and if necessary be recorded on diagrams and videotape. The big suction capacity prevents the water from becoming muddy and suction can thus be performed without interrupting the water supply.

[0013] The device is thoroughly tested by cleaning a drinking water tank with a volume of 10.000 m^3 and with a bottom area of 2300m^2 and with 185 supporting columns. The operation took two days and no interruption in the water supply was necessary.

The device has here been described in an application for water tanks but can of course be utilised for cleaning of tanks containing different, non inflammable liquids.

Claims

1. A device comprising a remotely controlled machine (1), for cleaning of inner surfaces, preferably in drinking water tanks, comprising electrically powered crawler tracks (10), brushes (12, 13) and a pump unit (4) that discharges sludge and particles via a hose (6) into a sludge container (7) outside the tank, a video camera (17), spotlights (14, 15) and a control unit (16),
characterised in
that the machine has a sonar unit (21) that produces signals representing echoes from the bottom and from obstacles in the surroundings of the machine, said signals being visualised and recorded during the whole operation in a presentation unit (23) in the control unit (16), and in
that the video camera is remotely controlled and directed by an operator to identify and locate the obstacles by means of the visualised and recorded sonar echo in the presentation unit (23) to facilitate safe and exact navigation in the water tank for effective cleaning.

Patentansprüche

1. Vorrichtung, welche eine ferngesteuerte Maschine (1) zum Reinigen von Innenflächen, vorzugsweise in Trinkwassertanks, aufweist, wobei die Maschine Raupenlaufbahnen (10), Bürsten (12, 13) und eine Pumpeneinheit (4), die Schlamm und Partikel über einen Schlauch (6) in einen Schlammbehälter (7) außerhalb des Tanks abfließen lässt, ferner eine Videokamera (17), Scheinwerfer (14, 15) und eine Steuereinheit (16) aufweist,
dadurch gekennzeichnet,
dass die Maschine eine Ultraschall-Einheit (21) aufweist, welche Signale erzeugt, die Echos vom Boden und von Hindernissen in der Umgebung der Maschine darstellen, wobei diese Signale während des gesamten Betriebs in einer Darstellungseinheit (23) in der Steuereinheit (16) bildhaft dargestellt und aufgezeichnet werden, und
dass die Videokamera ferngesteuert ist und von einem Maschinenbediener dirigiert wird, um Hindernisse mit Hilfe des visualisierten und aufgezeichneten Ultraschall-Echos in der Darstellungseinheit (23) zu identifizieren und zu lokalisieren, damit eine sichere und genaue Navigation in dem Wassertank zur wirksamen Reinigung erleichtert wird.

Revendications

1. Dispositif comprenant un engin commandé à distance (1) pour le nettoyage des surfaces internes, de préférence dans les réservoirs d'eau potable, comprenant des chenilles électriques (10), des brosses (12,13) et un groupe de pompage (4), lequel déverse les boues et particules par un tuyau dans un conteneur de boues (7) à l'extérieur du réservoir, une caméra vidéo (17), des spots (14,16) ainsi qu'une unité de commande qui se **caractérise par le fait que** l'engin est doté d'un dispositif sonar (21) qui émet des signaux constituant les échos qu'il reçoit du fond et des obstacles situés dans son environnement immédiat, lesdits signaux étant visualisés et enregistrés pendant toute la durée de l'opération dans un module de présentation (23) de l'unité de commande (16) et **par le fait que** la caméra vidéo est commandée à distance et orientée par un opérateur afin d'identifier et de localiser les obstacles au moyen de l'écho de sonar visualisé et enregistré dans le module de présentation (23) dans le but de faciliter une navigation sûre et précise dans le réservoir d'eau pour un nettoyage efficace.

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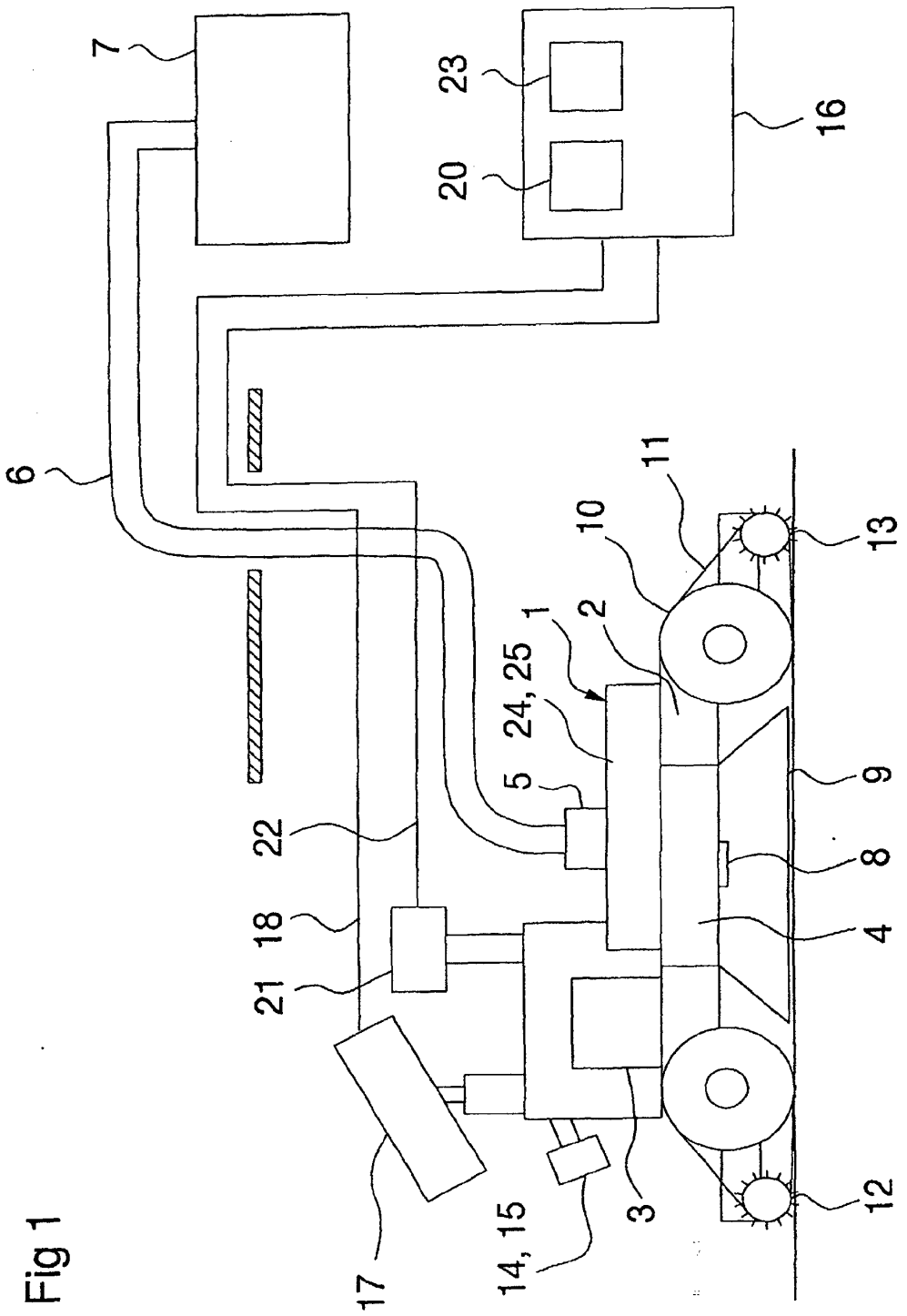

Fig 1

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Underwater cleaning robot

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ABSTRACT

The present invention discloses an underwater cleaning robot. The robot can work in the mode of remote and self-control and comprises a drainage mechanism, a cleaning and mobile platform as well as a control system. With the configuration and division of the drainage mechanism, the cleaning and mobile platform as well as the control system, the robot can undergo cleaning work autonomously or by remote control under water, on horizontal plane, vertical plane as well as tilt plane. The present invention has the characteristics of light weight, large capacity, compact and reasonable mechanical structure as well as good practicality, stability, energy saving, economy and generality, etc, and is the robot which can be used for underwater cleaning for the bottom of swimming pool and the pool wall.

CLAIMS(10) translated from Chinese

An underwater cleaning robot, characterized in that: it is a drainage mechanism, clean and mobile platforms and control system; wherein the drainage means including drainage, drive control flow passage sealed box and shell wall formed robot (24) , water filter and water inlet and backflow prevention device 0¾; water filter is fixed to the flow channel (M), with the robot housing body (1) and a drive control seal the inner wall of the flow channel box 04) is divided into two parts; drainage include the drain (10), the drain screw (11), drain bracket (12), drain holder (13), the drain screw bracket (15) and the drain of the drive shaft (17); the drain port (10) is fixed to the mounting drain bracket (12), and the drain is connected via the bracket (12) and the drain of the drive shaft (17), may surround the outlet of the drive shaft (17) rotates; drainage screw (11) by the drainage propeller speed DC motor (14) driven, propeller bracket fixed to the drain (15), the drain screw bracket (1¾ also the drain of the drive shaft (17) connected with the outlet (10) around the outlet shaft synchronous (17) is rotated; drain holder (13) and drive control box top sealing fixing, drain holder (1¾ also drain drive shaft (17) connected to a drive shaft rotatable about outlet (17) is rotated; drain servo drive (16) connected to and drives the drain Bracket (1¾ and drainage propeller bracket (15) around the drain of the drive shaft (17) is rotated; inlet 06) and the anti-backflow device (25) of the robot housing OO) bottom surface, ensure that the water flow channel 04) is not within back; cleaned with a mobile robot platform includes an outer housing (1), clean the drive wheel (3), timing gear (5) and drive belt; the robot outer casing (1) comprises a robot on the cover (18), Robot sidewall OO) and the robot main housing (19), said cleaning drive wheel (¾ includes four independently driven cylindrical hub, four cleaning wheels (3) a set of two, and the side wall by a robot Clean the drive wheel side stand robot main housing, clean driving wheel center support 02) is connected with the robot installed; two belt gear (5) and a drive belt (4) is a group attached to the robot main body (19) between the side plate and the robot sidewall OO), one of the timing belt gear (5) with a clean drive DC motor (7) is connected, another belt gear (¾ with a clean driving wheel C3) connection, two a belt gear (5) by a drive belt (4) Drives; control system includes a central processor, surveillance cameras, frame grabbers, inertial navigation device, remote control signal interface, the motor drive control system box (8), cleaning

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wheels DC motor (7), drain servo drive (16), drain propeller speed DC motor (14), the drive control sealed box and the control and energy management systems; surveillance cameras (¾ connected to the central processor via the image acquisition card, inertia navigation device, a remote control signal interface is also connected to the central processor, input part of the central processor chip and image acquisition card, inertial navigation device and a remote control signal interface including the control system; the central processor via the motor drive DC motor drive wheels clean (7), drain the servo drive (16), drain propeller speed DC motor (14), the control system box will include a central processor, image acquisition card, inertial navigation device, remote control signal interface, the motor drive control system package, the drive control sealed boxes will include a control system box (8), clean the drive DC motor (7), drain the servo drive (16), drain propeller speed DC motor (14) of the control system portion sealed package, waterproof properties; control and energy management system implementation of robot control and energy management.

2. The underwater cleaning robot according to claim 1, characterized in that the drainage means can choose to install one or more drainage, when you select to install multiple drainage, drainage outfall to keep the drive shaft (17) coaxial.

3. underwater cleaning robot according to claim 2, wherein said anti-backflow device 0¾ divided into two parts by a shaft frame fixed cover 06) above the water inlet can be rotated around the shaft, when the water into the robot water channel 04), the backflow prevention device 05) in two parts due to the role of water, about an axis of rotation, inlet 06) open; when you stop the water, backflow device 0¾ restore the closed state to ensure the flow channel 04 Water will not be back) inside.

4. underwater cleaning robot according to claim 1, characterized in that said control and energy management system includes a control signal floats antenna (27), signal relay and cable manager (¾), signal and energy cable (33), the control signal floats connected to the signal relay antenna installation and antenna interface cable manager, receiving a control signal to control the keyboard, via the signal relayed by the signal and energy transmission to the remote control signal interface cables underwater cleaning robot.

5. underwater cleaning robot according to claim 4, wherein said control and energy management system also includes a cable counterweight ring (34), signal and energy cables (3¾ internal control signals including lines, power lines , the density of the cable is less than the density of water, can be equipped with heavy ring by assembling cable (34) to change its density, to adjust the suspension in the water.

6. underwater cleaning robot according to claim 4, wherein said control and energy management system also includes a cable guide pulley frame (32), when the robot work with cable, cable guide pulley frame (32) mounted on the shore around the corner, including the fixed pulley, fixed pulley seat rotation shaft, to realize their own fixed pulley and fixed pulley rotation means about a rotation axis fixed pulley seat.

7. underwater cleaning robot according to claim 1, characterized in that said control and energy management system includes a control signal float antenna, 2T) and control signals float antenna cable

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(35), the control signal floats antenna, 2T) floats through the control signal antenna cable (3¾ direct communication with the robot remote control signal interface.

8. underwater cleaning robot according to claim 1, characterized in that said underwater cleaning robot modes include manual cleaning and self-cleaning; the manual mode, the control signal generated by the control keyboard manual operation, by m float antenna control signal directly or indirectly controlled underwater cleaning robots; the autonomous mode, the control signal from the central processor based on the perception of environmental information with its own position and attitude information, combined with pre-set cleaning tasks autonomously plan path and action, driving the robot to perform layer, complete underwater cleaning tasks.

9. The underwater cleaning robot according to claim 1, characterized in that the outlet (10) may surround the outlet of the drive shaft (17) is rotated, thereby changing the direction of the drainage, the robot travels, clean, and the vertical steering adherent traveling produce different forces.

10. The underwater cleaning robot according to claim 1, characterized in that said underwater cleaning robot of both power input and the rechargeable battery compartment, the robot can be externally powered, the battery case may be a short time by the robot powered by.

DESCRIPTION translated from Chinese

Underwater cleaning robot

Technical Field

[0001] The present invention relates to a robot for cleaning the underwater environment in particular, with autonomous mobile functions can be controlled by remote control or autonomous underwater horizontal, vertical and inclined surfaces are clean, people can replace complete autonomy underwater cleaning Working underwater cleaning robot.

Background

[0002] The sport of swimming history for thousands of years, with the improvement to accelerate pace of modern life and standards of living, swimming has become physical fitness, recreational important form of exercise. Pool hygiene situation is directly related to the swimmer's motion and motion effects, therefore, to keep the pool water and hygiene wall is essential. Swimming pool cleaning methods will be based on the form and size of the pool of change, for now, whether it is manual cleaning, or automatic water cycle, water resources or in other energy use and the use of labor there is a huge waste or redundant, resulting in Swimming-pool maintenance costs, but also directly increase the cost of swimmers swimming, therefore, a need for an autonomous underwater cleaning device to solve this problem.

DISCLOSURE

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[0003] The object of the present invention to provide a method capable of flexible, economic energy, multiple modes of operation of underwater robots, in order to better complete underwater cleaning work.

[0004] The present invention is an underwater cleaning robot, including drainage mechanism, clean and mobile platforms and control systems.

Drainage Authority [0005] The present invention comprises a drainage, the drive control flow passage sealed box with a robot shell wall formation, water filters and inlet and backflow devices. Including outfall drainage, drainage propeller, drain bracket, drain fixation, drainage propeller shaft bracket and drain. Drainage outfall mounting bracket to drain, and a drive shaft connected through the drain bracket and the drain can be rotated around the drive shaft; drained by the high speed DC motor drives a propeller, propeller bracket fixed along the drain, and the drain is also driving shaft connection, and drain synchronous rotation around the drive shaft; drain and drain holder bracket bracket and drainage propeller shaft connected by a common drain, rotatable about its rotation, drain holder and drive control at the top of sealed boxes fixed. Said flow channel includes a drive control box sealed outer wall and shell wall space robot constituted. Said water filter is fixed to the flow channel, and the robot shell wall and a drive control seal box will flow channels are divided into two parts. Inlet and backflow prevention device, wherein the underside of the bottom case of the robot, including the inlet and backflow prevention devices, anti-backflow device is divided into two parts by a shaft frame fixed cover to enter the top outlet, you can rotate around the shaft. Drainage agency can choose to install one or more drainage, when you select to install multiple drainage, to maintain drainage drainage drainage shaft coaxially.

Cleaning and mobile platforms herein [0006] The housing includes a robot body, clean the drive wheels, gear and belt drive belt. Robot comprises a robot on the cover housing, the robot and the robot main body side wall, using a robot shell forming polymer materials. Clean the drive wheel includes four independently driven cylindrical hub, the outer hub supporting the wheel according to cleaning surfaces of different materials, a group of two to four wheels clean by cleaning robots and robotic side wall of the main housing wheels side stand, center stand and robot installation and connection. Timing belt drive gear, two gears and a timing belt drive belt for a group, attached to the side panels between the robot and the robot main body side wall, wherein a timing belt and a drive gear connected to the DC motor, the other a timing belt gear and a clean driving wheel connection, both timing belt drive gear carried by a drive belt.

[0007] the control system of the present invention comprises a central processing unit, surveillance cameras, frame grabbers, inertial navigation device, a remote control signal interface, power management modules, motor drives, control system box, clean the drive wheel motor, drain drive servos, drainage propeller speed DC motor drive control sealed box and the control and energy management systems. Wherein the input portion of the central processor chip and image acquisition card, inertial navigation device and a remote control signal interface including the control system; the central processor chip and the motor drive control system constitutes the output section. The motor drive mechanism and clean the drive wheels become controlled DC clean drive execution-tier system; motor drive and drain

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outfall constitute rotation servo drive execution layer; a motor drive with high speed direct current mechanism into a drain propeller propeller-driven executives. The surveillance camera mounted on the front panel of the two main housing robots, surveillance cameras and frame grabbers constitute a control system environment sensing layer. The inertial navigation element is mounted on the robot drive control sealed box, constitute a control system itself posture alignment layer. The control system will include a central processor box, frame grabbers, inertial navigation device, a remote control signal interface, power management module, motor drive control system package, both the power input interface and rechargeable battery box, by an external power supply robot may also be the case for a short time by a battery-powered robot, the control system is fixed to the drive control box at the bottom of the seal tank. The power management module is used to steady flow and monitor the robot overcurrent circuit overload protection robot control system.Cleaning said DC motor drive wheel, gear box and equipped with the encoder, the front flange seal fixed to the drive control box side walls and the robot main body side wall, and belt by a gear belt, drive wheels clean . The drain of the servo drive, install drain holder fixed to the drive bracket and drainage outfall drain propeller shaft is rotated around the stent. The drainage propeller speed motor, propeller bracket fixed to the drainage, drainage drive propellers. The cleaning drive wheel motor, drain propeller speed DC motor is equipped with an encoder, can achieve motor servo motor drive control its. The drive control sealed box, including sealed box casing cover and the main box, sealed box enclosure lid includes slide grooves drain water features; driving control both ends sealed box through the sidewall of the main housing of the robot fixed to the robot inside the main housing, the control system includes a control system section box cleaner driving wheel motor, servo drives drain, drainage propeller speed DC motor sealed package, using a molding polymer material having waterproofing properties . Said control and energy management system includes a control signal float antenna, antenna cable float control signal, signal relay and cable management, signal and energy cables, cable guide pulley bracket and cable counterweight ring. Wherein the signal relay and cable manager includes a signal repeaters, cable managers, by managing holder and pond shore ground fixed, the control signal floats connected to the signal relay antenna installation and antenna connection cable manager The control signal receiving control of the keyboard, via the signal relay, remote control signal interface cable from the signal and energy transmission to the underwater cleaning robot; signal relay and cable manager with an external AC power supply and AC to DC transformer means by signal Energy and power input connector cable underwater cleaning robot, robot supply; signal relay and cable manager by the underwater cleaning robot central processor via the motor drive control retractable cable retractable cable Motor execution; signal relay and signal repeater cable Manager Implementation and control signal floats antenna connection, and sends the data to the robot; signal relay and cable management within the cable manager includes a retractable cable with encoder motors, the robot central processor control, retractable cable function. Energy cables include internal signal and control signal lines, power line density cables is less than the density of water, can be equipped with heavy-assembled cables through the ring to change its density, to adjust the suspension in the water. Cable counterweight ring high density polymer material, and the cable tightly interlocking, installation position can be adjusted. Said control signal floats antenna includes a control signal antenna and floats vector density is much lower than water, floats on water, and control of the keyboard for wireless communications, can drift antenna cable directly

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to the robot remote control signal interface communication via the control signal float can also be installed fixed to the signal relay and cable manager, and then through the cable signal and energy indirect communication with the robot. Signal repeater and cable manager can add a display device, for displaying underwater cleaning robot work status and related performance indicators. A cable guide pulley frame when the robot work with cable, attached to the shore around the corner, including the fixed pulley, fixed pulley seat rotation shaft, to realize their own fixed pulley and fixed pulley rotation means about a rotation axis fixed pulley seat.

[0008] The present invention provides an underwater cleaning robot of its operating modes include manual cleaning and self-cleaning. The manual mode, the control signal generated by the control keyboard manual operation, directly or indirectly controlled by a control signal underwater cleaning robot float antenna. The autonomous mode, the control signal from the central processor based on the information environment sensing layer itself pose an alignment layer, combined with pre-set cleaning tasks autonomously planned path and action, driving the robot to perform layer, complete underwater cleaning task.Long global cleaning, use a robot to work with cable, using the signal relay and cable management, and energy and signal cables; when short-term local clean robot uses a battery-powered box, without the use of signal repeater and cable management and signal and energy cables, using a control signal and the control signal antenna floats floats antenna cable, working time is relatively short.

[0009] The present invention provides an underwater cleaning robot to complete the process of cleaning tasks as follows:

[0010] underwater cleaning robot control command issued by the central processor to control the robot movements.Drainage mechanism, propeller speed DC motor driven drain drainage propeller rotation in accordance with the set speed, the water flow passage robot is discharged in its motor drive control, the internal flow channel to form a high vacuum, the water from the bottom of the robot into the suction outlet flow channel, through water filters filter the water under the debris, the clean water is discharged. Meanwhile, drain the propeller speed DC motor drive through the motor speed and current monitoring, you can determine the density of the dirt in the water channel, when the dirt reaches a certain density, issued a dirt full alert. Drain driven by servo motor drive control, drive shaft along a drain drain drain bracket around the slide groove rotated to change the direction of drain. Intake above the backflow device installed, when the water and the inlet into, because the force of water, backflow prevention device is opened, the water flow is stopped when entering the water backflow device due to the force of the disappearance off, it can prevent the flow channel efflux debris. Cleaning and mobile platforms, four independent wheels clean by motor drive control, can achieve independence movement, by using different combinations of wheel speed to achieve the robot forward, backward, turning and brushing cleaning tasks. When the robot to perform cleaning tasks with cable underwater robot use inertial navigation components and cleaning wheels using dead reckoning, to give the robot position information, according to the actual needs of the length of the retractable signal turn is controlled by the central processor and retractable cable Motor energy cables. According to the pool depth and the actual needs,

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select the appropriate location to install the cable counterweight ring, adjust the cable in water suspension. Signal repeater and cable manager from the cable guide pulley frame is retractable cable guide. When the robot to perform tasks underwater off the cable, antenna control signal floats drift antenna cable with the robot via a control signal floating, receive remote control signals to control robot motion. In the autonomous cleaning process, set the pool cleanliness image thresholding, robot use surveillance cameras pool bottom picture, by the cleanliness of the threshold value comparison and to determine the bottom of the pool, clean motion planning, complete cleaning tasks.

[0011] The present invention provides human underwater cleaner wherein the force due to the negative pressure, and high water drainage passage robot body, the robot can adhere to the wall surface of the pool cleaning vertical, upright adherent Robot travel movements.

[0012] The present invention provides an underwater cleaning robot characterized in that the outlet can be due to the movement along the slide groove outlet, the robot can travel, clean, and the vertical steering adherent travels have an effect.A plurality of drain outfall along the slide groove coordinate movement or location, change the direction of the drainage outfall on the motion of the robot have different forces. When the robot is floating in the water, you can adjust the direction of the two outfall drainage and drainage intensity, adjust the robot posture in the water to help the robot correct posture. Particularly when wall-climbing robots in the process, due to factors such as the pool steps might chassis top, making four clean driving wheel robot fails, then rely on the driver to adjust the drain position to the robot so that it Back to normal working condition.

[0013] The beneficial effects of the present invention are: low weight, high capacity, motor dexterity lightweight, has a compact mechanical structure is reasonable, intelligent, practical, stability, energy efficiency, economy and versatility of good features, can help as well instead of doing complete autonomy underwater cleaning.

Brief Description

[0014] Figure 1 - a schematic view of the whole of underwater cleaning robot, wherein: the outer shell robot 1-, 2- surveillance cameras, 3- clean the drive wheel, drive belt 4-, 5- belt gear;

[0015] Figure 2 - underwater cleaning robot drive control schematic sealed box, where: 6-drive control sealed box, 7 clean drive wheel motor, control system box 8-, 9- drain sliding groove;

[0016] Figure 3 - Schematic of drain underwater cleaning robots, including: 10-drain, 11 drainage propeller, 12 drain bracket, 13 drain holder, 14 drainage propeller speed DC motor, 15 drainage propeller bracket, 16-drain drive steering, 17-drain of the drive shaft;

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[0017] Figure 4 - underwater cleaning robot cleaner and mobile platforms schematic, wherein: 18- robot on the cover, the main housing robot 19-, 20-robot side walls, 21 clean driving wheel side of the bracket, and the 22 clean drive Wheel center bracket;

[0018] Figure 5 - underwater cleaning robot side cross-sectional view in which: 23- water filter, 24- water channel, 25-backflow device, and the 26 intake;

[0019] Figure 6 - underwater cleaning robot control system diagram.

[0020] Figure 7 - tethered underwater cleaning robot working schematic, wherein: 27- control signal floats antenna, 28- signal relay and cable manager, and the 29 cable manager, 30- management bracket, 31- Control Keyboard and the 32 cable guide pulley frame, 33- signal and energy cables, 34- cable counterweight ring.

[0021] Figure 8 - underwater cleaning robot off the cable working schematic, wherein: 35- control signal float antenna cable.DETAILED DESCRIPTION

[0022] below in conjunction with the accompanying drawings and the embodiment of the present invention will be further described below.

[0023] Example

[0024] The underwater cleaning robot of the present invention comprises a drainage means, clean and mobile platforms and control systems. 1, 2, 3, 4, 5, 6, 7, and FIG, said drain means comprises a drain 8, the drive control robot sealing box formed with the housing inner wall flow channel pair, water filter 23 and inlet and backflow prevention device 25. 10 includes a drain outlet, drain propeller 11, outlet frame 12, drain holder 13, the bracket 15 and the drain outlet propeller shaft 17.Underwater cleaning robot you can install multiple independent drainage, drainage coordinating movement. Drainage outfall drain 10 of the drive shaft 17 is connected through the bracket 12 and the drain can be rotated around the drive shaft; drainage propeller 11 by the high speed DC motor, with fixed propeller drainage stent 15, also connected to the drain of the drive shaft 17, and drain 10 synchronous rotation around the drive shaft; drain holder 13 and the drive control box at the top of the seal is fixed. M includes a driving control flow channel outer wall and an inner wall of the sealed box robot outer casing of the spatial composition. Water filter 23 is fixed to the water channel M, and the inner wall of the robot body 1 and a drive control seal box will flow channel M into two parts. Inlet 26 and backflow prevention device 25 located underside of the robot main body 19, the anti-backflow device is divided into two parts by a shaft frame fixed cover above the inlet 26 may be rotated about an axis. When the water enters the robot water channel M, the two parts of the anti-backflow device 25 due to the role of water, about an axis of rotation, inlet Shen open; when you stop the water, backflow prevention device 25 to restore the closed state to ensure the flow channel M within The water will not be back. Drainage agency can choose to install one or more drainage, when you select to install multiple drainage, to maintain drainage outfall drainage shaft 17 coaxially. The drainage means to

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clean and mobile platforms for the carrier, coordinated motion and clean with a mobile platform. Cleaning and mobile platform comprises a robot body 1, clean the drive wheels 3, 5 and the drive belt gear belt 4.Characterized in that said robot comprises a robot body 1 housing cover 18, side walls 20 and polymer materials robot robot main housing 19, the housing of the robot using a molding. The cleaning drive wheel 3 includes four independently driven cylindrical hub, the hub according to the outer cleaning tread supporting different materials, four clean a set of two wheels 3, the side wall by a robot and robot main housing Clean the body side bracket 21 wheels, clean the drive wheels of the central support 22 and connected to the robot installation. The timing belt drive gear 5 and the belt 4, two belt gear 5 and a drive belt 4 for a group, attached to the main housing 19 between the robot and the robot-side panel sidewall 20, wherein a timing belt gear 5 and 7 is connected to a DC motor drive, another belt gear 5 with a clean driving wheel 3, and the two belt gear 5 by the drive transmission belt 4. Control system includes a central processor, surveillance cameras, frame grabbers, inertial navigation device, remote control signal interface, the motor drive control system box 8, clean the drive wheels DC motor 7, drain drive servo 16, drainage propeller speed DC motor 14 The drive control sealed box and the control and energy management systems. Enter the portion of the central processor chip and image acquisition card, inertial navigation device and a remote control signal interface including the control system; the central processor chip and the motor drive control system constitutes the output section. Motor drive and clean the drive wheels 7 constitutes a clean DC motor drive control system of execution layer; motor drive servo drive and the outlet drain 16 constitute 10 rotates execution layer; a motor drive and drainage propeller speed DC motor 14 constitute 11 propeller-driven execution layer. The surveillance camera mounted on the robot main body 2 two front panel 19, surveillance cameras and frame grabber 2 constitute a control system environment sensing layer. The inertial navigation components mounted on the robot control system box 8 constitute a control system itself posture alignment layer. Control system box 8 will include a central processor, image acquisition card, inertial navigation device, a remote control signal interface, power management module, motor drive control system package, both the power input interface and rechargeable battery box, by an external power supply robots, also can in a short time from the battery pack to power the robot, the control system is fixed to the drive control box at the bottom of the seal tank. The power management module is used to steady flow and monitor the robot overcurrent circuit overload protection robot control system. Cleaning said DC motor drive wheel 7, gear box fitted with the encoder, the front mounting flange 19 is fixed to the drive control box side wall and the side wall sealing robot main housing, 3 drive wheels clean. Drain servo drive 16, fixed to the bracket 12 fixed drain, drain driver 10 and the drain 17 of the drive shaft holder 12 is rotated around the outlet. Drainage propeller speed DC motor 14, mounting bracket 15 is fixed to the drain of the propeller, the propeller 11 is rotated driving the drain. Clean the drive wheel DC motor 7, drainage propeller speed DC motor 14 is equipped with an encoder, it can achieve its motor drive servo motor control. The drive control sealed box, including sealed box casing cover and the main box, sealed box enclosure lid includes waterproof outfall slide groove 9; drive control box by sealing both ends of the side wall of the main housing 19 mounted robot polymer material is fixed to the main housing 19 inside the robot, will include a control system box 8, clean the drive wheels DC motor 7, drain drive servo 16, a control system section of drainage propeller speed DC motor 14 sealed package, using a molding with water features. Control and energy

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management system includes a control signal antenna 27 floats, floats antenna control signal cable 35, the signal relay and cable manager concept, signal and energy cable 33, cable 32 and cable guide pulley frame counterweight ring 34.Signal repeater and cable manager concept includes a signal repeaters, cable managers IV bracket 30 through the management and fixed ground pool deck, the control signal float 27 is connected to the antenna mounting signal repeater and antenna interface cable manager concept, receiving a control signal controlling the keyboard 31, via the signal relayed by the signal and energy transmission cable 33 to underwater cleaning robot remote control signal interface; signal relay and cable manager 28 is equipped with an external AC power supply and AC to DC transformer means Power and energy input connector signal cable 33 through underwater cleaning robot, robot supply; signal relay and cable manager View underwater cleaning robot by the central processor via the motor drive control retractable cable retractable cable Motor execution ; signal relay and cable manager Concept Implementation and control signal repeater signal floats antenna connection, and sends the data to the robot; signal relay and cable manager View fourth inner cable manager includes a retractable cable with encoder motor, the robot central processor control, retractable cable function. And energy in the signal cable 33 includes a control signal line, the density of the power cord, the cable is less than the density of water, can be equipped with heavy-assembled cables through the ring 34 changes its density, to adjust the suspension in the water. Cable counterweight ring 34 is a high-density polymer material, and the cable tightly interlocking, installation position can be adjusted. Control signal float antenna 27 includes a control signal antenna and floats vector density is much lower than water, floats on water, and control of the keyboard 31 wireless communication, can drift antenna cable 35 directly to the robot remote control signal interface communication via the control signal float can also be installed fixed to the signal relay and the cable manager 28, and then through the signal and energy cable 33 indirect communication with the robot. Signal repeater and cable manager View external display device can display the working status of underwater cleaning robots and related performance indicators. Cable guide pulley frame 32 when the robot work with cable shaft rotatably mounted on the shore around the corner, including the fixed pulley, fixed pulley seat rotation axis, rotation and achieve their own fixed pulley fixed pulley means to rotate around a fixed pulley seat.

[0025] The present invention provides an underwater cleaning robot of its operating modes include manual cleaning and self-cleaning. The manual mode, the control signal generated by the control keyboard manual operation, directly or indirectly controlled by a control signal underwater cleaning robot float antenna. The autonomous mode, the control signal from the central processor based on the information environment sensing layer itself pose an alignment layer, combined with pre-set cleaning tasks autonomously planned path and action, driving the robot to perform layer, complete underwater cleaning task.Long global cleaning, use a robot to work with cable, using the signal relay and cable managers and energy outlook and signal cable 33; short partial cleaning, the robot uses a battery-powered box, without the use of signal repeater and cable manager View the signal and energy cable 33, using a control signal antenna 27 floats and float control signal antenna cable 35, a relatively short time.

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[0026] The present invention provides an underwater cleaning robot to complete the process of cleaning tasks as: underwater cleaning robot control command issued by the central processor to control the robot movements. Drainage mechanism, drainage propeller speed DC motor 14 driven by the motor drives in its controlled drainage in accordance with the set speed of rotation of the propeller 11, the water flow channel M robot is discharged, the internal flow channel to form a high vacuum, the bottom of the robot water inlet from the suction flow passage right, through water filter 23 filters the water under the debris, the clean water is discharged. Meanwhile, drain the propeller speed DC motor drive through the motor speed and current monitoring, can determine within the flow channel M soil density, when the soil reaches a certain density, issued a dirt full alert. Drain 16 by driving the servo motor drive control, driving drain drain bracket 12 about the drive shaft 17 to slide along the drain groove 9 is rotated to change the direction of drain. Intake Shen installed above backflow device 25, when the water and the inlet into, due to the force of water, backflow prevention device 25 is opened, the water flow is stopped when entering backflow prevention device 25 due to the force of the water disappear and shut down, You can prevent the outflow of water channel M within debris. Cleaning and mobile platforms, four independent wheels 3 by a cleaning drive motor control, can achieve independence movement, by using different combinations of wheel speed to achieve the robot forward, backward, turning and brushing cleaning tasks. When the robot to perform cleaning tasks with cable underwater robot use inertial navigation device and clean the drive wheels 3 dead reckoning, to give the robot position information, according to the actual needs of the length of the retractable signal turn is controlled by the central processor retractable cable Motor and energy cable 33. According to the pool depth and the actual needs, select the appropriate location to install the cable counterweight ring 34, adjust the cable in water suspension. Signal repeater and cable manager View from the cable guide pulley frame 32 is retractable cable guide. When the robot off underwater cable in mission control signal antenna 27 floats drift antenna cable 35 is connected by a control signal floating robot, receive remote control signals to control robot motion. In the autonomous cleaning process, set the pool cleanliness image thresholding, robot use surveillance cameras to shoot pool bottom two pictures by the cleanliness of the threshold value to determine the bottom of the pool, clean motion planning, thereby regulating the four clean drive 3 wheel and drainage work state, complete cleaning tasks. Specific speed can be adjusted for each wheel 3, wheel speeds through different combinations, to achieve different strength cleaning action, e.g., the front wheel rotating clockwise fast, slow counterclockwise rotation of the rear wheel, the front wheel along the underwater cleaning robot is clockwise rotation of the determined direction of the road, but this time efforts to clean than the clockwise rotation of the rear wheel to be much larger. At the same time, to adjust the position of the direction of the drain outlet 10 and drain 11 of the propeller speed, can change the intensity of the cleaning, the robot so that a higher efficiency. For cleaning vertical wall to be using the same control strategy. The present invention provides an underwater cleaner who by the force of high vacuum and drainage channel M flowing water bodies within the robot, the robot can adhere to the pool for cleaning vertical wall, vertical robot can travel adherent action. The present invention provides an underwater cleaning robot since the drain outlet 10 can slide along the groove 9 motion, the robot can travel, clean, and the vertical steering adherent travels have an effect. A plurality of drain outlet 10 along the coordinate movement or positioning slide groove 9, changing the direction of the drain outlet 10, the movement of the robot have

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different forces. When the robot is floating in the water, you can adjust the intensity of the two drainage directions and drainage outfall 10, regulating the robot posture in the water to help the robot correct posture. Particularly when wall-climbing robots in the process, due to factors such as the pool steps might chassis top, making four cleaning robot wheels 3 fails, then rely on the driver to adjust the drain position to the robot, so its back to normal working condition. Underwater cleaning robot inertial navigation element itself mounted wheels 3 and 4 clean encoder guarantee by dead reckoning navigation autonomous underwater cleaning robot operation. When finished cleaning tasks, open the top cover 18 and the robot water filter 23, and then on the underwater cleaning robot for cleaning the water channel M can.

[0027] The present invention is not limited to this instance, any use of the design design ideas, make some simple changes in design should be entered within the scope of the invention.

PATENT CITATIONS

Cited Patent	Filing date	Publication date	Applicant	Title
CN101003300A	Jan 19, 2007	Jul 25, 2007	哈尔滨工程大学	Turning, rotating propeller of underwater robot with six degrees of freedom
GB2181040A				*Title not available*
JPH08318229A				*Title not available*
WO1984003869A1	Apr 5, 1984	Oct 11, 1984	John Cameron Robertson	Remotely-operable vehicles for use in the cleaning and inspection of marine contact surfaces

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Sep 18, 2013	C17	Cessation of patent right	

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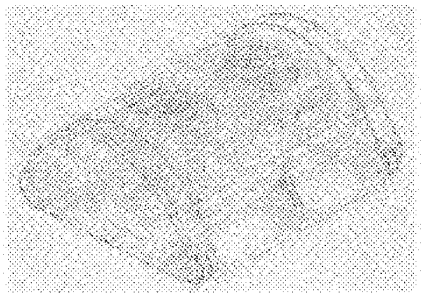
权利要求书 5 页 说明书 10 页 附图 4 页

[54] 发明名称

水下清洁机器人

[57] 摘要

本发明公开了一种水下清洁机器人，所述的机器人可以在遥控和自主控制两种工作模式下进行工作，包括排水机构、清洁与移动平台以及控系统。通过排水机构、清洁与移动平台以及控制系统的配合分工，可实现机器人在水下、水平面、垂直面以及倾斜面自主或遥控地进行清洁工作。本发明具有重量小、容量大，具有机械结构紧凑合理，实用性、稳定性、节能性、经济性和通用性好等特点，是一种可以用于游泳池池底和池壁水下清洁的机器人。



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1．一种水下清洁机器人， 其特征在于：它是由排水机构、清洁与移动平台及控制系统组成；排水机构包括排水器、驱动控制密封箱与机器人外壳内壁形成的流水通道（24）、流水过滤网（23）以及进水口与防倒流装置（25）；清洁与移动平台包括机器人外壳体（1）、清洁驱动轮（3）、同步带齿轮（5）与驱动同步带（4）；控制系统包括中心处理器、监控摄像机、图像采集卡、惯性导航元件、遥控信号接口、电机驱动器、控制系统盒（8）、清洁驱动轮直流电机（7）、排水口驱动舵机（16）、排水螺旋桨高速直流电机（14）、驱动控制密封箱以及控制及能源管理系统。

2．根据权利要求 1 所述的一种水下清洁机器人，其特征在于：所述的水下清洁机器人可安装多个独立的排水器，协调各排水器运动；排水口固定架（13）与驱动控制密封箱顶部固定；所述的流水通道（24）包括驱动控制密封箱外壁与机器人外壳体（1）内壁所构成空间；所述的流水过滤网（23）固定于流水通道（24），与机器人外壳体（1）内壁以及驱动控制密封箱将流水通道（24）分成两个部分；所述的进水口（26）与防倒流装置（25），位于机器人主壳体（20）底面，防倒流装置（25）分为两个部分，通过轴架固定，覆盖于进水口（26）上方，可以围绕轴转动；当水进入机器人流水通道（24）时，防倒流装置（25）的两个部分由于水流的作用，绕轴旋转，进水口（26）打开；当停止进水时，防倒流装置（25）恢复闭合状态，保证流水通道（24）内的水不会倒流。

3．根据权利要求 1 所述的一种水下清洁机器人，其特征在于：排水机构以清洁与移动平台为载体，与清洁与移动平台协调运动；清洁与移动平台包括机器人外壳体（1）、清洁驱动轮（3）、同步带齿轮（5）与驱动同步带（4）；机器人外壳体（1）包括机器人上顶盖（18）、机器人侧壁（20）以及机器人主壳体（19），机器人的壳体使用一次成型的高分子材料；清洁驱动轮（3）包括四个独立驱动的圆柱形轮毂，轮毂外层可根据清洁需要配套不同材料的轮面，四个清洁驱动轮（3）两个一组，通过机器人侧壁以及机器人主壳体的清洁驱动轮侧支架（21）、清洁驱动轮中心支架（22）与机器人安装连接；同步带齿轮（5）与驱动同步带（4），两个同步带齿轮（5）与一条驱动同步带（4）为一组，安装于机器人主壳体（19）侧面板与机器人侧壁（20）之间，其中一个同步带齿轮（5）与一个驱动直流电机（7）连接，另一同步带齿轮（5）与一个清洁驱动轮（3）连接，这两个同步带齿轮（5）由驱动同步带（4）进行传动。

4．根据权利要求 1 所述的一种水下清洁机器人，其特征在于：所述的控制系统包括中心处理器、监控摄像机、图像采集卡、惯性导航元件、遥控信号接

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口、电机驱动器、控制系统盒（8）、清洁驱动轮直流电机（7）、排水口驱动舵机（16）、排水螺旋桨高速直流电机（14）、驱动控制密封箱以及控制及能源管理系统；所述的中心处理器芯片与图像采集卡、惯性导航元件以及遥控信号接口构成控制系统的输入部分；中心处理器芯片与电机驱动器构成控制系统的输出部分；所述的电机驱动器与清洁驱动轮直流电机（7）构成了控制系统的清洁驱动执行层；电机驱动器与排水口驱动舵机（16）构成排水口（10）转动执行层；电机驱动器与排水螺旋桨高速直流电机（14）构成螺旋桨（11）驱动执行层；所述的监控摄像机（2）安装于机器人主壳体（19）的两个正面板上，监控摄像机（2）与图像采集卡构成控制系统环境感知层；所述的惯性导航元件安装于机器人控制系统盒（8）构成控制系统自身姿态定位层；所述的控制系统盒（8）将包括中心处理器、图像采集卡、惯性导航元件、遥控信号接口、电源管理模块、电机驱动器的控制系统封装，兼有电源输入接口与可充电电池盒，可由机器人外部供电，也可短时间内由电池盒为机器人供电，控制系统盒固定于驱动控制密封箱的底部；所述的电源管理模块用于稳压稳流以及监控机器人电路的过流过载，保护机器人控制系统；所述的清洁驱动轮直流电机（7），装配有减速箱与编码器，通过前法兰安装固定于驱动控制密封箱侧壁与机器人主壳体（19）侧壁，驱动清洁驱动轮（3）；所述的排水口驱动舵机（16），安装固定于排水口固定支架（12），驱动排水口（10）及排水口支架（12）围绕排水口驱动轴（17）转动；所述的排水螺旋桨高速直流电机（14），安装固定于排水螺旋桨支架（15），驱动排水螺旋桨（11）转动；所述的清洁驱动轮直流电机（7）、排水螺旋桨高速直流电机（14）都配有编码器，可以与其电机驱动器实现电机伺服控制；所述的驱动控制密封箱，包括密封箱箱体上盖以及主箱体，密封箱箱体上盖包括有防水功能的排水口滑动槽（9）；驱动控制密封箱通过机器人主壳体（19）的两端侧壁安装固定于机器人主壳体（19）内部，将包括控制系统盒（8）、清洁驱动轮直流电机（7）、排水口驱动舵机（16）、排水螺旋桨高速直流电机（14）的控制系统部分密闭封装，使用一次成型的高分子材料，具有防水特性；所述的控制及能源管理系统包括控制信号浮漂天线（27）、控制信号浮漂天线电缆（35）、信号中继及电缆管理器（28）、信号及能源电缆（33）、电缆导向滑轮架（32）以及电缆配重环（34）；所述的信号中继及电缆管理器（28）包括信号中继器、电缆管理器（29），通过管理器支架（30）与池岸地面固定，将控制信号浮漂天线安装（27）连接于信号中继及电缆管理器（28）天线接口，接收控制键盘（31）的控制信号，经过信号中继，由信号及能源电缆（33）传

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输给水下清洁机器人的遥控信号接口；信号中继及电缆管理器（28）配有外接交流电源以及交流到直流变压装置，通过信号及能源电缆（33）与水下清洁机器人的电源输入接口连接，为机器人供电；信号中继及电缆管理器（28）由水下清洁机器人中心处理器通过电机驱动器控制收放电缆电机执行电缆的收放；信号中继及电缆管理器（28）的信号中继器实现与控制信号浮漂天线连接，并发送数据给机器人；信号中继及电缆管理器（28）的电缆管理器（29）内包括带编码器的电缆收放电机，由机器人中心处理器控制，实现电缆收放功能；信号及能源电缆（33）内包括控制信号线、电源线，电缆的密度小于水的密度，可通过装配电缆配重环（34）改变其密度，以调节其在水中的悬浮状态；电缆配重环（34）为高密度高分子材料，与电缆紧密相扣，安装位置可以调节；所述的控制信号浮漂天线（27）包括控制信号天线与浮漂载体，其密度远小于水，漂浮于水面，与控制键盘（31）进行无线通讯，可通过控制信号浮漂天线电缆（35）直接与机器人遥控信号接口通讯，也可以安装固定于信号中继及电缆管理器（28），再通过信号及能源电缆（33）间接与机器人通讯；信号中继及电缆管理器（28）可以外接显示设备，显示水下清洁机器人工作状态及相关性能指标；所述的电缆导向滑轮架（32）当机器人带缆工作时，安装于岸边拐角处，包括定滑轮、定滑轮座转动轴，实现定滑轮自身转动以及定滑轮装置绕定滑轮座转动轴转动。

5．根据权利要求 1 所述的一种水下清洁机器人，其特征在于：工作模式包括手动清洁与自主清洁；所述的手动模式，其控制信号由控制键盘人工操作发出，通过控制信号浮漂天线直接或者间接地控制水下清洁机器人；所述的自主模式，其控制信号由中央处理器根据环境感知层与自身位姿定位层的信息，结合预先设定的清洁任务，自主地规划路径与动作，驱动机器人执行层，完成水下清洁任务；长时间全局清洁时，采用机器人带缆工作，使用信号中继及电缆管理器（28）与信号及能源电缆（33）；短时间局部清洁时，机器人使用电池盒供电，不使用信号中继及电缆管理器（28）与信号及能源电缆（33），使用控制信号浮漂天线（27）及控制信号浮漂天线电缆（35），工作时间相对较短。

6．根据权利要求 1 所述的一种水下清洁机器人，其特征在于：水下清洁机器人根据中央处理器发出的控制指令控制机器人动作；排水机构中，排水螺旋桨高速直流电机（14）在其电机驱动器的控制下带动排水螺旋桨（11）按照设定转速旋转，将机器人流水通道（24）内的水排出，使流水通道内部形成高负压，将机器人底部的池水从进水口吸入流水通道（24），经过流水过滤网（23）

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过滤下水流中的杂物，将清洁的水排出；同时，排水螺旋桨高速直流电机驱动器通过对电机转速及电流的监控，可以判断流水通道（24）内污物的密度，当污物达到一定密度时，发出污物已满警报；排水口驱动舵机（16）由其电机驱动器控制，带动排水口支架（12）围绕排水口驱动轴（17）沿排水口滑动槽（9）转动，改变排水方向；进水口（26）上面安装有防倒流装置（25），当水流又进水口进入时，由于水的作用力，防倒流装置（25）打开，当水流停止进入时，防倒流装置（25）由于水的作用力消失而关闭，可以防止流水通道（24）内杂物的流出；清洁与移动平台中，4 个独立的清洁驱动轮（3）由其电机驱动器控制，可以实现独立的运动，通过使用不同的轮速组合实现机器人的前进、后退、转弯以及刷洗清洁的任务。

7. 根据权利要求 1 所述的一种水下清洁机器人，其特征在于：当机器人带缆在水下执行清洁任务时，机器人利用惯性导航元件与清洁驱动轮（3）进行航位推算，得到机器人位置信息，进而由中心处理器控制收放电缆电机根据实际长度需要而收放信号及能源电缆（33）；根据游泳池深度与实际需要，选择合适位置安装电缆配重环（34），调节电缆在水中的悬浮状态；信号中继及电缆管理器（28）由电缆导向滑轮架（32）为电缆收放导向；当机器人脱缆在水下执行任务时，控制信号浮漂天线（27）通过控制信号浮漂天线电缆（35）与机器人连接，接收遥控信号，控制机器人运动；在自主清洁的过程中，设定游泳池清洁度图像阈值，机器人利用监控摄像机（2）拍摄游泳池池底图片，通过与阈值比较来判断游泳池池底的清洁程度，进行清洁运动规划，进而调节四个清洁驱动轮 3 和排水器的工作状态，完成清洁任务；同时，调整排水口（10）的排水位置方向以及排水螺旋桨（11）的转速，改变清洁力度，使机器人的工作效率更高；对于竖直池壁的清洁，也可以使用相同的控制策略。

8. 根据权利要求 1 所述的一种水下清洁机器人，其特征在于：机器人流水通道（24）内的高负压以及排水机构的作用力，使机器人黏附在游泳池竖直壁面上进行清洗，实现机器人竖直贴壁行进动作。

9. 根据权利要求 1 所述的一种水下清洁机器人，其特征在于：排水口（10）可以沿排水口滑动槽（9）运动，对机器人的行进、清洁、转向以及竖直贴壁行进产生作用；多个排水口（10）协调沿排水口滑动槽（9）运动或定位，改变排水口（10）排水方向，对机器人的运动产生不同的作用力；机器人在水中处于漂浮状态时，通过调整两个排水口（10）的排水方向与排水力度，可调节机器人在水中的姿态；当机器人在爬壁的过程中，由于游泳池台阶等因素的影响，

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可能会底盘顶起，使机器人的 4 个清洁驱动轮（3）失效，这时调整排水口位置给机器人推动力，使其回到正常工作的状态中。

10. 根据权利要求 1 所述的一种水下清洁机器人，其特征在于：完成清洁任务后，打开机器人上顶盖（18）以及流水过滤网（23），对水下清洁机器人流水通道（24）可进行清洗。

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水下清洁机器人

技术领域

本发明涉及一种机器人，特别用于水下环境的清洁，具有自主移动功能可以通过遥控或自主控制用于水下水平面、垂直面以及倾斜面清洁，能够代替人自主完成水下清洁工作的水下清洁机器人。

背景技术

游泳这项运动已有几千年的历史，随着现代生活节奏的加快和生活水平的提高，游泳已成为人们强身健体、休闲娱乐的重要运动形式。游泳池的清洁卫生状况直接关系到游泳者的运动状态和运动效果，因此，保持游泳池池水与池壁的清洁卫生是至关重要的。游泳池的清洁方式会根据游泳池的形式和规模而改变，就目前来看，无论是人工清洁，还是自动水循环，都在水资源或其它能源利用以及劳动力使用上存在着巨大的浪费或者冗余，造成游泳池维护成本提高，而且还直接增加了游泳者的游泳运动费用，因此，需要一种自动水下清洁装置来解决这一问题。

发明内容

本发明的目的在于提出了一种能够灵活机动、经济节能、多种工作模式的水下机器人，从而更好地完成水下清洁工作。

本发明是一种水下清洁机器人，包括排水机构、清洁与移动平台以及控制系统。

本发明所述的排水机构包括排水器、驱动控制密封箱与机器人外壳内壁形成的流水通道、流水过滤网以及进水口与防倒流装置。排水器包括排水口、排水螺旋桨、排水口支架、排水口固定架、排水螺旋桨支架以及排水口驱动轴。排水器的排水口安装固定于排水口支架，并通过排水口支架与排水口驱动轴连接，可以围绕驱动轴转动；排水螺旋桨由高速直流电机驱动，一同固定于排水螺旋桨支架，亦与排水口驱动轴连接，与排水口同步围绕驱动轴转动；排水口固定架与排水口支架以及排水螺旋桨支架共同由排水口驱动轴连接，可绕其旋转，排水口固定架与驱动控制密封箱顶部固定。所述的流水通道包括驱动控制密封箱外壁与机器人外壳内壁所构成空间。所述的流水过滤网固定于流水通道，与

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机器人外壳内壁以及驱动控制密封箱将流水通道分成两个部分。所述的进水口与防倒流装置，位于机器人底壳体底面，包括进水口以及防倒流装置，防倒流装置分为两个部分，通过轴架固定，覆盖于进水口上方，可以围绕轴转动。排水机构可选择安装一个或多个排水器，当选择安装多个排水器时，要保持排水器排水器的排水驱动轴同轴。

本发明所述的清洁与移动平台包括机器人外壳体、清洁驱动轮、同步带齿轮与驱动同步带。 机器人外壳体包括机器人上顶盖、机器人侧壁以及机器人主壳体，机器人的壳体使用一次成型的高分子材料。 清洁驱动轮包括四个独立驱动的圆柱形轮毂，轮毂外层可根据清洁需要配套不同材料的轮面，四个清洁驱动轮两个一组，通过机器人侧壁以及机器人主壳体的清洁驱动轮侧支架、中心支架与机器人安装连接。 同步带齿轮与驱动同步带，两个同步带齿轮与一条驱动同步带为一组，安装于机器人主壳体侧面板与机器人侧壁之间，其中一个同步带齿轮与一个驱动直流电机连接，另一同步带齿轮与一个清洁驱动轮连接，这两个同步带齿轮由驱动同步带进行传动。

本发明所述的控制系统包括中心处理器、监控摄像机、图像采集卡、惯性导航元件、遥控信号接口、电源管理模块、电机驱动器、控制系统盒、清洁驱动轮直流电机、排水口驱动舵机、排水螺旋桨高速直流电机、驱动控制密封箱以及控制及能源管理系统。其特征在于所述的中心处理器芯片与图像采集卡、惯性导航元件以及遥控信号接口构成控制系统的输入部分；中心处理器芯片与电机驱动器构成控制系统的输出部分。所述的电机驱动器与清洁驱动轮直流电机构成了控制系统的清洁驱动执行层；电机驱动器与排水口驱动舵机构成排水口转动执行层；电机驱动器与排水螺旋桨高速直流电机构成螺旋桨驱动执行层。所述的监控摄像机安装于机器人主壳体的两个正面板上，监控摄像机与图像采集卡构成控制系统环境感知层。所述的惯性导航元件安装于机器人驱动控制密封箱，构成控制系统自身姿态定位层。所述的控制系统盒将包括中心处理器、图像采集卡、惯性导航元件、遥控信号接口、电源管理模块、电机驱动器的控制系统封装，兼有电源输入接口与可充电电池盒，可由机器人外部供电，也可短时间内由电池盒为机器人供电，控制系统盒固定于驱动控制密封箱的底部。所述的电源管理模块用于稳压稳流以及监控机器人电路的过流过载，保护机器人控制系统。所述的清洁驱动轮直流电机，装配有减速箱与编码器，通过前法兰安装固定于驱动控制密封箱侧壁与机器人主壳体侧壁，通过同步带齿轮与同

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步带，驱动清洁驱动轮。所述的排水口驱动舵机，安装固定于排水口固定架，驱动排水口支架以及排水螺旋桨支架围绕排水口驱动轴转动。所述的排水螺旋桨高速直流电机，安装固定于排水螺旋桨支架，驱动排水螺旋桨转动。所述的清洁驱动轮直流电机、排水螺旋桨高速直流电机都配有编码器，可以与其电机驱动器实现电机伺服控制。所述的驱动控制密封箱，包括密封箱箱体上盖以及主箱体，密封箱箱体上盖包括有防水功能的排水口滑动槽；驱动控制密封箱通过机器人主壳体的两端侧壁安装固定于机器人主壳体内部，将包括控制系统盒、清洁驱动轮直流电机、排水口驱动舵机、排水螺旋桨高速直流电机的控制系统部分密闭封装，使用一次成型的高分子材料，具有防水特性。所述的控制及能源管理系统包括控制信号浮漂天线、控制信号浮漂天线电缆、信号中继及电缆管理器、信号及能源电缆、电缆导向滑轮架以及电缆配重环。其特征在于所述的信号中继及电缆管理器包括信号中继器、电缆管理器，通过管理器支架与池岸地面固定，将控制信号浮漂天线安装连接于信号中继及电缆管理器天线接口，接收控制键盘的控制信号，经过信号中继，由信号及能源电缆传输给水下清洁机器人的遥控信号接口；信号中继及电缆管理器配有外接交流电源以及交流到直流变压装置，通过信号及能源电缆与水下清洁机器人的电源输入接口连接，为机器人供电；信号中继及电缆管理器由水下清洁机器人中心处理器通过电机驱动器控制收放电缆电机执行电缆的收放；信号中继及电缆管理器的信号中继器实现与控制信号浮漂天线连接，并发送数据给机器人；信号中继及电缆管理器的电缆管理器内包括带编码器的电缆收放电机，由机器人中心处理器控制，实现电缆收放功能。信号及能源电缆内包括控制信号线、电源线，电缆的密度小于水的密度，可通过装配电缆配重环改变其密度，以调节其在水中的悬浮状态。电缆配重环为高密度高分子材料，与电缆紧密相扣，安装位置可以调节。所述的控制信号浮漂天线包括控制信号天线与浮漂载体，其密度远小于水，漂浮于水面，与控制键盘进行无线通讯，可通过控制信号浮漂天线电缆直接与机器人遥控信号接口通讯，也可以安装固定于信号中继及电缆管理器，再通过信号及能源电缆间接与机器人通讯。信号中继及电缆管理器可以外接显示设备，显示水下清洁机器人工作状态及相关性能指标。所述的电缆导向滑轮架当机器人带缆工作时，安装于岸边拐角处，包括定滑轮、定滑轮座转动轴，实现定滑轮自身转动以及定滑轮装置绕定滑轮座转动轴转动。

本发明提出的水下清洁机器人其工作模式包括手动清洁与自主清洁。所述

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的手动模式，其控制信号由控制键盘人工操作发出，通过控制信号浮漂天线直接或者间接地控制水下清洁机器人。所述的自主模式，其控制信号由中央处理器根据环境感知层与自身位姿定位层的信息，结合预先设定的清洁任务，自主地规划路径与动作，驱动机器人执行层，完成水下清洁任务。长时间全局清洁时，采用机器人带缆工作，使用信号中继及电缆管理器与信号及能源电缆；短时间局部清洁时，机器人使用电池盒供电，不使用信号中继及电缆管理器与信号及能源电缆，使用控制信号浮漂天线及控制信号浮漂天线电缆，工作时间相对较短。

本发明提出的水下清洁机器人完成清洁任务的过程为：

水下清洁机器人根据中央处理器发出的控制指令控制机器人动作。排水机构中，排水螺旋桨高速直流电机在其电机驱动器的控制下带动排水螺旋桨按照设定转速旋转，将机器人流水通道内的水排出，使流水通道内部形成高负压，将机器人底部的池水从进水口吸入流水通道，经过流水过滤网过滤下水流中的杂物，将清洁的水排出。同时，排水螺旋桨高速直流电机驱动器通过对电机转速及电流的监控，可以判断流水通道内污物的密度，当污物达到一定密度时，发出污物已满警报。排水口驱动舵机由其电机驱动器控制，带动排水口支架围绕排水口驱动轴沿排水口滑动槽转动，改变排水方向。进水口上面安装有防倒流装置，当水流又进水口进入时，由于水的作用力，防倒流装置打开，当水流停止进入时，防倒流装置由于水的作用力消失而关闭，可以防止流水通道内杂物的流出。清洁与移动平台中，4 个独立的清洁驱动轮由其电机驱动器控制，可以实现独立的运动，通过使用不同的轮速组合实现机器人的前进、后退、转弯以及刷洗清洁的任务。当机器人带缆在水下执行清洁任务时，机器人利用惯性导航元件与清洁驱动轮进行航位推算，得到机器人位置信息，进而由中心处理器控制收放电缆电机根据实际长度需要而收放信号及能源电缆。根据游泳池深度与实际需要，选择合适位置安装电缆配重环，调节电缆在水中的悬浮状态。信号中继及电缆管理器由电缆导向滑轮架为电缆收放导向。当机器人脱缆在水下执行任务时，控制信号浮漂天线通过控制信号浮漂天线电缆与机器人连接，接收遥控信号，控制机器人运动。在自主清洁的过程中，设定游泳池清洁度图像阈值，机器人利用监控摄像机拍摄游泳池池底图片，通过与阈值比较来判断游泳池池底的清洁程度，进行清洁运动规划，完成清洁任务。

本发明提出的水下清洁器人其特征在于由于机器人流水通道内的高负压以

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及排水机构的作用力，可使机器人黏附在游泳池竖直壁面上进行清洗，实现机器人竖直贴壁行进动作。

本发明提出的水下清洁机器人其特征在于由于排水口可以沿排水口滑动槽运动，可以对机器人的行进、清洁、转向以及竖直贴壁行进产生作用。多个排水口协调沿排水口滑动槽运动或定位，改变排水口排水方向，对机器人的运动产生不同的作用力。如机器人在水中处于漂浮状态时，可以通过调整两个排水口的排水方向与排水力度，调节机器人在水中的姿态，帮助机器人正确的姿态。特别是当机器人在爬壁的过程中，由于游泳池台阶等因素的影响，可能会底盘顶起，使机器人的 4 个清洁驱动轮失效，这时要靠调整排水口位置给机器人推动力，使其回到正常工作的状态中来。

本发明的有益效果是：重量小、容量大，运动灵巧轻便，具有机械结构紧凑合理，智能性、实用性、稳定性、节能性、经济性和通用性好等特点，能够帮助以及代替人工自主完成水下清洁工作。

附图说明

图 1—水下清洁机器人整体示意图，其中：1—机器人外壳体，2—监控摄像机，3—清洁驱动轮，4—驱动同步带，5—同步带齿轮；

图 2—水下清洁机器人驱动控制密封箱示意图，其中：6—驱动控制密封箱，7—清洁驱动轮直流电机，8—控制系统盒，9—排水口滑动槽；

图 3—水下清洁机器人排水器示意图，其中：10—排水口，11—排水螺旋桨，12—排水口支架，13—排水口固定架，14—排水螺旋桨高速直流电机，15—排水螺旋桨支架，16—排水口驱动舵机，17—排水口驱动轴；

图 4—水下清洁机器人清洁与移动平台示意图，其中：18—机器人上顶盖，19—机器人主壳体，20—机器人侧壁，21—清洁驱动轮侧支架，22—清洁驱动轮中心支架；

图 5—水下清洁机器人侧向剖面图，其中：23—流水过滤网，24—流水通道，25—防倒流装置，26—进水口；

图 6—水下清洁机器人控制系统示意图。

图 7—水下清洁机器人带缆工作示意图，其中：27—控制信号浮漂天线，28—信号中继及电缆管理器，29—电缆管理器，30—管理器支架，31—控制键盘，32—电缆导向滑轮架，33—信号及能源电缆，34—电缆配重环。

图 8—水下清洁机器人脱缆工作示意图，其中：35—控制信号浮漂天线电缆。

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具体实施方式

下面结合附图和实施例对本发明作进一步说明。

实施例

本发明的水下清洁机器人包括排水机构、清洁与移动平台以及控制系统。如图 1、图 2、图 3、图 4、图 5、图 6、图 7 以及图 8 所示，所述的排水机构包括排水器、驱动控制密封箱与机器人外壳内壁形成的流水通道 24、流水过滤网 23 以及进水口与防倒流装置 25。排水器包括排水口 10、排水螺旋桨 11、排水口支架 12、排水口固定架 13、排水螺旋桨支架 15 以及排水口驱动轴 17。水下清洁机器人可安装多个独立的排水器，协调各排水器的运动。排水器排水口 10 通过排水口支架 12 与排水口驱动轴 17 连接，可以围绕驱动轴转动；排水螺旋桨 11 由高速直流电机驱动，一同固定于排水螺旋桨支架 15，亦与排水口驱动轴 17 连接，与排水口 10 同步围绕驱动轴转动；排水口固定架 13 与驱动控制密封箱顶部固定。流水通道 24 包括驱动控制密封箱外壁与机器人外壳体 1 内壁所构成空间。流水过滤网 23 固定于流水通道 24，与机器人外壳体 1 内壁以及驱动控制密封箱将流水通道 24 分成两个部分。进水口 26 与防倒流装置 25，位于机器人主壳体 19 底面，防倒流装置分为两个部分，通过轴架固定，覆盖于进水口 26 上方，可以围绕轴转动。当水进入机器人流水通道 24 时，防倒流装置 25 的两个部分由于水流的作用，绕轴旋转，进水口 26 打开；当停止进水时，防倒流装置 25 恢复闭合状态，保证流水通道 24 内的水不会倒流。排水机构可选择安装一个或多个排水器，当选择安装多个排水器时，要保持排水器排水器的排水口驱动轴 17 同轴。所述的排水机构以清洁与移动平台为载体，与清洁与移动平台协调运动。所述的清洁与移动平台包括机器人外壳体 1、清洁驱动轮 3、同步带齿轮 5 与驱动同步带 4。其特征在于所述的机器人外壳体 1 包括机器人上顶盖 18、机器人侧壁 20 以及机器人主壳体 19，机器人的壳体使用一次成型的高分子材料。所述的清洁驱动轮 3 包括四个独立驱动的圆柱形轮毂，轮毂外层可根据清洁需要配套不同材料的轮面，四个清洁驱动轮 3 两个一组，通过机器人侧壁以及机器人主壳体的清洁驱动轮侧支架 21、清洁驱动轮中心支架 22 与机器人安装连接。所述的同步带齿轮 5 与驱动同步带 4，两个同步带齿轮 5 与一条驱动同步带 4 为一组，安装于机器人主壳体 19 侧面板与机器人侧壁 20 之间，其中一

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个同步带齿轮 5 与一个驱动直流电机 7 连接，另一同步带齿轮 5 与一个清洁驱动轮 3 连接，这两个同步带齿轮 5 由驱动同步带 4 进行传动。控制系统包括中心处理器、监控摄像机、图像采集卡、惯性导航元件、遥控信号接口、电机驱动器、控制系统盒 8、清洁驱动轮直流电机 7、排水口驱动舵机 16、排水螺旋桨高速直流电机 14、驱动控制密封箱以及控制及能源管理系统。中心处理器芯片与图像采集卡、惯性导航元件以及遥控信号接口构成控制系统的输入部分；中心处理器芯片与电机驱动器构成控制系统的输出部分。电机驱动器与清洁驱动轮直流电机 7 构成了控制系统的清洁驱动执行层；电机驱动器与排水口驱动舵机 16 构成排水口 10 转动执行层；电机驱动器与排水螺旋桨高速直流电机 14 构成螺旋桨 11 驱动执行层。所述的监控摄像机 2 安装于机器人主壳体 19 的两个正面板上，监控摄像机 2 与图像采集卡构成控制系统环境感知层。所述的惯性导航元件安装于机器人控制系统盒 8 构成控制系统自身姿态定位层。控制系统盒 8 将包括中心处理器、图像采集卡、惯性导航元件、遥控信号接口、电源管理模块、电机驱动器的控制系统封装，兼有电源输入接口与可充电电池盒，可由机器人外部供电，也可短时间内由电池盒为机器人供电，控制系统盒固定于驱动控制密封箱的底部。所述的电源管理模块用于稳压稳流以及监控机器人电路的过流过载，保护机器人控制系统。所述的清洁驱动轮直流电机 7，装配有减速箱与编码器，通过前法兰安装固定于驱动控制密封箱侧壁与机器人主壳体 19 侧壁，驱动清洁驱动轮 3。排水口驱动舵机 16，安装固定于排水口固定支架 12，驱动排水口 10 及排水口支架 12 围绕排水口驱动轴 17 转动。排水螺旋桨高速直流电机 14，安装固定于排水螺旋桨支架 15，驱动排水螺旋桨 11 转动。清洁驱动轮直流电机 7、排水螺旋桨高速直流电机 14 都配有编码器，可以与其电机驱动器实现电机伺服控制。驱动控制密封箱，包括密封箱箱体上盖以及主箱体，密封箱箱体上盖包括有防水功能的排水口滑动槽 9；驱动控制密封箱通过机器人主壳体 19 的两端侧壁安装固定于机器人主壳体 19 内部，将包括控制系统盒 8、清洁驱动轮直流电机 7、排水口驱动舵机 16、排水螺旋桨高速直流电机 14 的控制系统部分密闭封装，使用一次成型的高分子材料，具有防水特性。控制及能源管理系统包括控制信号浮漂天线 27、控制信号浮漂天线电缆 35、信号中继及电缆管理器 28、信号及能源电缆 33、电缆导向滑轮架 32 以及电缆配重环 34。信号中继及电缆管理器 28 包括信号中继器、电缆管理器 29，通过管理器支架 30 与池岸地面固定，将控制信号浮漂天线安装 27 连接于信号中继及电缆管理器

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28 天线接口，接收控制键盘 31 的控制信号，经过信号中继，由信号及能源电缆 33 传输给水下清洁机器人的遥控信号接口；信号中继及电缆管理器 28 配有外接交流电源以及交流到直流变压装置，通过信号及能源电缆 33 与水下清洁机器人的电源输入接口连接，为机器人供电；信号中继及电缆管理器 28 由水下清洁机器人中心处理器通过电机驱动器控制收放电缆电机执行电缆的收放；信号中继及电缆管理器 28 的信号中继器实现与控制信号浮漂天线连接，并发送数据给机器人；信号中继及电缆管理器 28 的电缆管理器 29 内包括带编码器的电缆收放电机，由机器人中心处理器控制，实现电缆收放功能。信号及能源电缆 33 内包括控制信号线、电源线，电缆的密度小于水的密度，可通过装配电缆配重环 34 改变其密度，以调节其在水中的悬浮状态。电缆配重环 34 为高密度高分子材料，与电缆紧密相扣，安装位置可以调节。控制信号浮漂天线 27 包括控制信号天线与浮漂载体，其密度远小于水，漂浮于水面，与控制键盘 31 进行无线通讯，可通过控制信号浮漂天线电缆 35 直接与机器人遥控信号接口通讯，也可以安装固定于信号中继及电缆管理器 28，再通过信号及能源电缆 33 间接与机器人通讯。信号中继及电缆管理器 28 可以外接显示设备，显示水下清洁机器人工作状态及相关性能指标。电缆导向滑轮架 32 当机器人带缆工作时，安装于岸边拐角处，包括定滑轮、定滑轮座转动轴，实现定滑轮自身转动以及定滑轮装置绕定滑轮座转动轴转动。

本发明提出的水下清洁机器人其工作模式包括手动清洁与自主清洁。所述的手动模式，其控制信号由控制键盘人工操作发出，通过控制信号浮漂天线直接或者间接地控制水下清洁机器人。所述的自主模式，其控制信号由中央处理器根据环境感知层与自身位姿定位层的信息，结合预先设定的清洁任务，自主地规划路径与动作，驱动机器人执行层，完成水下清洁任务。长时间全局清洁时，采用机器人带缆工作，使用信号中继及电缆管理器 28 与信号及能源电缆 33；短时间局部清洁时，机器人使用电池盒供电，不使用信号中继及电缆管理器 28 与信号及能源电缆 33，使用控制信号浮漂天线 27 及控制信号浮漂天线电缆 35，工作时间相对较短。

本发明提出的水下清洁机器人完成清洁任务的过程为：水下清洁机器人根据中央处理器发出的控制指令控制机器人动作。排水机构中，排水螺旋桨高速直流电机 14 在其电机驱动器的控制下带动排水螺旋桨 11 按照设定转速旋转，将机器人流水通道 24 内的水排出，使流水通道内部形成高负压，将机器人底部

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的池水从进水口吸入流水通道 24，经过流水过滤网 23 过滤下水流中的杂物，将清洁的水排出。同时，排水螺旋桨高速直流电机驱动器通过对电机转速及电流的监控，可以判断流水通道 24 内污物的密度，当污物达到一定密度时，发出污物已满警报。排水口驱动舵机 16 由其电机驱动器控制，带动排水口支架 12 围绕排水口驱动轴 17 沿排水口滑动槽 9 转动，改变排水方向。进水口 26 上面安装有防倒流装置 25，当水流又进水口进入时，由于水的作用力，防倒流装置 25 打开，当水流停止进入时，防倒流装置 25 由于水的作用力消失而关闭，可以防止流水通道 24 内杂物的流出。清洁与移动平台中，4 个独立的清洁驱动轮 3 由其电机驱动器控制，可以实现独立的运动，通过使用不同的轮速组合实现机器人的前进、后退、转弯以及刷洗清洁的任务。当机器人带缆在水下执行清洁任务时，机器人利用惯性导航元件与清洁驱动轮 3 进行航位推算，得到机器人位置信息，进而由中心处理器控制收放电缆电机根据实际长度需要而收放信号及能源电缆 33。根据游泳池深度与实际需要，选择合适位置安装电缆配重环 34，调节电缆在水中的悬浮状态。信号中继及电缆管理器 28 由电缆导向滑轮架 32 为电缆收放导向。当机器人脱缆在水下执行任务时，控制信号浮漂天线 27 通过控制信号浮漂天线电缆 35 与机器人连接，接收遥控信号，控制机器人运动。在自主清洁的过程中，设定游泳池清洁度图像阈值，机器人利用监控摄像机 2 拍摄游泳池池底图片，通过与阈值比较来判断游泳池池底的清洁程度，进行清洁运动规划，进而调节四个清洁驱动轮 3 和排水器的工作状态，完成清洁任务。具体可以调整每个轮子 3 的转速，通过不同的轮速组合，实现不同力度的清洁动作，例如，前轮顺时针快速旋转，后轮逆时针慢速旋转，水下清洁机器人则会沿前轮顺时针旋转所确定的方向行进，但这时的清洁力度要比后轮顺时针旋转时要大很多。同时，调整排水口 10 的排水位置方向以及排水螺旋桨 11 的转速，也可以改变清洁力度，使机器人的工作效率更高。对于竖直池壁的清洁，也可以使用相同的控制策略。本发明提出的水下清洁器人由于机器人流水通道 24 内的高负压以及排水机构的作用力，可使机器人黏附在游泳池竖直壁面上进行清洗，实现机器人竖直贴壁行进动作。本发明提出的水下清洁机器人由于排水口 10 可以沿排水口滑动槽 9 运动，可以对机器人的行进、清洁、转向以及竖直贴壁行进产生作用。多个排水口 10 协调沿排水口滑动槽 9 运动或定位，改变排水口 10 排水方向，对机器人的运动产生不同的作用力。如机器人在水中处于漂浮状态时，可以通过调整两个排水口 10 的排水方向与排水力度，调节机器人

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在水中的姿态，帮助机器人正确的姿态。特别是当机器人在爬壁的过程中，由于游泳池台阶等因素的影响，可能会底盘顶起，使机器人的 4 个清洁驱动轮 3 失效，这时要靠调整排水口位置给机器人推动力，使其回到正常工作的状态中来。水下清洁机器人根据自身安装的惯性导航元件与 4 个清洁驱动轮 3 的编码器通过航位推算保证水下清洁机器人自主导航运行。当完成清洁任务后，打开机器人上顶盖 18 以及流水过滤网 23，然后对水下清洁机器人流水通道 24 进行清洗即可。

本发明不限于此实例，凡是利用本设计的设计思路，做一些简单变化的设计都应进入该发明的保护范围之内。

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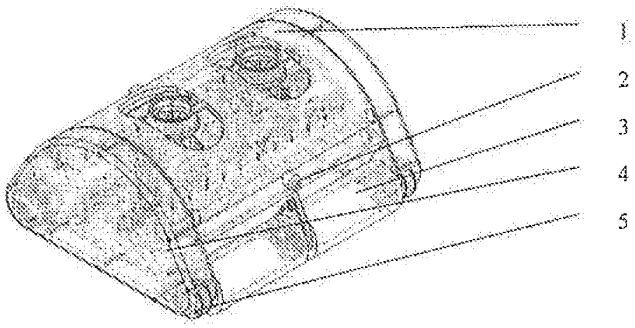

图 1

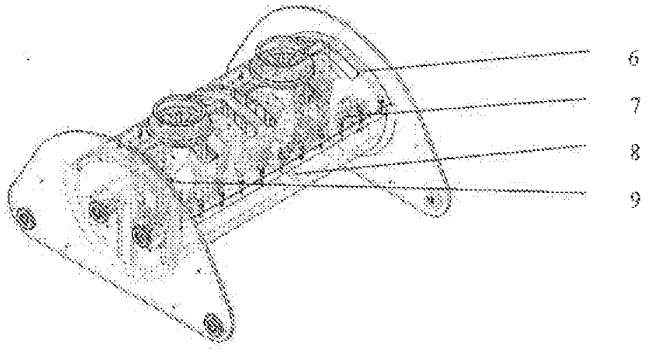

图 2

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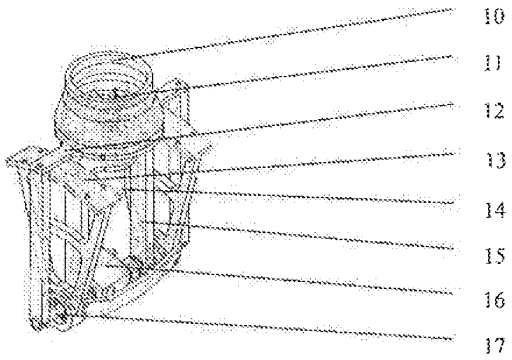

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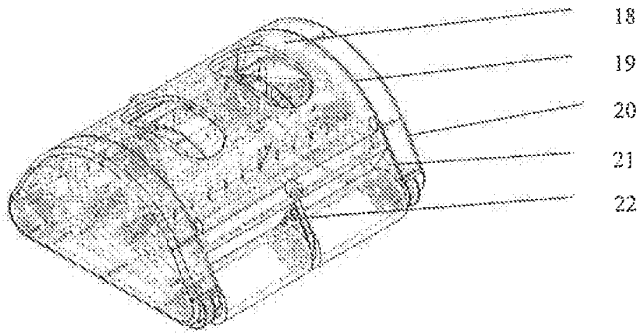

图 4

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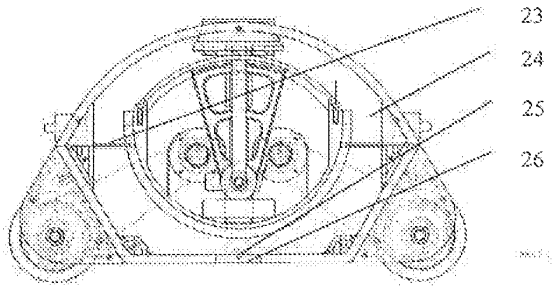

图 5

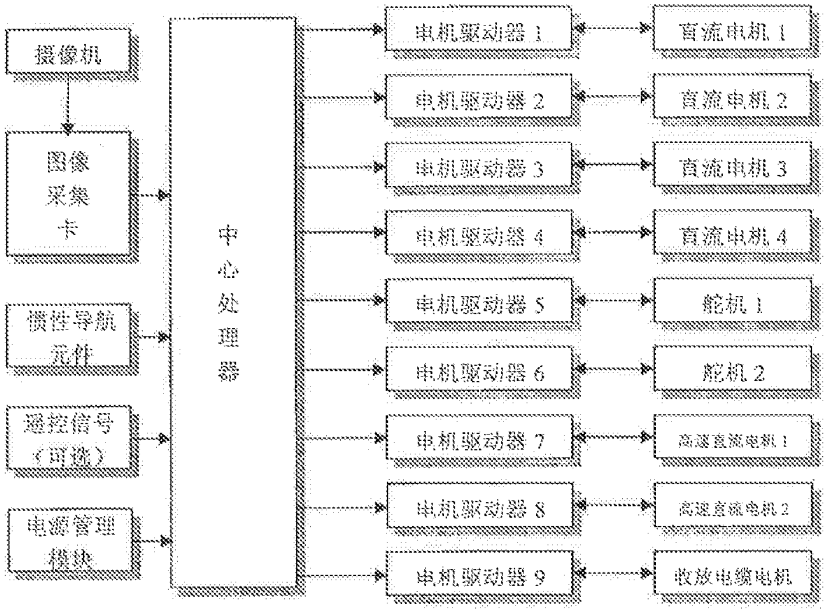

图 6

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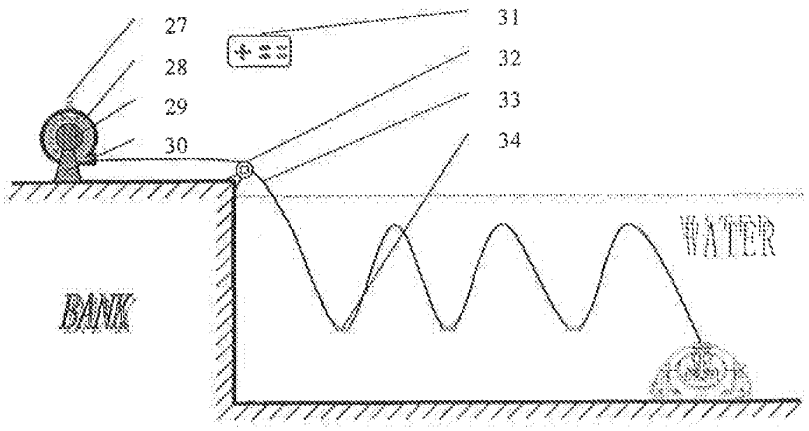

图 7

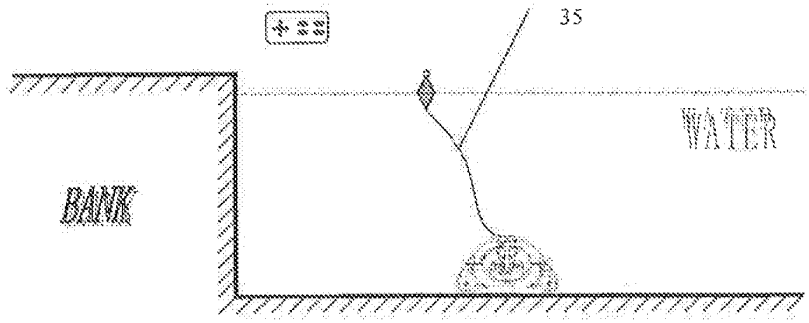

图 8

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Bibliographic data: JPS6162905 (A) — 1986-03-31

AUTOMATIC OPERATING METHOD OF UNMANNED VEHICLE

Page bookmark	JPS6162905 (A) - AUTOMATIC OPERATING METHOD OF UNMANNED VEHICLE
Inventor(s):	CHIKAISHI YASUSHI ±
Applicant(s):	KOMATSU MFG CO LTD ±
Classification:	- **international:** *G05D1/02;* (IPC1-7): G05D1/02
	- cooperative: G05D1/0242; G05D1/0246; G05D2201/0202
Application number:	JP19840184841 19840904
Priority number(s):	JP19840184841 19840904

Abstract of JPS6162905 (A)

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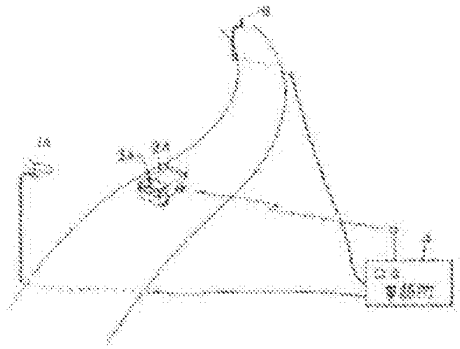

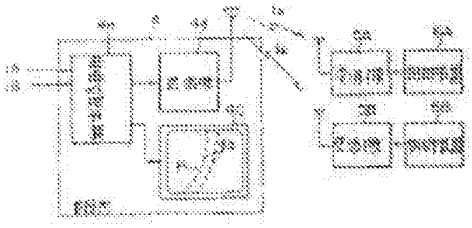

PURPOSE:To easily send commands for the setting, alteration, etc., of a run course by teaching the track of the run course captured by an image pickup means, and detecting the deviation of the mark of the unmanned vehicle from the track and sending a steering command by radio. CONSTITUTION:Video cameras 1A and 1B are arranged as image pickup means on the run path at an operation site and the run path is captured entirely by either video camera 1. An infrared light emitting device 3A is fitted to plural dump trucks 2A as unmanned vehicles which run on this run path and image signals from said video cameras 1 are transmitted to an office 4. Those image signals are image-processed at the office 4 and control commands such as a steering command are transmitted to the dump trucks 2 by radio. Consequently, each dump trucks 2A receives a command based upon the deviation of its mark from the previously taught target line from the office 4 to enter unmanned operation.

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⑲日本国特許庁(JP)　⑪特許出願公開

⑫公開特許公報(A)　昭61-62905

⑤Int.Cl.⁴	識別記号	庁内整理番号	⑬公開　昭和61年(1986)3月31日
G 05 D 1/02		7052-5H	

審査請求　未請求　発明の数 1　(全6頁)

⑭発明の名称　無人車両の自動運転方法

⑳特　願　昭59-184841
㉒出　願　昭59(1984)9月4日

㉑発 明 者　近　石　　康　司　船橋市小室町2832
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㉔代 理 人　弁理士　木村　高久

明　細　書

1. 発明の名称

無人車両の自動運転方法

2. 特許請求の範囲

(1) 無人車両に目印を取り付け、該目印を撮影する撮像手段を設置し、前記無人車両が所定の走行コースを走行する際に前記目印が描く撮影画面上の軌跡を予め目標線として教示しておき、前記無人車両の走行中に前記撮像手段によって撮影した撮影画面上の前記目標線に対する目印のずれを逐次検出し、この検出したずれに対応する操舵指令を送信して無人車両を自動運転することを特徴とする無人車両の自動運転方法。

(2) 前記目印は赤外線発光器である特許請求の範囲第(1)項記載の無人車両の自動運転方法。

3. 発明の詳細な説明

〔産業上の利用分野〕

本発明は無人車両を所定の走行コースに沿って目的地へ導く無人車両の自動運転方法に関する。

〔従来の技術〕

従来、無人車両を所定の走行コースに沿って目的地へ導く方法としては、走行路に誘導用ケーブルを敷設し、この誘導用ケーブルに低周波電流を流し、それにより生じる交番磁界を車両に取り付けた磁界検出コイルにより検出し、誘導用ケーブルをまたぎながら又は誘導用ケーブルとの距離を一定に保ちながら車両を走行させる方法がある。

〔発明が解決しようとする問題点〕

しかしながら、上記方法は、全ての走行路に沿って誘導用ケーブルを敷設する必要があるために工事がたいへんであり、走行コースも容易に変更することができないといった問題がある。

本発明は上記実情に鑑みてなされたもので、上記誘導用ケーブルを敷設する必要がなく、予め教示した所定の走行コースに対するコースずれをリアルタイムに修正することができる無人車両の自動運転方法を提供することを目的とす

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る。

〔問題点を解決するための手段および作用〕

本発明によれば、無人車両の所定の走行コースを全て捕捉する態様で撮像手段を設置するとともに、無人車両には無人車両の特定位置が撮像手段によって認識しやすいように目印を取り付け、一方、無人車両が前記所定の走行コースを走行する際に前記目印が描く撮影画面上の軌跡を予め目標線として表示しておき、前記無人車両の走行中に前記撮像手段で撮影した撮影画面上の前記目標線に対する目印のずれを逐次検出し、この検出したずれに対応する操舵指令を無線送信して無人車両が所定の走行コースを正確に走行するように自動運転するようにしている。

〔実施例〕

以下、本発明を添付図面を参照して詳細に説明する。

第1図は無人車両が稼動する現場の一例を示す全体図で、無人車両としてダンプトラックが

鉱山・砂石場などの作業現場で稼動している場合に関して示している。

この作業現場の走行路には、第2図に示すように撮像手段としてビデオカメラ1A，1B…が配設され、全走行路がいずれかのビデオカメラによって捕捉できるようになっている。なお、このビデオカメラは赤外域の感度が良好な固体撮像素子型のビデオカメラであるが、赤外線のみを透過するフィルタを設けたものでもよい。

一方、この走行路を走行する複数のダンプトラック2A，2B…にはそれぞれ赤外線発光器3A，3B…が取り付けられている(第2図)。

前記ビデオカメラ1A，1B…からの画像信号は、それぞれ事務所4に伝送される。事務所4はこれらの画像信号から後述する画像処理等を行ない、各ダンプトラック2A，2B…に対して操舵指令等の制御指令を無線送信し、ダンプトラックは事務所4からの指令を受信して無人運転される。

次に、事務所4における画像処理等について

第3図を参照しながら説明する。同図において、各ビデオカメラ1A，1B…からの画像信号は、事務所4の画像処理装置4aに加えられる。画像処理装置4aには、ダンプトラックが所定の走行コースを走行する際に、ダンプトラックに取り付けた赤外線発光器が撮影画面上に描くべき軌跡が予め目標線4bとして表示されている。この目標線4bはモニタ4cに示すように、捨場から積込場への上り車線と積込場から捨場への下り車線の車線別にそれぞれ設定されている。なお、目標線4bの表示方法としては、各ビデオカメラによって捕捉した走行路をモニタ4c上に映し出し、このモニタ4c上にライトペンを用いて目標線を入力する方法、あるいはダンプトラックを有人走行させ、そのときの赤外線発光器の描く軌跡を検出記憶させるといった方法が考えられる。

さて、画像処理装置4aは、各ビデオカメラ1A，1B…から入力する画像信号を各ビデオカメラ毎に1画面づつ取り込み、順次時分割処

理する。いま、ビデオカメラ1Aからの画面中をダンプトラック2Aが走行している場合について考える。

画像処理装置4aは、まずビデオカメラ1Aからの画像信号を赤外域の帯域フィルタを通し、さらに2値化をすることによりダンプトラック2Aの赤外線発光器3Aの発光点Pのみの画像データを検出する。そして、この発光点の画面上の位置を検出し、上記のようにして予め表示された目標線に対する前記発光点位置Pのずれを検出し、そのずれに対応した操舵指令を送信機4dより発信する。なお、目標線が上りと下りの2本ある場合には、ずれを検出する際の基準となる目標線は、発光点位置Pが近い方の目標線あるいは発光点位置Pの移動方向から対応する目標線を選択する。勿論、2本の目標線に対する発光点位置のずれ方向が同じであっても、基準とする目標線によって(上り側の目標線か下り側の目標線かによって)操舵方向が異なる。また、検出した発光点がいずれのダンプトラッ

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クのものかを認識し、そのダンプトラックのみが受信可能な周波数で前記操舵指令は発信するようにしている。なお、上記ダンプトラックの識別は、例えば赤外線発光器３Ａ，３Ｂ…をそれぞ異なる周期で点滅させておき、画像処理装置４ａで検出した発光点の点滅周期を検出することにより行なうことができる。

一方、ダンプトラック２Ａ，２Ｂ…はそれぞれ受信機５Ａ，５Ｂ…および制御装置６Ａ，６Ｂ…を有している。受信機５Ａ，５Ｂ…はそれぞれ自車固有の周波数の指令のみ受信できるようになっている。また、制御装置６Ａ，６Ｂ…は自動操舵制御装置、車速制御装置、ダンプ制御装置、無人運転時における各種安全装置等から構成されている。いま、事務所４の送信機４ｄから周波数ｆＡで操舵指令が送信されると、ダンプトラック２Ａの受信機５Ａがこの指令を受信してこれを制御装置６Ａの自動操舵制御装置に加え、この自動操舵制御装置によりダンプトラック２Ａの自動操舵が行なわれる。

このようにして、各ダンプトラック２Ａ，２Ｂ…は、それぞれ赤外線発光器３Ａ，３Ｂ…のモニタ画面上の発光点位置が目標線４ｂ上をたどるように事務所４から操舵指令を受け、この操舵指令により自動運転される。

また、上記目標線４ｂを第４図に示すように表示するとともに、目標線４ｂの地点ＡからＢは速度指令をｘ km／h、地点ＢからＣはｙkm／h地点Ｃでは停止、地点ＣからＤはバック、地点Ｄでは停止およびダンプ、地点ＤからＥは再び速度指令をｘ km／hのように、適宜速度指令、停止指令、バック指令、ダンプ指令等を表示することができる。したがって、この場合には事務所４の画像処理装置４ａは、上述した操舵指令とともに、発光点位置が目標線４ｂのいずれの区間あるいは地点にあるかによって速度指令、停止指令、バック指令、ダンプ指令を送信機４ｄに出力し、送信機４ｄからはこれらの指令信号が送信される。そして、これらの指令信号を受信したダンプトラックは、自動操舵制御装置、

車速制御装置、ダンプ制御装置により自動運転される。

一方、積込場においては、その入口でダンプトラックを上述のようにして一時停止させ、その後は第１図に示すように積込場を撮影するビデオカメラ１のモニタ画像（第５図参照）を見ながらラジコンで遠隔操縦する。また、ビデオカメラ１も遠隔操縦型とする。勿論、上述した捨場においてもダンプトラックをラジコンで遠隔操縦するようにしてもよい。

また、ダンプトラックの走行路上の障害物（人、転石、侵入車両等）は、障害物のない画像フレームを予めメモリに記憶させ、適宜のサンプル周期で取り込んだ画像の画像フレームと前記記憶した画像フレームとの間でフレーム間減算を行なうことにより物体を認識し、更にその物体が車両の走行路上にあるか否かを判別し、走行路上にあるときその物体を障害物として検出する。なお、前記認識物体が他の車線側にある場合、あるいはすでに通過した自車走行路上

にある場合等は障害物としては取り扱わない。

上記のようにして障害物の検出が行なわれた場合には、ダンプトラックを停止させる指令信号を送信し、その後、障害物を検出したビデオカメラの画像をモニタに映し出し、その画像を見ながら障害物を回避するまでラジコンで遠隔操縦する。

第６図は無人車両が稼動する現場の他の例を示す全体図で、無人車両として穿孔機１０が稼動している場合に関して示している。この穿孔機１０には赤外線発光器１１が取り付けられ、また穿孔機１０がこの作業現場を移動しても前記赤外線発光器１１がその視野内に入るようにビデオカメラ１２が設置されている。

さて、この場合の目標線の表示方法としては、穿孔機１０を有人走行させ、あるいはビデオカメラ１２によって捕捉した現場をモニタに映し出して無線操縦し、そのときの赤外線発光器１１の描くモニタ画面上の軌跡を検出記憶させるといった方法が考えられる。勿論、穿孔機１０を

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穿孔位置ごとに一時停止させ、その位置も同時に記憶させる。第7図はこのようにして教示された目標線および穿孔位置A_{11}～A_{nn}を示している。

そして、自動運転する場合には、穿孔機10を穿孔位置A_{11}に移動させ、ここで穿孔指令を与えて所要の穿孔作業を実行させ、穿孔作業が終了すると次の穿孔位置A_{12}まで機能指令等を与えて移動させ、ここで再び穿孔指令を与えて所要の穿孔作業を実行させる。このようにして予め目標線とともに教示した全穿孔位置での穿孔作業を自動的に順次実行させる。なお、穿孔作業の終了時点は、穿孔機側から赤外線発光器を点滅させることにより、あるいは車載の送信機等により事務所側に知らせる。

なお、本発明方法は上記ダンプトラックや穿孔機に限らず、例えば走行路のわだちや転石あるいは飛こぼれ等を除去するために定期的に走行させるモータグレーダ、ダム工事のように比較的単純な転圧作業を行なう振動ローラ等の締

発明に係る無人車両の自動運転方法を適用した事務所とダンプトラックとの概略構成を示すブロック図、第4図は本発明に係る目標線（走行コース）その他の指令の教示例を示すために用いた図、第5図は積込場のモニタ画像の一例を示す図、第6図は本発明に係る無人車両の自動運転方法が適用される作業現場の他の例を示す図、第7図は第6図に示す作業現場における目標線その他の指令の教示例を示すために用いた図である。

1，1A，1B，12－ビデオカメラ、2A－ダンプトラック、3A，11－赤外線発光器、4－事務所、4a－画像処理装置、4b－目標線、4c－モニタ、4d－送信機、5A，5B－受信機、6A，6B－制御装置、10－穿孔機。

出願人代理人　木　村　高　久

固め機械等、種々の無人車両に適用できる。

なお、本実施例では無人車両の位置を検出するための目印として赤外線発光器を取り付けるようにしたが、これに限らず、撮像手段によって容易に認識できる目印であれば如何なるものでもよい。更に、撮像手段の台数、制御する無人車両の台数および目標線の教示方法は本実施例に限定されない。

〔発明の効果〕

以上説明したように本発明によれば、撮像手段を用いて無人車両を自動運転することができ、走行コースの設定、変更、その他車速等の種々の指令の付与が簡単である。また、撮像手段を用いてラジコンで無線操縦ができるので、アクシデントが発生した場合等におけるフレキシビリティが高い。

4. 図面の簡単な説明

第1図は本発明に係る無人車両の自動運転方法が適用される作業現場の一例を示す図、第2図は第1図の走行路の一部拡大図、第3図は本

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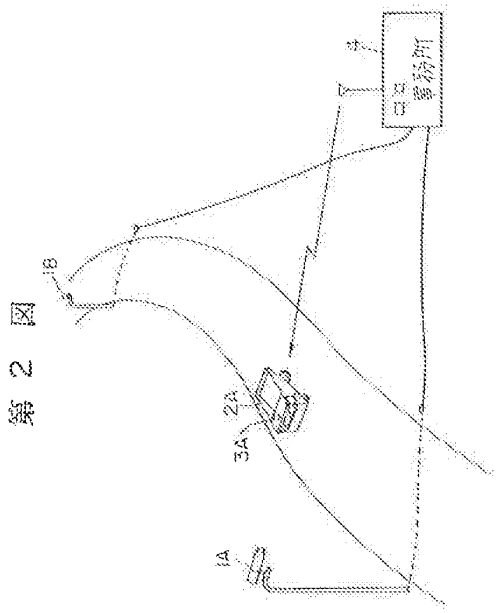
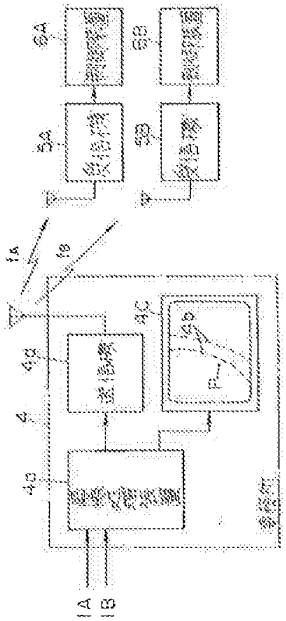
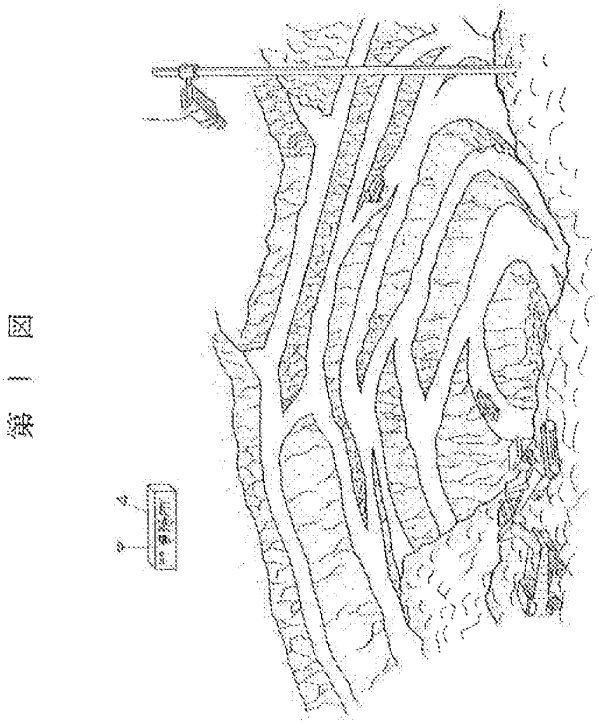
第2図



第3図



第1図



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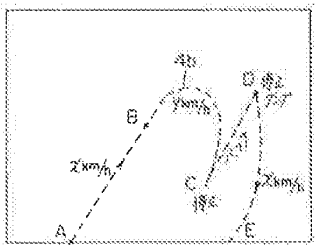
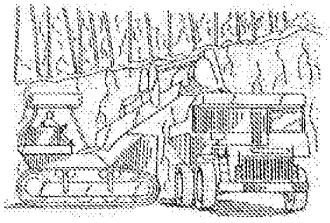
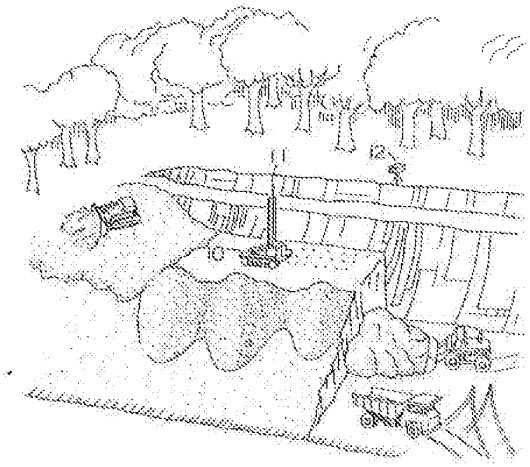
第 4 図



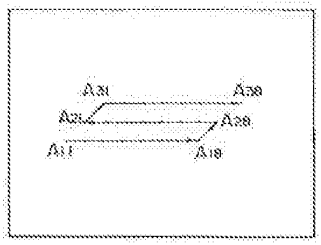
第 5 図



第 6 図



第 7 図



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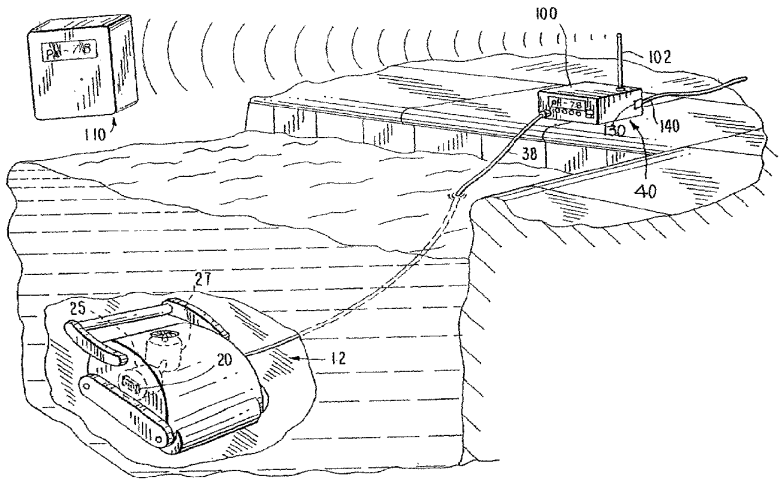
(54) Title: POOL CLEANER WITH ON-BOARD WATER ANALYSIS, DATA RECORDING AND TRANSMISSION DEVICE



(57) Abstract: A self-propelled robotic pool cleaner (10) carries one or a plurality of sensors (20) for sensing and analyzing various water conditions in a pool or tank and periodically communicates the resulting information on the current value of each condition determined by a given sensor to a remote display device (44) for display and, optionally, to activate an audible (52) and/or visible (54) alarm to alert the person responsible for maintenance that one or more water conditions are outside of a pre-determined acceptable range. The display device (44) can be operated interactively to permit the user to enter information that establishes the acceptable range of water condition values.

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POOL CLEANER WITH ON-BOARD WATER ANALYSIS, DATA RECORDING AND TRANSMISSION DEVICE

Field of the Invention

This invention relates to sensors and data recording and display devices used to analyze various characteristics of swimming pool water for the purpose of determining the need to add additional chemicals to change or to adjust, for example, the chlorine content and pH.

Background of the Invention

Various automated sensing and analysis devices have been developed to measure, record and display the level of free chlorine, oxidation reduction potential ("redox"), the pH value, hardness, total dissolved solids ("TDS") temperature and other characteristics and conditions of swimming pool water in order to simplify and facilitate the maintenance of the conditions within a desired or optimum range. These devices include a sensor capable of periodically sampling and measuring the pH and the free chlorine ion level of water. The results of the analysis are converted to digital form by circuitry known to the art and stored in the memory of a microprocessor. The stored data can be accessed for display to determine whether any maintenance action is required to restore the conditions of the water to the desired pH and chlorine content range. These devices can also be activated to obtain a display of conditions on demand. The display is via an LCD screen of the type commonly found on pagers and cellular telephones.

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The water is typically sampled by means installed in the piping associated with the water filter treatment apparatus. The purchase price, installation expense and maintenance costs associated with this prior art system can be substantial. Means for accessing a display or read-out must also be provided. Thus, the prior art requires that a complete, separate system and apparatus be installed and periodically checked at a location that may not be particularly convenient, such as a filter room or filter house located under the pool or in an even more remote location.

In addition to being inconvenient, the systems of the prior art require the owner to remain vigilant to weather conditions, such as outdoor temperatures, extent of sunshine and the like, which can have a marked effect on the frequency with which conditions of the pool water can change. Quite simply, the owner must remember to check the system in order to maintain the water in a safe and healthy condition.

For most residential pools, the home owner and/or his family members, a gardener or other employee with other principal duties will be responsible for pool maintenance. Since water conditions can fall outside of the desired or safe range without a visible manifestation, an improved system is required to alert the person responsible for monitoring pool maintenance that conditions should be checked and some remedial action be taken.

It is therefore an object of the present invention to provide sensing, analysis, recording, data processing and display apparatus that is integrated directly into a robotic pool cleaner assembly and one or more ancillary components, and which is

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readily accessible either on a component of the assembly or on the remote stationary or hand-held device dedicated to this purpose.

A further object of the invention is to provide an improved apparatus and method for monitoring and analyzing the condition of the water in a swimming pool or other tank or vessel by directly reading the conditions in the volume of liquid contained in the pool rather than liquid passing through a conduit or pipe and for providing a display of the relevant data reflecting such conditions at predetermined periodic intervals and/or on demand.

It is yet a further object of the invention to provide means and a method for displaying such data that will not require modifications of the filter or piping system used to treat and carry the water, to thereby minimize the expenses associated with obtaining and displaying such information.

It is yet another object of the invention to provide an automatic apparatus and method that will provide a signal alerting a change in conditions requiring maintenance or remedial action and to also provide customized instructions and data as to the maintenance or remedial action required, including, for example, the amount and type of one or more chemicals that must be added to restore the condition of the water to a predetermined desired level or range based upon the specific type of chemicals that have been used historically in the maintenance of the pool being monitored.

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Summary of the Invention

The above objects and other advantages are achieved by the invention in which a robotic pool cleaner used to clean the bottom wall of a pool or tank is provided with on-board sensor and analysis means for measuring one or more characteristics or conditions of the water in the pool, a programmed microprocessor for receiving data from the sensor and analysis means, data storage means associated with the microprocessor, data transmitting means and associated display means for displaying data derived from the sensor means.

As used herein, the term "sensor" means any one or more of commercially available devices that have the ability to sample water in which the device is immersed, analyze the content of the water for one or more parameters including, for example the level of free chlorine, oxidation reduction potential ("redox"), the pH value, hardness, total dissolved solids ("TDS") and temperature, and to store or transmit for storage the results of the analysis in digital form.

Sensors suitable for use in the practice of the invention are available from commercial sources including the following : Omega USA of Stamford, CT., www.omega.com; Honeywell Sensing and Control of Freeport, IL., http//content.honeywell.com/sensing/products/analytical; Signet Scientific Company, http://www.gfsignet.com; Hanna Instruments S.P.A. of Padova, Italy, http://www.hannainst.com; and ZD Instrument Co. of Jiangsu Province, China; http://www.zdinstrument.com.

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When a remote power supply is used, the data is transmitted from the operating submerged pool cleaner via a separate data cable that is attached to the power cable or contained within the same insulating cover as the power conductors. The data transmission line(s) can be a shielded coaxial cable. The data line is then attached to the data display device. The connection can be permanent or via a jack when a separate data line is employed.

In one preferred embodiment, where the robotic pool cleaner receives its power from a remote power supply located outside of the pool, the data display means is associated with the power supply, either in a separate housing mounted on the exterior of the power supply or by incorporating the display means into the power supply housing. In a particularly preferred embodiment, the display means is interactive and includes a switch for activating the display screen and, in an especially preferred embodiment, a keypad or function keys that is operable by the user to advance the various characteristics and conditions that have been stored in the microprocessor's memory device and to selectively view the instructions for remedial action, such as chemical type and quantity that is to be added to restore the desired condition of the pool water.

In a second preferred embodiment, the pool cleaner is powered by an integral rechargeable battery and is provided with an antenna, the transmitting end of which floats on the surface of the pool water to transmit a signal to either or both of a stationary or a hand-held device. The transmission of data can be programmed for a periodic transmission or in response to signal from the receiver/display device that is

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passed through the floating antenna to the microprocessor which is activated to transmit stored data from the last test or series of tests. In a particularly preferred embodiment, the hand-held display device can be configured similarly to a cell phone with a case, antenna, display screen, keypad and battery power supply. Alternatively, the hand-held device can be configured similar to a television remote control device.

The sensor means can be positioned on the interior of the housing of the pool cleaner in an active flow path of water being drawn into the pool cleaner filter assembly. This location provides an accurate sampling of the actual conditions in the pool and also protects the sensors from damage.

Alternatively, the sensors can be mounted on the exterior of the housing in a protective casing through which casing pool water to be sampled will flow. Sensor conductor leads pass through openings in the cleaner housing to the microprocessor memory unit.

The power requirements for the sensor, microprocessor and transmitter are obtained from the power supplied to the pool cleaner to operate the pump or pumps and any drive motor or motors. As noted above, this can be a remote power source located outside of the pool or a rechargeable battery that is also positioned inside the pool cleaner housing.

For a battery-powered pool cleaner, a separate antenna wire must be provided, with the free end floating at the surface of the pool water. The antenna is preferably attached via a plug and jack assembly passing through the pool cleaner housing that is attached to the microprocessor and transmitter circuit. In this way, the antenna can

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be removed and coiled for storage when the cleaner is removed from the pool for maintenance or storage. Alternatively, the antenna can be attached to a manually operated reel or drawn from an automatic coiling device located on the exterior or interior of the pool cleaner housing.

As previously noted, the on-board sensor means can include means for analyzing any one or more of the water characteristics and conditions that are presently available or that may be developed in the future. A separate power source can be provided to the sensor unit(s) to permit their operation even when the pool cleaner is not operating to clean the pool. The separate power source can be a circuit supplied by the remote power supply or a separate rechargeable or dry cell battery. In this embodiment, the pool cleaner is left in the pool and will display or even signal a change in conditions requiring remedial action to restore the pool water.

In the case of either the remote power supply or the integral battery power supply, the apparatus can include a remote hand-held display device having the characteristics of a pager, or a more sophisticated device that has additional interactive functional capabilities than the pager that can be carried by the user to interrogate the stored data.

The programmed microprocessor can include the generation of an audible and/or visible warning signal to indicate that one or more of the measured conditions is outside of a predetermined acceptable range. For example, in heated swimming pools, the program for a temperature sensor can include an audible alarm to indicate when the water temperature has dropped below or exceeded a predetermined value.

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Such a condition might arise in the event of a failure of the pool's heating element and/or its associated temperature sensor and thermostatic control device. A rise in water temperature will also cause more chlorine to be released into the atmosphere and will accelerate the replacement requirement for this chemical. Prompt remedial action can save time and money in restoring the desired balance.

The most common maintenance requirement for swimming pools is the addition of a source of chlorine ions in order to inhibit the growth of bacteria, algae and the like. The effect of direct sunlight and an increase in temperature is well known to reduce the level of chlorine ion. Thus, in a preferred embodiment of the invention, a chlorine sensor is included and the microprocessor is programmed to provide a signal to indicate when the chlorine level drops below the desired predetermined level.

In an especially preferred embodiment, the microprocessor and memory device is programmed to permit the owner to identify the particular type and form of chlorine-containing chemical that has historically been used in the treatment of the pool. For example, HTH is available in the form of a liquid additive, crystals and powder. A microprocessor is programmed to display a recommended amount of the particular type and form of chlorine ion chemical that must be added based upon the entry of data that includes the volume of water in the pool that must be treated. The program can also include other parameters, such as water temperature and sun load in identifying the volume and/or weight of chemical product to be added.

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In one particularly preferred embodiment, the microprocessor is programmed with information about all of the known chemical products commonly used in a particular geographical area where the pool cleaner is to be sold. The programmed information can include trademarks and brand names. Algorithms are provided to account for water temperature, sun loads, water hardness ranges, pH ranges and such other parameters are customarily measured.

The user is provided with one or more menus from which are selected the particular brand and/or type of chemical used to maintain the pool in which the pool cleaner of the invention is to be used. The volume of the water in the pool is also entered. Thereafter, during use, the display will include a screen with information as to how much of the previously specific chemical is to be added to restore water conditions within the desired or prescribed range.

As will be apparent to one of ordinary skill in the art, that data from the on-board sensors can also be transmitted to a stationary data display device, such as a personal computer, portable notebook or laptop computer for access by the user. For convenience, all such computers will be referred to as "stationary devices" to distinguish them from the hand-held devices described above. The stationary display device can be located in the user's home. The pool monitoring system can also be incorporated into an advanced household monitoring system of the type that are known to the prior art.

Any of the various types of transmitting methods and apparatus known to the art or developed in the future can be adopted. In the case of a remote power supply,

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the data display device can be hard-wired to one of more secondary display devices in the user's home. In the case of a battery-powered pool cleaner, one or more stationary receiving antennas can be positioned in the vicinity of the pool to pick-up the data signals from the microprocessor. If necessary or desired, the receiving antennas can be provided with booster to enhance the signal for retransmission.

The data transmission and receiving system of the invention further comprehends the use of the Internet for providing access to the data from other remote locations, either accessible to the owner or to a commercial pool servicing organization. This type of system can also be used by institutions, such as universities, municipal parks departments and the like, to monitor the conditions of numerous pools under their jurisdiction for the purpose of dispatching an employee to correct conditions that are not within acceptable ranges. Use of the invention in such circumstances would permit maintenance personnel to take action promptly on an as-needed basis to enhance efficiency, reduce costs and maximize operations within predetermined safety limits for the benefit of swimmers and others using the pools.

Brief Description of the Drawings

The invention will be described in more detail below and with reference to the attached drawings in which:

FIG. 1 is a schematic illustration of one preferred embodiment of a pool cleaner of the invention provided with an external sensor array in operation with a

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remote power supply equipped with a data display screen and interactive display switches;

FIG. 2 is an enlarged front, top, right side perspective view of the power supply of FIG. 1;

FIG. 3 is a schematic illustration of the invention similar to FIG. 1 showing the sensor array positioned on the interior of the pool cleaner housing and its relation to a remote hard-wired data display device and pager and to an alternative hand-held device that communicates interactively with the hard-wired device;

FIG. 4 is a schematic illustration of the invention in which the power is supplied by a battery that is integral with the pool cleaner; and

FIG. 5 is a schematic block diagram of an interactive communications system in accordance with another preferred embodiment which integrates a battery-powered pool cleaner with a plurality of local and remote interactive data display devices and antennas, and an Internet link.

Detailed Description of the Preferred Embodiments

In one preferred embodiment of the invention illustrated in Fig. 1, a pool cleaner generally referred to as 10, is provided with an external sensor array 20 comprising one or more sensors (or sensors/analyzers) 23 contained in a protective housing 21 provided with one or more water sampling inlets 22. Each sensor 23 is adapted to sense a respective condition of the water in the pool and is therefore physically disposed in or on the pool cleaner 10 so as to be in sensing relation to the

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water. In this embodiment, an external power supply 40 is connected to the pool cleaner 10 by power cable 50.

A preferred arrangement of the display and controls as integrated into the casing of the power supply housing 42 is illustrated in Fig. 2. Liquid crystal display 44 is prominently positioned for easy viewing on a front or top side surface of housing 42. A multi-conductor power supply cable outlet 50 is mounted through the housing 42 and includes terminals 51 for receiving information (data) transmitted from the one or more sensors 23 in the pool cleaner 10. The power supply 40 is also provided with an on/off power switch 46 and one or more, but preferably a plurality of, function and characteristic display switches in the form of pushbuttons 48. These function actuators 48 interact with the microprocessor (not illustrated) that is either located in the power supply housing 42 or more preferably, on-board the pool cleaner.

In one preferred method of practicing the invention, the one or more sensors 23 are periodically activated and the data generated processed to determine whether it is within the predetermined acceptable range. In the event that the data is outside the desired range, an audible alarm can be generated from signal unit 52 and/or a visible signal device such as flashing light 54 is activated. Either or both of these signal devices can be omitted or deactivated and the user can interrogate the device to obtain a on-demand display of the data for any one or more of the characteristics stored in the microprocessor's memory device. In a particularly preferred embodiment, the

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microprocessor is programmed to display the acceptable value or range along with the most recent actual analysis result.

The display also preferably prompts the user with information about the proactive or remedial action to be taken, such as "add chlorine." In this embodiment the microprocessor memory device is programmed with information concerning the specific type (i.e., liquid, crystal, powder) and strength or concentration and brand name of the chemicals historically used to treat the pool to maintain its balance. In this embodiment, the user can be prompted to display the required type and amount of chemical additive to be used, taking into account other variables such as the actual volume of the water contained in the pool, water temperature and the like. The programming of microprocessors with this information for use in an interactive manner is known to the art and/or can be extended in accordance with the teachings of the invention by one of ordinary skill.

In the alternative embodiment illustrated in Figure 3, showing the interior of a pool cleaner 30 that has been turned upside down for clarity, the sensor array 20 can be incorporated into the casing 25 positioned on the interior of the housing in the active flow path of the water that has been drawn through the filter bag 27. This particular configuration, with the sensors 23 located on the interior of the housing 12, is preferred in order to minimize the possibility of damage by mishandling the pool cleaner 30. This is also a preferred location for the sensor array 20 if the cleaner 30 is to be left in the pool when it is not performing its cleaning operations.

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A further embodiment of the invention is illustrated in Fig. 4 where the pool cleaner power is supplied by an on-board rechargeable battery 31, which eliminates the need for an external power cable. In this embodiment, the data must be transmitted through an antenna 70, the transmitting end 72 of which floats on the surface of the pool water.

The antenna 70 can be terminated by a jack and mating plug assembly 74 to permit removal from the housing during storage. A signal transmitting cable 76 links the antenna 70 to the sensor array assembly.

In this embodiment, a remote display device, which can be a hand held display 120 (see Fig. 4), a PC or laptop computer 125 (see Fig. 5) with an appropriate receiving and transmitting antenna 205 of its own or a stationary receiver 100 configured similar to that of the power supply display module 40 described above, can be employed. The stationary receiving transmitter 100 may receive the signal from the floating antenna 70 and retransmit it via antenna 102 to the pager 110 or a more interactive hand-held remote control device 120 (see Fig. 5). Here a separate power cable 38 may be used.

The remote receiving antenna 205 can be installed on a mast 200 dedicated to that use, on a building 210 or home proximate the pool, or at any other convenient location that is within range of the floating antenna.

In the embodiment depicted in Fig. 5, the stationary receiving transmitter 100 receives the signal from the floating antenna 70 and retransmits it via antenna 102 to pager 110 or the more interactive hand-held remote control device 120.

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The transmitter/receiver 100 can also be provided with a modem 130 allowing direct access and communication of data via telephone lines 140 or satellite through the Internet to either type of device 110 or 120.

Transmitter receiver 100 can also be integrated into commercially available electronic home monitoring and control systems. The receiver 100 can be hard-wired or connected via antenna 210 and a separate receiver transmitter unit. Such systems typically include signal-type alarms to alert the home owner to conditions requiring attention. The systems also permit the interactive scanning of data that is collected and stored in the system's memory. In a particularly preferred embodiment of the invention, the pool cleaner chemicals are stored in reservoirs connected to automated measuring and injection valves to permit maintenance of the system from the keypad of a PC or other interactive controller keypad forming part of the system.

While the disclosed method and apparatus have been particularly shown and described with respect to the preferred embodiments, it will be apparent to those skilled in the art from the description provided that various modifications in form and detail may be made therein without departing from the scope and spirit of the invention. Accordingly, modifications such as those suggested above, but not limited thereto are to be considered within the scope of the invention, which is to be determined by reference to the appended claims.

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I CLAIM:

1. A self-propelled robotic pool cleaner for cleaning at least a submerged lower wall of a pool or tank containing water, said pool cleaner comprising:

a cleaner housing;

a sensor array including at least one sensor, said array being supported by said cleaner housing in a position at which each of said at least one sensor is in sensing relation to the water as said pool cleaner moves, each sensor of said array further sensing a specific condition of the water;

a power source electronically connected to said sensor array to operate each of said at least one sensor; and

means for outputting information to a remote display on each condition sensed by said at least one sensor on said array .

2. The pool cleaner of claim 1, wherein said sensor array is positioned in the interior of said cleaner housing in an active flow path of water through said pool cleaner.

3. The pool cleaner of claim 1, further comprising a protective housing including at least one water inlet mounted on an exterior surface of said cleaner housing, said sensor array being mounted within said protective housing such that

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water entering said protective housing through said at least one water inlet flows in contact with said at least one sensor in said sensing relation.

4. The pool cleaner of claim 1, wherein said means for outputting information includes a data cable extending from said cleaner housing for connection to the remote display.

5. The pool cleaner of claim 4, wherein said power source includes a power cable extending from said cleaner housing for connection to a remote source of electrical power, and said data cable comprises at least one conductor within said power cable.

6. The pool cleaner of claim 1, wherein said means for outputting information includes a wireless transmitter for transmitting the information as a wireless signal from said pool cleaner to the remote display.

7. The pool cleaner of claim 1, wherein said wireless transmitter includes an antenna having a free end adapted to float on an upper surface of the water in the pool.

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8. The pool cleaner of claim 6, wherein said power supply includes a power cable extending from said cleaner housing for connection to a remote power source.

9. The pool cleaner of claim 1, wherein said power arrangement includes a battery within said cleaner housing for acting as a power source.

10. The pool cleaner of claim 1, further comprising a processor for processing data from said sensor array to generate the information to be output.

11. A self-propelled robotic pool cleaning system for cleaning at least a submerged lower wall of a pool or tank containing water, said pool cleaning system comprising:

a pool cleaner comprising:

a cleaner housing;

a sensor array including at least one sensor, each of said at least one sensor being supported by said cleaner housing in a position in sensing relation to the water as said pool cleaner moves, each sensor of said at least one sensor sensing a specific condition of the water;

a power source for supplying power to said sensor array to operate each said at least one sensor; and

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information output means for transmitting information on a condition sensed by each of said at least one sensor; and

a remote display device in communication with said information output means.

12. The system of claim 11, wherein said sensor array is positioned in the interior of said cleaner housing in an active flow path of water.

13. The system of claim 11, said pool cleaner further comprising a protective housing including at least one water inlet mounted on an exterior surface of said cleaner housing, said sensor array being mounted in said protective housing such that water entering said protective housing through said at least one water inlet flows in sensing contact with said at least one sensor.

14. The system of claim 11, wherein said information output means includes a data cable operatively extending from said cleaner housing for connection to said remote display device.

15. The system of claim 14, wherein said power source includes a power cable extending from said cleaner housing for connection to a remote power source, and said data cable comprises at least one conductor in said power cable.

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16. The system of claim 15, wherein the power source is positioned in a power supply housing and said remote display device is included in the power supply housing.

17. The system of claim 11, wherein said means for outputting information includes a wireless transmitter for communicating a signal from said pool cleaner to said remote display device.

18. The system of claim 17, wherein said wireless transmitter includes an antenna having a free end adapted to float on an upper surface of the water.

19. The system of claim 17, wherein said power source includes a rechargeable battery mounted in said cleaner housing.

20. The system of claim 11, wherein said power source includes a power cable extending from said cleaner housing for connection to a remote power source.

21. The system of claim 20, wherein the power source is positioned in a power supply housing and said remote display device is located at the power supply housing.

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22. The system of claim 11, further comprising means for generating an audible and/or visible alarm signal in response to said sensor array detecting a predetermined unacceptable value for a water condition.

23. The system of claim 22, wherein said remote display device includes a display housing and said alarm generating means is on said display housing.

24. The system of claim 23, wherein said display device displays an acceptable range for the value of a water condition and a most recent value of the same water condition as determined by a sensor on the pool cleaner.

25. The system of claim 22, wherein said pool cleaner further comprises a processor for processing data from said sensor array to generate the information to be output.

26. The system of claim 11, wherein a predetermined one of said pool cleaner and said remote display device includes a processor for analyzing the information output from said sensor array, said display device providing an alarm signal in response to said processor determining that at least one condition detected by said sensor array requires remedial action.

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26. The system of claim 25, wherein said processor includes an algorithm employing a predetermined range of values corresponding to each of one or more water conditions to determine whether a corresponding sensed water condition requires remedial action.

27. The system of claim 26, wherein said display device is interactive to permit input of additional information to said processor, and wherein the algorithm further employs the additional information input to said processor to determine whether at least one condition requires remedial action.

28. The system of claim 11, wherein said display device is hand-held.

29. The system of claim 11, wherein said display device is stationary.

30. The system of claim 11, wherein said display device communicates a recommendation for remediating the at least one condition detected by said sensor array that requires remedial action.

31. A method of operating a pool cleaning system for cleaning at least a submerged lower wall of a pool or tank containing water, wherein the pool cleaning system comprises:

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a self-propelled robotic pool cleaner, comprising a cleaner housing, a sensor array including at least one sensor, the array being supported by the cleaner housing in sensing relation to the water and a power arrangement for supplying power to the sensor array to operate said at least one sensor, and

a remote display device,

said method comprising the steps of:

sensing at least one condition of the water using a sensor of the array;

outputting information to the remote display as to each of said at least one conditions sensed by said array; and

displaying information relevant to the at least one condition of the water.

32. The method of claim 30, further comprising the step of generating an audible and/or visual alarm signal in response to said sensing step sensing a predetermined undesirable value for at least one of the water conditions.

33. The method of claim 30, wherein the display device includes a processor for analyzing the information from the pool cleaner, said method further comprising the step of providing an alarm signal in response to the processor determining that at least one condition sensed in said sensing step requires remedial action.

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34. The method of claim 33, wherein said step of providing an alarm signal includes the step of communicating a recommended action for remediating the at least one condition that requires remedial action.

35. The method of claim 34, wherein said step of providing an alarm signal includes the step of applying an algorithm in the processor to employ the information to determine whether at least one condition requires remedial action.

36. The method of claim 35, wherein the display device is interactive and receives the input of additional information to the processor, and wherein said step of applying the algorithm further applies the additional information input to the processor to determine whether at least one condition requires remedial action.

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FIG. 1

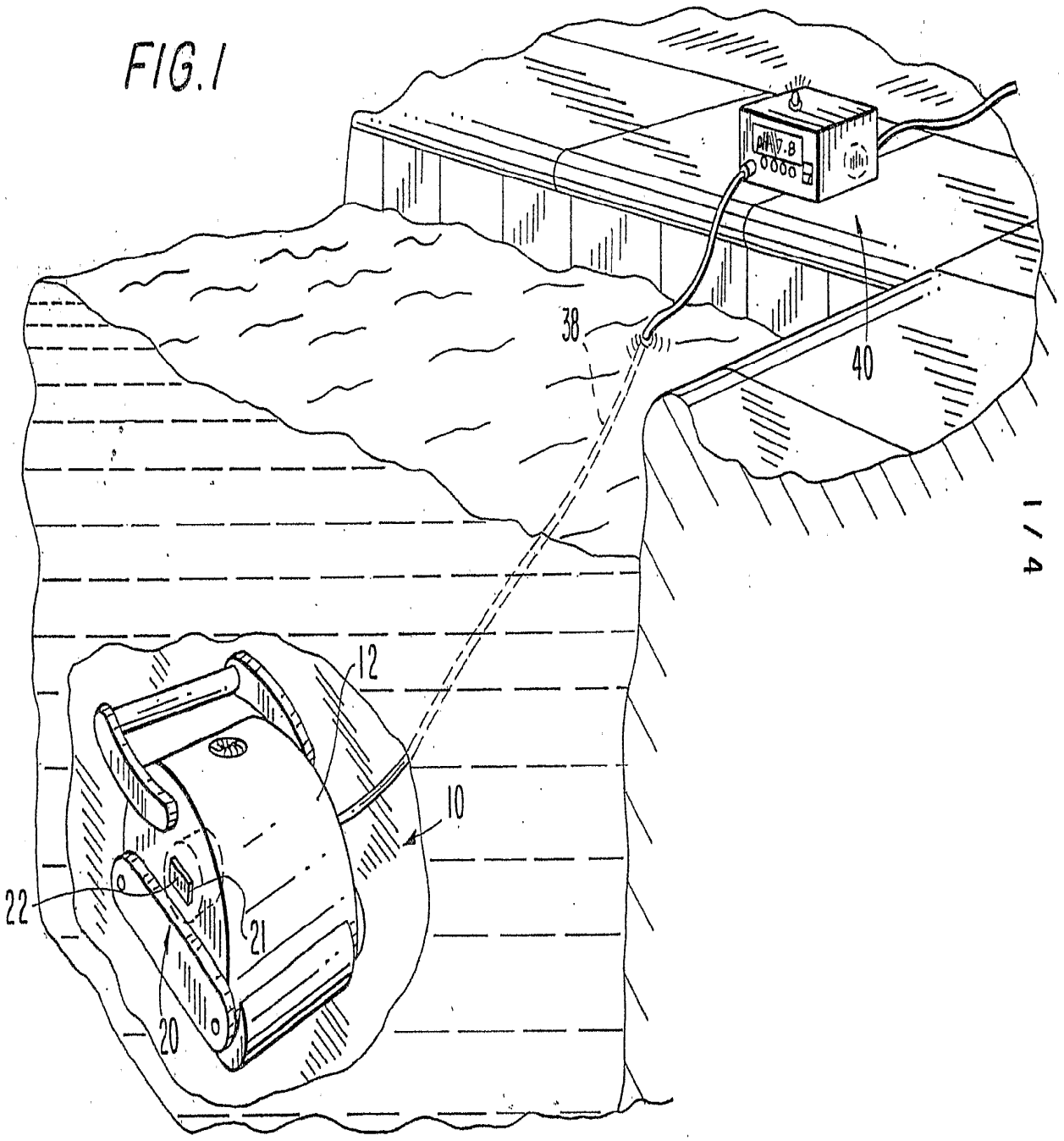

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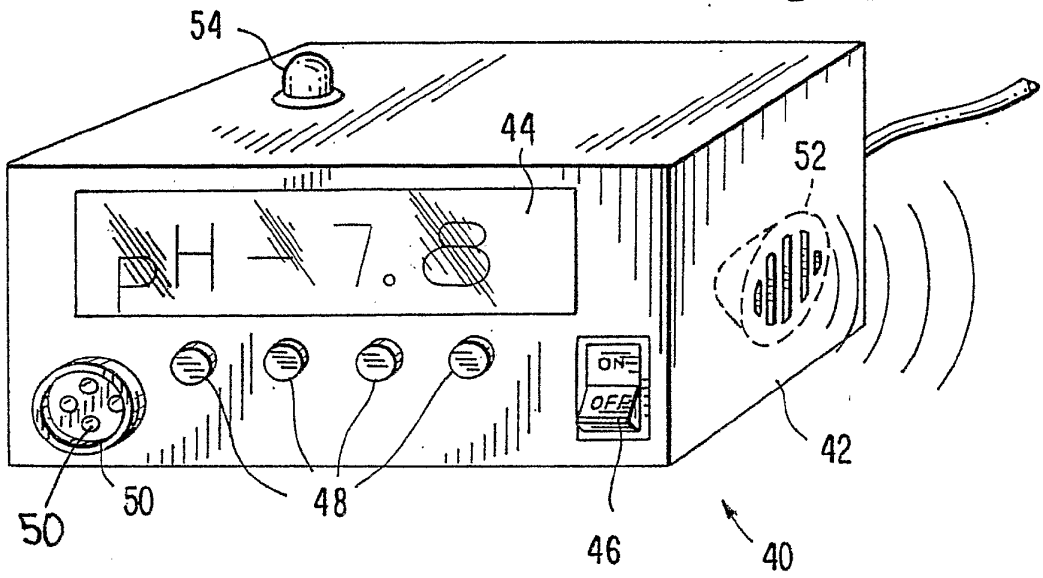
FIG. 2



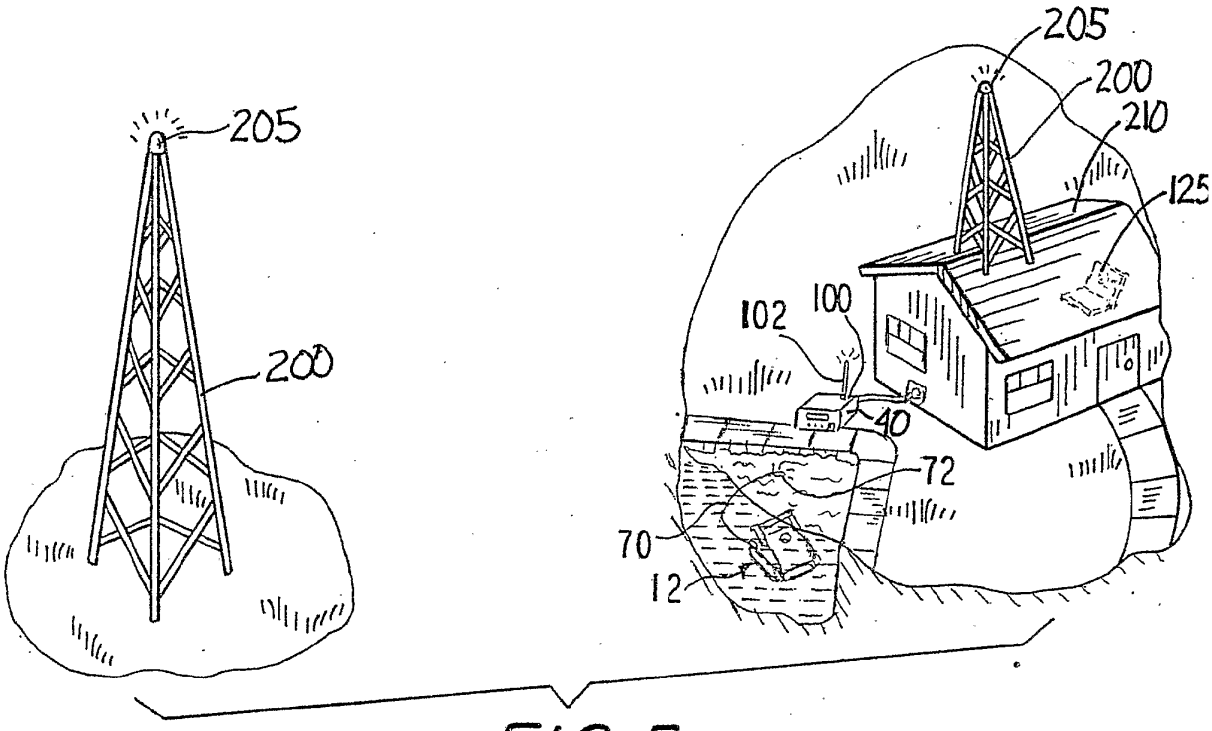


FIG. 5

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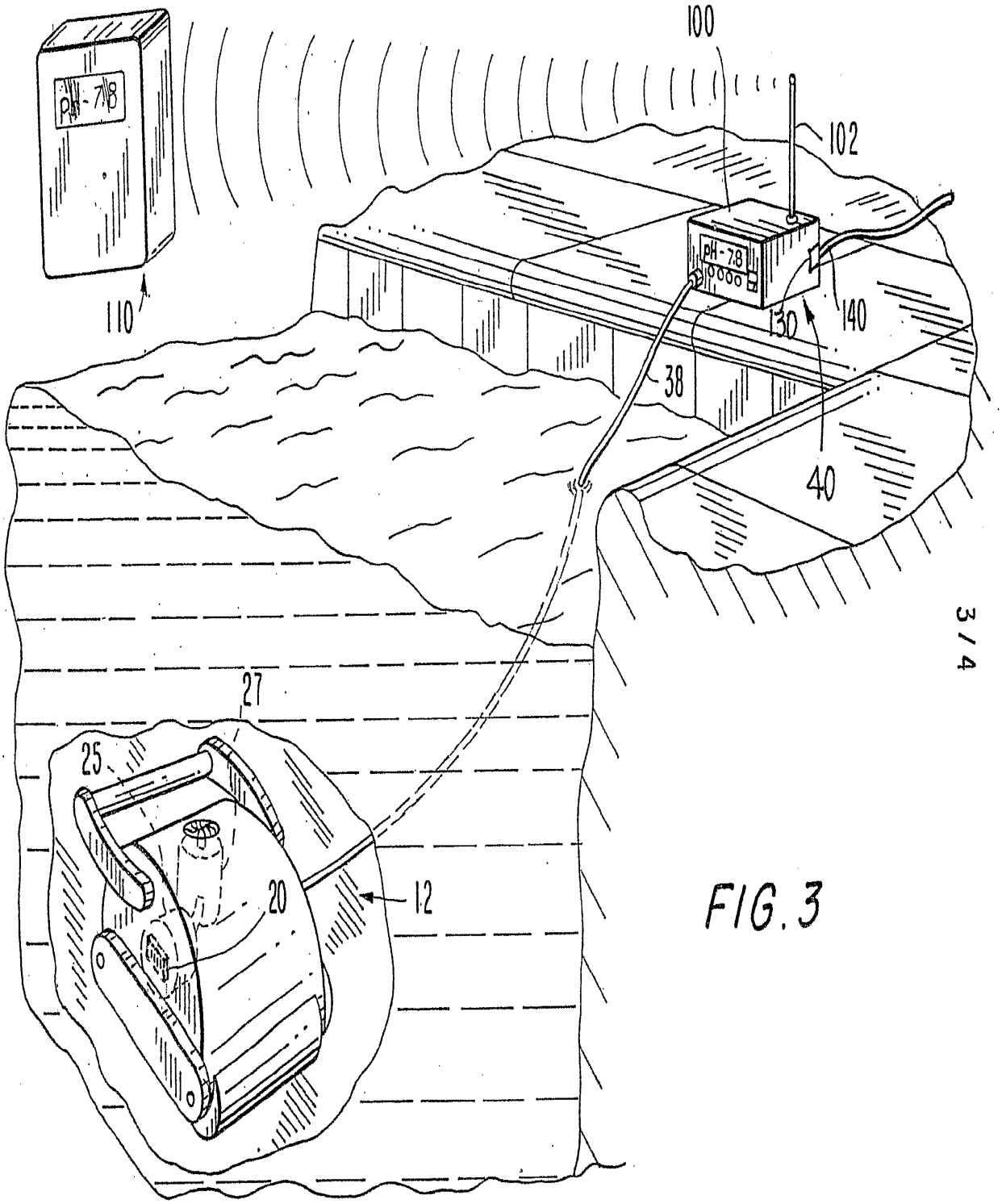

FIG. 3

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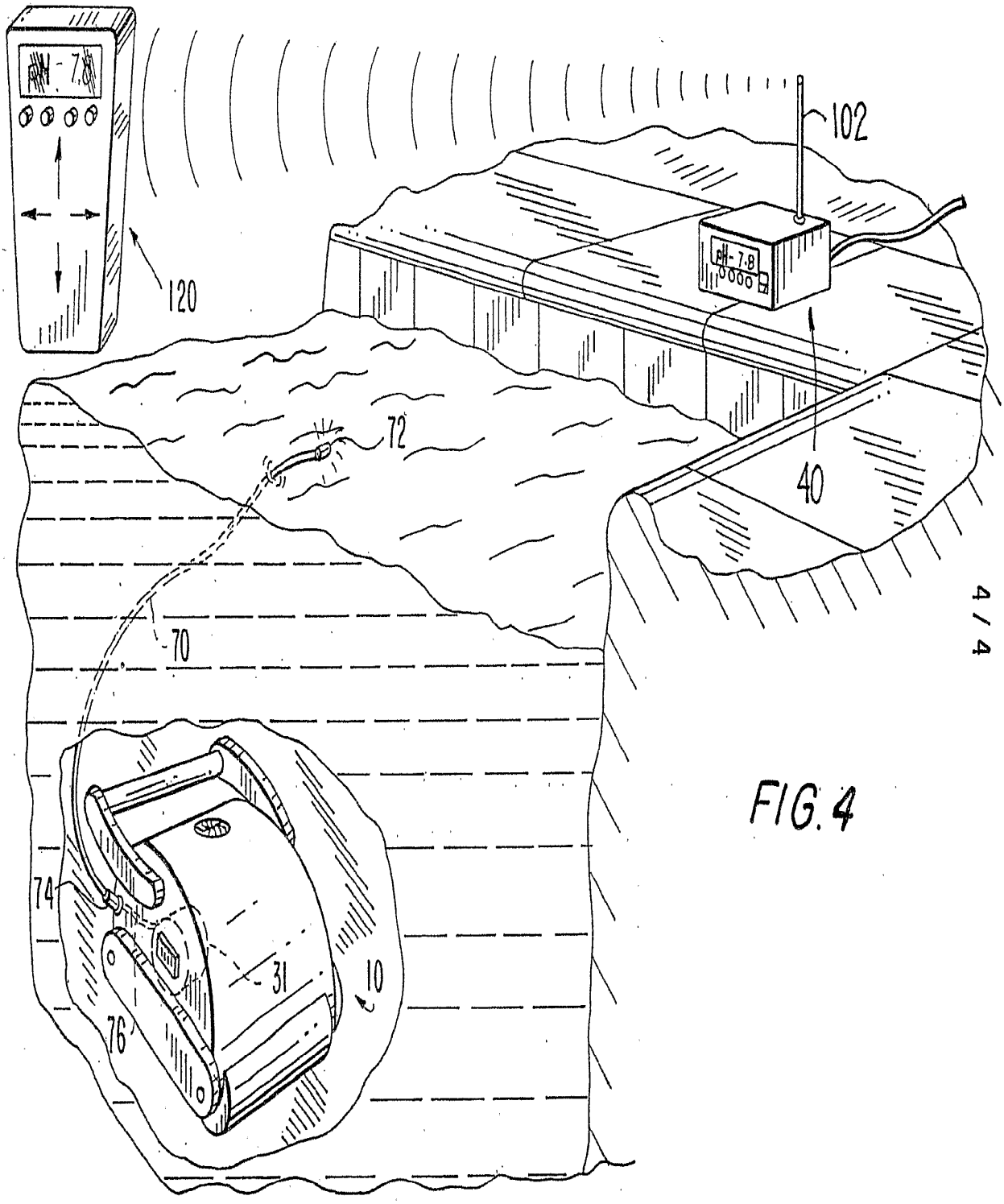

FIG. 4

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US03/26352

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : G08B 1/08, 5/00; H04Q 1/30; E04H 4/16; B08B 7/04; G01N 27/416; E04H 3/16
US CL : 340/539.1, 573.1, 691.1; 15/1.7; 134/18; 324/438; 210/169

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 340/539.1, 573.1, 691.1; 15/1.7; 134/18; 324/438; 210/169

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6,222,449 B1 (TWINING) 24 April 2001, col. 4, lines 7-10; and col. 5, lines 19-32.	1-36
Y	US 5,218,304 A (KINLEN et al) 08 June 1993, col. 2, lines 50-55; col. 4, lines 16-31; and col. 6, lines 7-15.	1-36
Y	US 5,337,434 A (ERLICH) 16 August 1994, col. 2, lines 44-59; and col. 4, lines 48-55.	1-36

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

* Special categories of cited documents:

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
23 November 2003 (23.11.2003)

Date of mailing of the international search report
12 JAN 2004

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INTERNATIONAL SEARCH REPORT

PCT/US03/26352

Continuation of B. FIELDS SEARCHED Item 3:
EAST Search term: robotic pool cleaner, sensor, water conditions, power source, remote display, transmitter, audible/ visual alarm.

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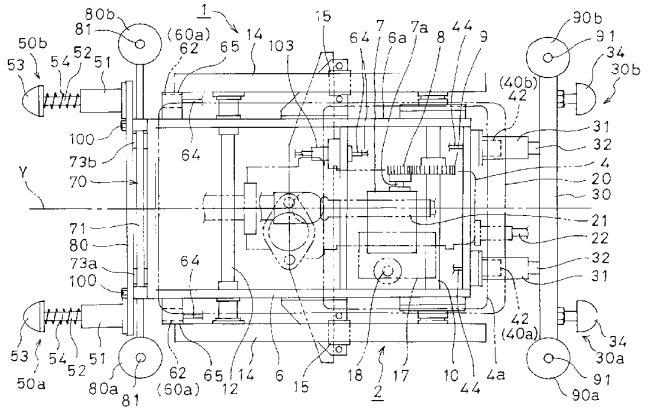
[続葉有]

(54) Title: WORKING VEHICLE

(54) 発明の名称: 作業車

[図１]



(57) Abstract: The bottom surface of a swimming pool (P) or the like is cleaned thoroughly to the corners. A working vehicle comprises a truck (2) movable freely in the forwards and backwards directions, right and left front touch sensors (50a, 50b) that project forward from the truck (2) and advance/retreat freely and independently, right and left front lead switches (60a, 60b) operated by the movement of the front touch sensors (50a, 50b), and a impeding means (70) for holding one of the front touch sensors (50a, 50b) to project forward from the other and switching the projection holding side alternately. The impeding means (70) supports an interference member (71), which impedes the movement of the front touch sensors (50a, 50b) alternatively by moving to the right and left, by a plurality of rolling members (73a, 73b) from below, and first notches (74a, 74b) and second notches (75a, 75b) for positioning are provided at lower part of the interference member (71) coming into rolling contact with the circumferential surface of the rolling members (73a, 73b) so that the impeding means (70) functions without malfunction.

(57) 要約: プール(Ｐ)などの底面をすみずみまで万遍なくきれいに掃除する。前後方向に移動自在の台車(２)と、前記台車(２)から前方に向かって突出され、独立的に進退自在とした左右の前接触センサー(５０ａ，５０ｂ)と、各前接触センサー(５０ａ，５０ｂ)の進退によって操作される左右の前リードスイッチ(６０ａ，６０ｂ)と、各前接触センサー(５０ａ，５０ｂ)の一方を他方より前方に向かって突出した状態に保持し、かつ突出保持する側を交互に切替る阻害手段(７０)を備える。阻害手段(７０)は、左右に移

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DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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動させることより各前接触センサー(５０ａ，５０ｂ)の退入を択一的に阻止するための干渉部材(７１)を、複数の転がり部材(７３ａ，７３ｂ)で下方から支え、各転がり部材(７３ａ，７３ｂ)の周面が転がり接触する干渉部材(７０)の下部に位置決め用の第１の切欠き(７４ａ，７４ｂ)及び第２の切欠き(７５ａ，７５ｂ)を設け、阻害手段(７０)を誤動作なく機能させる。

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明 細 書

作業車

技術分野

[0001] 本発明は、壁で囲われた限定区域内を移動しながら各種作業を行うための作業車に関し、特にプールなど（この明細書においてプールは、水を湛えておくもの総称とする。）の底面の清掃に好適に用いることができる作業車に関する。

背景技術

[0002] 特許文献1に記載されているように、従来、プールなどの底面をV字状の走行軌跡で移動しながら前記底面を万遍なく掃除する掃除機が知られている。

[0003] 特許文献1に記載されている掃除機は、自由回転車輪によって水底を前後方向に移動自在とした台車、台車下面に左右方向に延設され、かつ下方に開口された吸込口、吸込口にその吸込側が接続された水中ポンプ、水中ポンプの吐出口に導水管によって接続されかつ台車の前及び後に向けて開口された噴出口、導水管に設けられかつ吐出口から前のまたは後の噴出口に至る流路を択一に切換える切替弁を主たる構成とする。

[0004] 切替弁は、前後方向に摺動することにより前記切替が可能であり、さらに切替弁と一体にかつ前後端に接触センサーが設けられる。接触センサーは、左右に延びかつ前後に設けられた、前後のセンサー棒の左右に一個ずつ計4個設けられる。そして4個の接触センサーのうち、左側または右側の2個は固定センサーであり、他の2個は固定センサーよりも突出または没入の状態となる摺動センサーとして構成される。

[0005] 前後のセンサー棒には、さらにこれに対して左右方向に摺動自在に摺動棒が設けられる。摺動棒の左右各端には左右接触センサーが左右に突出して設けられる。そしてさらに摺動センサーに近い側の左右接触センサーが摺動センサーの方向に近接したときに、摺動センサーを突出した状態に保持する阻害手段が設けられている。

[0006] 以上の構成において、水中ポンプに図示しない電源から電力を供給すると、水中ポンプの作動により、吸込口から水底のごみなどを吸込み掃除する。一方水中ポンプから吐出された圧力水は吐出口、導水管を経由して、そのときの切替弁の状態に

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よって噴出口の何れか一方から噴出し、その反動によって台車が進行する。そして掃除機が壁に突当たると左右の各センサー共壁に突当たるが、左側の摺動センサーは突出した状態のままであり、まず掃除機は若干反時計方向にまわされる(尻振りされる)。またそれと同時に切替弁はその摺動により切替わり水噴出の噴出口が切替わり、掃除機は方向を少し振って戻る。これを自動的に繰返して水底を左から右に掃除して行く。

[0007] ついに右側の左右接触センサーが側壁に接触し、摺動棒がセンサー棒に対して左方向に摺動する。これに伴い阻害手段が解除され、摺動センサーが没入可能の状態となる。即ち摺動センサーは壁に突きあたった時固定センサーよりも引込んだ状態となり、掃除機は前記とは逆に前後の壁に突当たる度に逐次左側に寄る。このようにして、水底を万遍なく掃除する。

特許文献1:特許第2579599号公報

発明の開示

発明が解決しようとする課題

[0008] 上記掃除機で水底を万遍なく掃除するためには、摺動棒を左右接触センサーが側壁に接触するまで確実に位置保持し、かつ、左右接触センサーが側壁に接触したときに確実に摺動させて、阻害手段を誤動作なく機能させることが重要である。しかしながら、摺動棒は、筒状のセンサー棒に摺動自在に支承されているだけで、摺動抵抗のみで位置を保持する構造になっているため、掃除機が尻振りされたときに摺動してしまい、例えば掃除機をプールの右端に寄せる前に左側に向かって寄せたり、また、摺動棒とセンサー棒の隙間にごみなどの異物が詰まるなどして、左右接触センサーが側壁に接触したにもかかわらず摺動棒が摺動できず、例えば掃除機をプールの右端で繰り返し前後に移動させたりする。このように従来技術においては、阻害手段が誤動作し易く、プールなどの壁で囲われた限定区域内を万遍なく移動させることに対し信頼性に欠けるという課題があった。

課題を解決するための手段

[0009] 本発明は上記課題を解決するために、前後方向に移動自在とした台車と、前記台車から前記移動方向の一方に向かって突出され、独立的に進退自在とした左右一

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対の接触センサーと、前記各接触センサーの進退によって操作される左右一対の移動方向切替部材と、前記各接触センサーの一方を他方より前記移動方向の一方に向かって突出した状態に保持し、かつ突出保持する側を交互に切替る阻害手段を備えた作業車において、前記阻害手段は、前記各接触センサーが突出される前記台車の一端で左右方向に延設され、前記各接触センサーの退入を阻止する干渉部材と、一方が一方の前記接触センサーに対向するとき他方が他方の前記接触センサーに対し位置ずれするように、前記干渉部材に並設された左右一対のセンサー通過部と、前後方向に延びる中心軸を有し、前記干渉部材を左右方向に移動自在に下方から支える複数の転がり部材と、前記各転がり部材の周面が転がり接触する前記干渉部材の下部に設けられ、前記各センサー通過部の一方が一方の前記接触センサーに対向する前記干渉部材の第1の移動位置で前記各転がり部材の周側部の一部を嵌込ませて前記干渉部材を前記第1の移動位置に保持する第1の切欠き及び前記各センサー通過部の他方が他方の前記接触センサーに対向する前記干渉部材の第2の移動位置で前記各転がり部材の周側部の一部を嵌込ませて前記干渉部材を前記第2の移動位置に保持する第2切欠きと、前記台車の左右両側に向かって突出された前記干渉部材の左右端部に取付けられる左右一対の他の接触センサーとを備え、前記他の各接触センサーの接触によって前記干渉部材を前記第1の移動位置と前記第2の移動位置の2位置間で左右方向に往復移動させる構成としたもので、この構成を採用することにより、阻害手段を誤動作なく確実に機能させることができ、例えばプールなどの壁で囲われた限定区域内を万遍なく移動させることに対し信頼性を確保することができ、従来技術に対して大きく貢献することができるものである。

[0010] また、本発明においては、前記台車の前記移動方向の他方に向かって突出され、一体的に進退自在とした左右一対の第2接触センサーと、前記各第2接触センサーの進退によって操作される左右一対の移動方向第2切替部材と、前記各第2接触センサーが突出される前記台車の他端で左右方向に延設され、前記台車の左右両側に向かって突出されたセンサー取付アームの左右端部に取付けられる左右一対の他の第2接触センサーとを備え、前記阻害手段は、突出保持した一方の前記接触セ

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ンサーに近い側の一方の前記他の接触センサーをそれと同方向に突出している一方の前記他の第2接触センサーの前方又は後方で略同じ突出位置に保持させ、かつ、退入を許容した他方の前記接触センサーに近い側の他方の前記他の接触センサーをそれと同方向に突出している他方の前記他の第2接触センサーの前方又は後方でそれよりも外側の突出位置に保持し、前記台車の前記移動方向の前記一方から前記他方への切替えを前記各移動方向切替部材の何れか一方によって行い、前記台車の前記移動方向の前記他方から前記一方への切替えを前記各移動方向第2切替部材の両方によって行う構成を付加することにより、例えばプールなどの壁で囲われた限定区域内をレ字状の走行軌跡で万遍なく移動させることができる。

[0011] また、本発明においては、左右の前記接触センサー、左右の前記第2接触センサー、左右の前記他の第2接触センサーは、前記台車の前後方向の中心線を対称軸とする左右対称位置に配置されている構成を付加することにより、前記接触センサー、前記第2接触センサー、前記他の第2接触センサー、引いては移動方向切替部材及び移動方向第2切替部材などを左右で共用することができ、コスト削減を図ることができる。また、前記接触センサー、前記第2接触センサー、前記他の第2接触センサー、引いては移動方向切替部材及び移動方向第2切替部材などの構造、配置などが左右同一であるため、走行軌跡の設定を容易に行うことができる。

[0012] また、本発明においては、前記台車の下面に左右方向に延設され、かつ、下方に開口された吸込口と、前記吸込口に吸込側が接続された水中ポンプと、前記水中ポンプの吐出側に接続されるろ過器を備える構成を付加することにより、プールなどの底面を移動しながら前記底面を万遍なく掃除する掃除機を構成することができる。

[0013] また、本発明においては、前記台車は、車体フレームと、前記車体フレームに搭載する原動機と、前記車体フレームに回転自在に横架され、前記原動機によって回転される1本の駆動車軸と、前記駆動車軸上に取付けられ一体に回転する左右の駆動輪と、前記各駆動輪の前方又は後方に配置され、前記車体フレームに左右方向に延びる支軸を介して回転自在に取付けられる左右の従動輪と、前記駆動輪及び従動輪を囲むように前記車体フレームの左右側に配置された左右の軌道帯を備える構成を採用することにより、高く、かつ、安定した直進性（車軸と直角方向）を得ることが

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でき、例えばプールなどの壁で囲われた限定区域内を万遍なく移動させることに対しより高い信頼性を確保することができる。

発明の効果

[0014] 以上のように本発明によれば、阻害手段を誤動作なく確実に機能させることができ、例えばプールなどの壁で囲われた限定区域内を万遍なく移動させることに対し信頼性を確保することができ、従来技術に対して大きく貢献することができるという顕著な効果を奏するものである。

図面の簡単な説明

[0015] [図1]本発明の一実施の形態による作業車を示す全体平面図である。

[図2]本発明の一実施の形態による作業車を示す全体側面図である。

[図3]本発明の一実施の形態による作業車の移動方向の一方の接触センサー部の側面説明図である。

[図4]本発明の一実施の形態による作業車の移動方向のもう一方の接触センサー部の正面説明図である。

[図5]本発明の一実施の形態による作業車の移動方向のもう一方の接触センサー部の平面説明図である。

[図6]本発明の一実施の形態による作業車の走行軌跡を示す壁で囲われた限定区域の平面図である。

符号の説明

[0016] 1 作業車

2 台車

3 吸込口

4 水中ポンプ

5 ろ過器

6 車体フレーム

7 モータ(原動機)

10 駆動車軸

11 駆動プーり(駆動輪)

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12 支軸

13 従動プーリ(従動輪)

14 ゴムベルト(軌道帯)

30 センサー横連結ロッド(センサー取付アーム)

30a, 30b 後接触センサー(第2接触センサー)

40a, 40b 後リードスイッチ(移動方向第2切替部材)

50a, 50b 前接触センサー(接触センサー)

60a, 60b 前リードスイッチ(移動方向切替部材)

70 阻害手段

71 干渉部材

72a, 72b センサー通過部

73a, 73b 転がり部材

74a, 74b 第1の切欠き

75a, 75b 第2切欠き

80a, 80b 前側の左右接触センサー(他の接触センサー)

90a, 90b 後側の左右接触センサー(他の第2接触センサー)

P プール(壁で囲われた限定区域)

P1, P2, P3, P4 側壁

R1, R2 走行軌跡

発明を実施するための最良の形態

[0017] 以下、本発明の実施の形態を図面に基づいて詳述する。図1は本発明の一実施の形態による作業車を示す全体平面図、図2は本発明の一実施の形態による作業車を示す全体側面図である。

[0018] 図1, 図2において、作業車1は、前後方向(縦方向)に移動自在とした台車2に、作業用として、台車2の下面に左右方向(横方向)に延設され、かつ、下方に開口された吸込口3と、吸込口3に可撓管3aを介して吸込側が接続された水中ポンプ4と、水中ポンプ4の吐出側に着脱自在に接続されるろ過器5(例えば水は通して塵埃は通さないナイロン布からなるろ過袋)とを備え、壁で囲われた限定区域の一例としての矩

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形状のプールP（図6参照）などの底面を掃除（作業の一例）する掃除機を構成している。

[0019] 台車2は、矩形枠状の車体フレーム6と、車体フレーム6の後部（図1，図2の右側）に形成された上面開口状の箱6a内に搭載する原動機としてのモータ7と、車体フレーム6の後部に箱6a内を横切る状態で回転自在に横架され、箱6a内でモータ軸7aと大小2個の減速用伝動歯車8，9を介して連動連結される1本の駆動車軸10と、車体フレーム6の左右両外側に突出される駆動車軸10の左右両端部に取付けられ、駆動車軸10と一体に回転する左右の駆動輪としての駆動プーり11と、車体フレーム6の前部（図1，図2の左側）に回転自在に横架される1本の支軸12と、車体フレーム6の左右両外側に突出される支軸12の左右両端部に回転自在に取付けられ、左右の駆動プーリ11の前方に配置される左右の従動輪としての従動プーり13と、前後に並ぶ駆動プーリ11及び従動プーリ12に巻掛けられ、車体フレーム6の左右両外側に配置された左右の軌道帯としてのゴムベルト14と、前後に並ぶ駆動プーリ11及び従動プーリ12の間に配置され、ゴムベルト14の非接地側を上方から下方に押圧し、ゴムベルト14の張り具合を調整するテンションローラ15とを備えて構成されている。

[0020] また、箱6aの開口上面を水中ポンプ4のベース板4aによって閉鎖し、箱6aとベース板4aの間にパッキン16を配置すると共に、駆動車軸10が箱6aを挿通する部分に図示しないオイルシールなどの軸封装置を配置して、箱6a内への水の浸入を防止している。このように気密に保たれる箱6a内には、作業車1の走行や作業を制御するためのコントローラ17が収納されている。コントローラ17に接続するケーブル18が箱6aを挿通する部分にもシール部材が配置されている。

[0021] なお、図1，図2において、符号19は水中ポンプ4をベース板4aに取付けるポンプホルダー、20は台車2の上側に着脱自在に取付けられ、水中ポンプ4などを覆う下面開口状の箱形の車体カバー、21はポンプホルダー19の上面に取付けられ、車体カバー20の上側に突出して配置される取手である。車体カバー20の上側にはろ過器5を接続する水中ポンプ4の吐出口も突出して配置され、コントローラ17に接続されたケーブル18も引出されている。また、水中ポンプ4のケーブル22は車体カバー20の後面から外部に引出されている。

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[0022] さらに、作業車1は、台車2の後端から後方に向かって突出され、作業車1の前後方向の中心線Yに沿って一体的に進退自在とした左右一対の第2接触センサーとしての左右の後接触センサー30a，30bと、各後接触センサー30a，30bによって操作される左右一対の移動方向第2切替部材としての左右の後リードスイッチ40a，40bと、台車2の前端から前方に向かって突出され、作業車1の前後方向の中心線Yに沿って独立的に進退自在とした左右一対の接触センサーとしての左右の前接触センサー50a，50bbと、各前接触センサー50a，50bの進退によって操作される左右一対の移動方向切替部材としての左右の前リードスイッチ60a，60bと、各前接触センサー50a，50bの一方を他方より前方に向かって突出した状態に保持し、かつ突出保持する側を交互に切替る阻害手段70と、台車2の左外側に配置する前後一対の横接触センサーとしての左接触センサー80a，90aと、台車2の右外側に配置する前後一対の横接触センサーとしての右接触センサー80b，90bとを備えるもので、図1，図2及び図3を参照して各後接触センサー30a，30b、各後リードスイッチ40a，40b、後側の左右接触センサー90a，90bを説明し、次に、図1，図2及び図4，図5を参照して各前接触センサー50a，50b、各前リードスイッチ60a，60b、阻害手段70、前側の左右接触センサー80a，80bを説明する。

[0023] 図3は本発明の一実施の形態による作業車の後側の接触センサー部の側面説明図であり、図1，図2及び図3に示すように、各後接触センサー30a，30bは、筒状のセンサーキャップ31と、センサーキャップ31内に摺動自在に嵌合されるピストン状のセンサーストッパー部32aを一端側に有して、センサーストッパー部32aからセンサーキャップ31の外側に突出するセンサーロッド32と、センサーキャップ31内に配置され、センサーストッパー部32aを介してセンサーロッド32を突出方向に付勢するコイルスプリングであるセンサーバネ33と、接触対象のプールPの側壁を傷付けないようそれに突き当てる合成樹脂製で略半球状の接触子34とを備えて構成されている。センサーキャップ31，センサーストッパー部32a，センサーロッド32，センサーバネ33は同軸上に配置され、作業車1の前後方向の中心線Yに沿って伸縮する片側ロッド式のシリンダ構造を構成している。

[0024] 各後リードスイッチ40a，40bには、独立した磁石部41と、スイッチ部42の2つより構

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成され、両者の接近または隔離によりスイッチ部42の接点43a，43b（ノーマルオープン）が開閉するマグネットスイッチが使用され、磁石部41が各センサーロッド32のセンサーストッパー部32aの中心部に配置され、スイッチ部42がセンサーキャップ31のロッド側とは反対側の内端部に配置され、両者がセンサーロッド32と同軸上で対向している。これにより、各後リードスイッチ40a，40bがセンサーロッド32の進退により開閉するように構成されている。

[0025] 各左右接触センサー90a，90bには、接触対象のプールPの側壁を傷付けないように接触し、かつ、接触後に回転（転がり接触）するように、上下方向に延びる垂直軸91回りで回転する転がり接触部材である合成樹脂製で円盤状のローラが使用されている。

[0026] そして、車体フレーム6の後端（箱2aの後側面）の左右側部にそれぞれセンサーロッド32が後方に向けて突出する状態でセンサーキャップ31が取付けると共に、各センサーロッド32の先端に接触子34を取付け、台車2の後端側から後方に向けて突出される左右の後接触センサー30a，30bを構成するのであるが、各後接触センサー30a，30bの接触子34及びセンサーロッド32を作業車1の前後方向の中心線Yに沿って一体的に進退させるために、各センサーロッド32の先端側は、台車2の左右方向に延びるセンサー横連結ロッド30により相互に一体連結されている。この連結により各後接触センサー30a，30bのシリンダ構造を介して車体フレーム6の後端に前後方向に平行移動自在に連結支持されるセンサー横連結ロッド30は、この左右両端部を各ゴムベルト14よりもさらに左右外側にまで延出しており、センサー横連結ロッド30の後側面に、各接触子34が各ゴムベルト14の相互間寸法よりやや狭い間隔を設けて後向きに突出した状態で取付けられている。また、後側の左右接触センサー90a，90bの略半分が各ゴムベルト14よりも外側に位置するように、後側の左右接触センサー90a，90bを中心軸91を介してセンサー横連結ロッド30の左右両端部上側に回転自在に取付け、この後側の左右接触センサー90a，90bを、左右の後接触センサー30a，30bが突出される台車2の後端で左右方向に延設され、台車2の左右両側に向かって突出されたセンサー取付アーム（センサー横連結ロッド30）の左右端部に取付けられる左右一対の他の第2接触センサーとしている。

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[0027] また、後接触センサー30a，30b、後リードスイッチ40a，40b、後側の左右接触センサー90a，90b及びセンサー横連結ロッド30は、作業車1の前後方向の中心線Yを対称軸として左右対称構造を有している。

[0028] さらに、各スイッチ部42のリード線44は、各センサーキャップ31のロッド側とは反対側の端部から車体フレーム6の箱6a内に引出されてコントローラ17に接続され、コントローラ17は各後リードスイッチ40a，40bのアンド出力によってモータ7を逆転駆動させるための移動方向切替信号をモータドライブ回路に出力するように回路構成されている。

[0029] 図4は本発明の一実施の形態による作業車の前側の接触センサー部の正面説明図、図5は本発明の一実施の形態による作業車の前側の接触センサー部の平面説明図であり、図1，図2及び図4，図5に示すように、各前接触センサー50a，50bは、筒状のセンサーキャップ51と、センサーキャップ51内に摺動自在に嵌合されるピストン状のセンサーストッパー部52aを軸方向中間部に有して、両端側をセンサーキャップ51の両端側から外側に突出するセンサーロッド52と、センサーロッド52の一端に取付けられ、接触対象のプールPの側壁を傷付けないようそれに突き当てる合成樹脂製で略半球状の接触子53と、センサーキャップ51と接触子53間のセンサーロッド52外側に配置され、センサーロッド52の接触子53取付け側を突出方向に付勢するコイルスプリングであるセンサーバネ54とを備えて構成されている。センサーキャップ51，センサーストッパー部52a，センサーロッド52，接触子53，センサーバネ54は同軸上に配置され、作業車1の前後方向の中心線Yに沿って伸縮する両側ロッド式のシリンダ構造を構成している。

[0030] 各前リードスイッチ60a，60bには、後リードスイッチ40a，40bと同じマグネットスイッチが使用され、磁石部61（41）が各センサーロッド52の接触子53取付け側とは反他側の端部中心部に配置され、スイッチ部62（42）が車体フレーム6の前端左右両外側にスイッチ取付け台65を介して取付けられ、両者がセンサーロッド52と同軸上で対向している。これにより、各前リードスイッチ60a，60bがセンサーロッド52の進退により開閉するように構成されている。

[0031] 前側の左右接触センサー80a，80bには、後側の左右接触センサー90a，90bと同

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じローラが使用され、上下方向に延びる垂直軸81回りで回転する。

[0032] そして、台車2の前側に左右方向に延設され、各スイッチ部62の前側を通過させて左右両端部を各ゴムベルト14の前方にまで延出するセンサープレート80を備え、車体フレーム6の前端にセンサープレート80を車体フレーム6の前側面から前方に所定寸法だけ離反させた状態で4本のボルト100及びスペーサ101を介して取付け、センサープレート80前側面の左右側端部に、センサーロッド52の接触子53取付け側が前方に向けて突出する状態でセンサーキャップ51を取付け、台車2の前端側から前方に向けて突出され、接触子54及びセンサーロッド52を作業車1の前後方向の中心線Yに沿って独立的に進退させる左右の前接触センサー50a，50bを構成している。

[0033] また、各前接触センサー50a，50bは、この軸線が平面視において各後接触センサー30a，30bの接触子34の中心線に一致するように配置され、センサープレート80には、各前接触センサー50a，50bの軸線と同芯な左右の貫通孔102a，102bが設けられ、センサーロッド52の接触子53取付け側とは反他側を各貫通孔102a，102bを介してセンサープレート80の後側で作業車1の前後方向の中心線Yに沿って進退させ、磁石部61とスイッチ部62の接近または隔離によりスイッチ部62の図示しない接点63a，63b（ノーマルオープン）を開閉するように構成している。

[0034] また、前接触センサー50a，50b、前リードスイッチ60a，60bは、作業車1の前後方向の中心線Yを対称軸として左右対称構造を有している。

[0035] さらに、各スイッチ部62のリード線64は、車体フレーム6の箱6aの前側壁に設けられたケーブルホルダー103から一括に箱6a内に引込まれてコントローラ17に接続され、コントローラ17は左右の前リードスイッチ60a，60bのオア出力によってもモータ7を逆転駆動させるための移動方向切替信号をモータドライブ回路に出力するように回路構成されている。

[0036] 阻害手段70は、各センサーロッド52の退入を択一的に阻止するために、車体フレーム6とセンサープレート80の隙間に配置されて、左右上側のスペーサー101と左右下側のスペーサー101間を通して左右方向に延設され、かつ、各磁石部61と各スイッチ部62の間を横切って左右両端部を各ゴムベルト14よりもさらに左右外側にま

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で延出する細幅な平板状の干渉部材71と、各センサーロッド52の軸線の相互間隔と異なる中心線の相互間隔を持って干渉部材71に並設される、各センサーロッド52よりやや大径の左右一対の貫通孔でなり、一方の中心線が一方のセンサーロッド52の軸線に一致してそのセンサーロッド52に対向するとき、他方の中心線が他方のセンサーロッド52の軸線から左側又は右側に位置ずれしてそのセンサーロッド52に対向しない左右一対のセンサー通過部72a，72bと、センサープレート80に枢着された前後方向に延びる水平な中心軸73を有し、車体フレーム6とセンサープレート80の隙間に中心軸73回りで回転自在に配置されて、各センサー通過部72a，72bより内側の干渉部材71下部に周面（回転面）を当接させ、干渉部材71を左右方向に移動自在に下方から支える転輪からなる複数（本実施形態では左右2個）の転がり部材73a，73bと、各転がり部材73a，73bの周面が転がり接触する干渉部材71の下部に設けられ、左側のセンサー通過部72aが左側のセンサーロッド52に対向する干渉部材71の第1の移動位置で各転がり部材73a，73bの周側部の一部を嵌込ませて干渉部材71を第1の移動位置に保持する略半円形状の左右の第1の切欠き74a，74b及び右側のセンサー通過部73bが右側のセンサーロッド52に対向する干渉部材71の第2の移動位置（図示の位置）で各転がり部材73a，73bの周側部の一部を嵌込ませて干渉部材71を第2の移動位置に保持する略半円形状（第1の切欠き74a，74bと同形状）の左右の第2の切欠き75a，75bと、干渉部材71の左右両端部上側に中心軸81を介して回転自在に取付ける前側の左右接触センサー80a，80bとを備え、前側の左右接触センサー80a，80bのプールPの側壁との接触によって干渉部材71を第1の移動位置と第2の移動位置の2位置間で左右方向に往復移動させるように構成している。ここで、ステンレス等の金属製の干渉部材71を支持する部材が金属製で、金属と金属の接触になることがないよう、金属製の干渉部材71を支持する部材すなわち転がり部材73a，73bには合成樹脂製の転輪が使用されている。

[0037] また、阻害手段70は、干渉部材71を第1の移動位置に保持しているときは、作業車1の前後方向の中心線Yと平行で、後側の左接触センサー90aの中心を通過する直線よりも左外側に前側の左接触センサー80aの中心を位置させ、前側の左接触センサー80aを後側の左接触センサー90aよりも左外側に突出保持すると共に、干渉

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部材71を図示の第2の移動位置に保持しているときは、作業車1の前後方向の中心線Yと平行で、後側の右接触センサー90bの中心を通過する直線よりも右外側に前側の右接触センサー80bの中心を位置させ、前側の右接触センサー80bを後側の右接触センサー90bよりも右外側に突出保持する。すなわち退入を許容した側の前接触センサー50a又は50bに近い側の前側の横接触センサー80a又は80bをその後方にあり同方向に突出する後側の横接触センサー90a又は90bよりも外側に突出保持するように構成している。

[0038] さらに、阻害手段70は、干渉部材71を第1の移動位置に保持しているときは、作業車1の前後方向の中心線Yと平行で、後側の右接触センサー90bの中心を通過する直線上に前側の右接触センサー80bの中心を位置させ、前側の右接触センサー80bを後側の右接触センサー90bと略同じ左右方向位置に突出保持すると共に、干渉部材71を図示の第2の移動位置に保持しているときは、作業車1の前後方向の中心線Yと平行で、後側の左接触センサー90aの中心を通過する直線上に前側の左接触センサー80aの中心を位置させ、前側の左接触センサー80aを後側の左接触センサー90aと略同じ左右位置に突出保持する。すなわち退入を阻止し突出状態に保持した側の前接触センサー50a又は50bに近い側の前側の横接触センサー80a又は80bをその後方にあり同方向に突出する後側の横接触センサー90a又は90bと略同じ左右方向位置に突出保持するように構成している。

[0039] このように阻害手段70によって後側の左右接触センサー90a，90bに対し左右方向位置が変位する前側の左右接触センサー80a，80bを、左右の前接触センサー50a，50bが突出される台車2の前端で左右方向に延設され、台車2の左右両側に向かって突出されたセンサー取付アーム（干渉部材71）の左右端部に取付けられる左右一対の他の接触センサーとしている。

[0040] 上記のように構成された作業車1の動作を図6を参照して説明する。図6は本発明の一実施の形態による作業車の走行軌跡を示すプールの平面図である。作業車1を水が湛えられたプールP内に入れ、ケーブル18，22を図示しない電源に接続し、手元スイッチなどを操作して水中ポンプ4及びモータ7を作動させることにより、作業車1は、モータ7の作動によりプールPの底面を移動しながら、水中ポンプ7の作動により

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台車2下面の吸込口3から水と共に前記底面のごみを吸込み、ろ過器5により水とごみを分離してごみをろ過器5内に回収し、プールPの底面を掃除する。

[0041] この際、図6に示すように、プールPの長辺側の一方の側壁P1（図6の下側の側壁、以下、「下側壁」という。）の際から作業車1の前が長辺側の他方の側壁P2（図6の上側の側壁、以下、「上側壁」という。）に向く姿勢で作業車1をプールPに入れ、その投入位置Aから作業車1を先ず前進走行を開始させる（コントローラー17の初期設定）。これにより、作業車1は、図6の下から上方向へ移動しながら上側壁P2に寄って行き、台車1から前方に同じ前後方向位置で突出している左右の前接触センサー50a，50bの接触子53が略同時に上側壁P2に突当たると、そのときの阻害手段70の状態によって何れか一方の前接触センサー50a又は50bのセンサーロッド52を退入させるので、この退入した前接触センサー50a又は50b側に台車2の後側が横に振られ、作業車1の姿勢が全体的に上側壁P2に対して傾けられる。図示の場合、阻害手段70の干渉部材71が第2の移動位置に保持された状態にあるので、右側の前接触センサー50bのセンサーロッド52が退入し、台車2の後側が右側に振られる（この作業車1の状態を基準にこれ以降の動作説明を行う）。この直後、右側の前接触センサー50bのセンサーロッド52によって右側の前リードスイッチ50bが閉じられるので、この右側の前リードスイッチ50bの出力によってモータ7が逆転し、作業車1の移動方向が前進から後進に切替えられる。

[0042] このような上側壁P2への接触による姿勢変更と移動方向の切替えにより、作業車1は、上側壁P2に接触した後に後進走行を開始し、図6の上から右斜め下方向へ移動しながら下側壁P1に寄って行く。これにより、台車1から後方に同じ前後方向位置で突出している左右の後接触センサー30a，30bの接触子34のうち、先に左側の後接触センサー30aの接触子34が上側壁P2に突当たるので、台車2の前側が右側に振られ、これに伴って右側の後接触センサー30bの接触子34が上側壁P2に突当たることにより、作業車1の姿勢が下側壁P2に対して垂直に戻される。この直後、左右の後接触センサー30a，30bのセンサーロッド32が共に退入し、左右の後リードスイッチ40a，40bが共に閉じられるので、これら左右の後リードスイッチ40a，40bのアンド出力によってモータ7が逆転し、作業車1の移動方向が後進から前進に切替えられ

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、このような下側壁P1への接触による姿勢変更と移動方向の切替えにより、作業車1は下側壁P2に接触した後に再び前進走行を開始する。

[0043] 上記のように作業車1は、上側壁P2への接触による姿勢変更と移動方向の切替え及び下側壁P1への接触による姿勢変更と移動方向の切替えにより、下側壁P1と上側壁P2の間を下に開いたレ字状の走行軌跡で1往復し、それを繰返しながら投入位置Aから図6の実線で示すようなジグザグの走行軌跡R1で徐々にプールPの右端に寄って行く。

[0044] また、作業車1がプールPの短辺側の一方の側壁、すなわち右側壁P3(図6の右側の側壁)の際に至ると、作業車1がその移動に伴って右側壁P3に接近する後進走行工程において、台車2から右外側に突出している前後の右接触センサー80b，90bのうち、先に後側の右接触センサー90bが右側壁P3に接触した後に転がり接触し、台車2の前側が右側壁P3に徐々に接近して行き、ついには前側の右接触センサー80bが右側壁P3に接触して左側に押圧される。これにより、阻害手段70の干渉部材71が左側に移動し、第2の切欠き75a，75bが各転がり部材73a，73bから離脱し、第1の切欠き74a，74bが各転がり部材73a，73bに嵌込まれ、第2の移動位置から第1の移動位置に保持され、阻害手段70は左側の前接触センサー50aのセンサーロッド52を退入可能とし、右側の前接触センサー50bのセンサーロッド52を突出状態に保持し、また、前側の右接触センサー80bを後側の右接触センサー90bと略同じ左右方向位置に突出保持すると共に、前側の左接触センサー80aを後側の左接触センサー90aよりも外側に突出保持する。

[0045] このような右側壁P3への接触による横行方向の切替えにより、作業車1は、その切替位置Bから略同じ左右方向位置に突出保持された前後の右接触センサー80b，90bを右側壁P3に転がり接触させながら右側壁P3に沿って下側壁P1まで移動し、下側壁P1への接触による移動方向の切替えにより右側壁P3に沿って上側壁P2まで移動した位置Cで、上側壁P2への接触による姿勢変更と移動方向の切替えを行うのであるが、このとき阻害手段70の干渉部材71は既に第1の移動位置に保持された状態にあり、左側の前接触センサー50aのセンサーロッド52が退入するので、台車2の後側は左側に振られる。また、これ以降の上側壁P2への接触による姿勢変更は台車

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2の後側を左側に振る姿勢変更となり、また、下側壁P1への接触による姿勢変更は台車2の前側を左側に振る姿勢変更となる。

[0046] 上記ように作業車1は、C位置から上側壁P2への接触による姿勢変更と移動方向の切替え及び下側壁P1への接触による姿勢変更と移動方向の切替えにより、下側壁P1と上側壁P2の間を上に開いたレ字状の走行軌跡で1往復し、それを繰返しながらC位置から図6の破線で示すようなジグザグの走行軌跡R2でプールPの右端から徐々に左端に寄って行く。

[0047] さらに、作業車1がプールPの短辺側の他方の側壁、すなわち左側壁P4（図6の左側の側壁）の際に至ると、作業車1がその移動に伴って左側壁P4に接近する後進走行工程において、台車2から左外側に突出している前後の左接触センサー80a，90aのうち、先に後側の左接触センサー90aが左側壁P4に接触した後に転がり接触し、台車2の前側が左側壁P4に徐々に接近して行き、ついには前側の左接触センサー80aが左側壁P4に接触して右側に押圧される。これにより、阻害手段70の干渉部材71が右側に移動し、第1の切欠き74a，74bが各転がり部材73a，73bから離脱し、第2の切欠き75a，75bが各転がり部材73a，73bに嵌込まれ、第1の移動位置から第2の移動位置に保持され、阻害手段70は再び右側の前接触センサー50bのセンサーロッド52を退入可能とし、左側の前接触センサー50aのセンサーロッド52を突出状態に保持し、また、前側の左接触センサー80aを後側の左接触センサー90aと略同じ左右方向位置に突出保持すると共に、前側の右接触センサー80bを後側の右接触センサー90bよりも外側に突出保持する。

[0048] このような左側壁P4への接触による横行方向の切替えにより、作業車1は、その切替位置Dから略同じ左右方向位置に突出保持された前後の左接触センサー80a，90aを左側壁P4に転がり接触させながら左側壁P4に沿って下側壁P1まで移動し、下側壁P1への接触による移動方向の切替えにより左側壁P4に沿って上側壁P2まで移動した位置Eで、上側壁P2への接触による姿勢変更と移動方向の切替えを行うのであるが、このとき阻害手段70の干渉部材71は既に第2の移動位置に保持された状態にあり、右側の前接触センサー50bのセンサーロッド52が退入するので、台車2の後側は右側に振られる。また、これ以降の上側壁P2への接触による姿勢変更は台車

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2の後側を右側に振る姿勢変更となり、また、下側壁P1への接触による姿勢変更は台車2の前側を右側に振る姿勢変更となる。

[0049] 上記のように作業車1は、E位置から上側壁P2への接触による姿勢変更と移動方向の切替え及び下側壁P1への接触による姿勢変更と移動方向の切替えにより、下側壁P1と上側壁P2の間を下に開いたレ字状の走行軌跡で1往復し、それを繰返しながらE位置から図6の実線で示すようなジグザグの走行軌跡R1でプールPの左端から徐々に右端に寄って行く。

[0050] 従って、作業車1は、上記のような各走行軌跡R1，R2でプールPの底面をエンドレスで走行移動することにより、プールPの底面をすみずみまで万遍なくきれいに掃除することができ、また、走行軌跡R1，R2がジグザグのために、ケーブル18，22に捻り力が加わりにくく、ケーブル18，22の絡付きにより作業車1の走行が阻害されたり、停止してしまうなどの不都合も起こしにくいものである。

[0051] なお、作業開始時の作業車1の進行方向は、前進、後進の何れに設定して置いてもよい。

[0052] 上記のように本実施の形態による作業車1は、前後方向に移動自在とした台車2と、前記台車2から前記移動方向の一方に向かって突出され、独立的に進退自在とした左右一対の接触センサー50a，50bと、前記各接触センサー50a，50bの進退によって操作される左右一対の移動方向切替部材60a，60bと、前記各接触センサー50a，50bの一方を他方より前記移動方向の一方に向かって突出した状態に保持し、かつ突出保持する側を交互に切替る阻害手段70を備え、前記阻害手段70は、前記各接触センサー50a，50bが突出される前記台車2の一端で左右方向に延設され、前記各接触センサー50a，50bの退入を阻止する干渉部材71と、一方が一方の前記接触センサー50a又は50bに対向するとき他方が他方の前記接触センサー50a又は50bに対し位置ずれするように、前記干渉部材70に並設された左右一対のセンサー通過部72a，72bと、前後方向に延びる中心軸73を有し、前記干渉部材70を左右方向に移動自在に下方から支える複数の転がり部材73a，73bと、前記各転がり部材73a，73bの周面が転がり接触する前記干渉部材70の下部に設けられ、前記各センサー通過部72a，72bの一方が一方の前記接触センサー50a又は50bに対向する

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前記干渉部材70の第1の移動位置で前記各転がり部材73a，73bの周側部の一部を嵌込ませて前記干渉部材70を前記第1の移動位置に保持する第1の切欠き74a，74b及び前記各センサー通過部72a，72bの他方が他方の前記接触センサー50a又は50bに対向する前記干渉部材70の第2の移動位置で前記各転がり部材73a，73bの周側部の一部を嵌込ませて前記干渉部材70を前記第2の移動位置に保持する第2切欠き75a，75bと、前記台車2の左右両側に向かって突出された前記干渉部材70の左右端部に取付けられる左右一対の他の接触センサー80a，80bとを備え、前記他の各接触センサー80a，80bの接触によって前記干渉部材70を前記第1の移動位置と前記第2の移動位置の2位置間で左右方向に往復移動させるもので、例えば、上下側壁P2，P1への接触による作業車1の姿勢変更、左右側壁P4，P3への接触による横行方向の切替えに伴う姿勢変更の際に、干渉部材70に左右横方向への押圧力が作用したとしても、干渉部材70を転がり部材73a，73bと第1の切欠き74a，74b又は第2切欠き75a，75bの嵌め合いにより、他の各接触センサー80a，80bが側壁P3，P4に接触するまで確実に位置保持し、かつ、干渉部材70を摺動させることなく転がり部材73a，73bの上で転がり接触移動させることにより、他の各接触センサー80a，80bが側壁P3，P4に接触したときに確実に移動させ、阻害手段70を誤動作なく機能させることができ、プールP内を万遍なく移動させることに対し信頼性（作業性能の信頼性）を確保することができ、従来技術に対して大きく貢献することができる。

[0053] 前記台車2の前記移動方向の他方に向かって突出され、一体的に進退自在とした左右一対の第2接触センサー30a，30bと、前記各第2接触センサー30a，30bの進退によって操作される左右一対の移動方向第2切替部材40a，40bと、前記各第2接触センサー30a，30bが突出される前記台車2の他端で左右方向に延設され、前記台車2の左右両側に向かって突出されたセンサー取付アーム30の左右端部に取付けられる左右一対の他の第2接触センサー90a，90bとを備え、前記阻害手段70は、突出保持した一方の前記接触センサー50a又は50bに近い側の一方の前記他の接触センサー80a又は80bをそれと同方向に突出している一方の前記他の第2接触センサー90a又は90bの前方又は後方で略同じ突出位置に保持させ、かつ、退入を

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許容した他方の前記接触センサー50a又は50bに近い側の他方の前記他の接触センサー80a又は80bをそれと同方向に突出している他方の前記他の第2接触センサー90a，90bの前方又は後方でそれよりも外側の突出位置に保持し、前記台車2の前記移動方向の前記一方から前記他方への切替えを前記各移動方向切替部材60a，60bの何れか一方によって行い、前記台車2の前記移動方向の前記他方から前記一方への切替えを前記各移動方向第2切替部材40a，40bの両方によって行うもので、プールP内をレ字状の走行軌跡R1，R2で万遍なく移動させることができ、プールPの底面をすみずみまで万遍なくきれいに掃除することができる(作業性能の向上)。

[0054] 左右の前記接触センサー50a，50b、左右の前記第2接触センサー30a，30b、左右の前記他の第2接触センサー90a，90bは、前記台車2の前後方向の中心線を対称軸とする左右対称位置に配置されているもので、前記接触センサー50a，50b、前記第2接触センサー30a，30b、前記他の第2接触センサー90a，90b、引いては移動方向切替部材60a，60b及び移動方向第2切替部材40a，40bなどを左右で共用することができ、コスト削減を図ることができる。また、前記接触センサー50a，50b、前記第2接触センサー30a，30b、前記他の第2接触センサー90a，90b、引いては移動方向切替部材60a，60b及び移動方向第2切替部材40a，40bなどの構造、配置などが左右同一であるため、走行軌跡R1，R2の設定を容易に行うことができる(各種作業、使用環境への対応性向上)。

[0055] 前記台車2は、車体フレーム6と、前記車体フレーム6に搭載する原動機7と、前記車体フレーム6に回転自在に横架され、前記原動機7によって回転される1本の駆動車軸10と、前記駆動車軸10上に取付けられ一体に回転する左右の駆動輪11と、前記各駆動輪11の前方又は後方に配置され、前記車体フレーム6に左右方向に延びる支軸12を介して回転自在に取付けられる左右の従動輪13と、前記駆動輪11及び従動輪13を囲むように前記車体フレーム6の左右側に配置された左右の軌道帯14を備えるもので、高く、かつ、安定した直進性(車軸と直角方向)を得ることができ、プールP内を万遍なく移動させることに対しより高い信頼性(作業性能の信頼性)を確保することができる(作業性能の向上及び各種作業、使用環境への対応性向上)。

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[0056] 以上、本実施の形態は本発明の作業車の好適な一実施の形態を示したが、本発明はそれに限定されることなく、その要旨を逸脱しない範囲内で種々変形実施することができる。

Beatbot, Ex. 1011
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請求の範囲

[1] 前後方向に移動自在とした台車と、前記台車から前記移動方向の一方に向かって突出され、独立的に進退自在とした左右一対の接触センサーと、前記各接触センサーの進退によって操作される左右一対の移動方向切替部材と、前記各接触センサーの一方を他方より前記移動方向の一方に向かって突出した状態に保持し、かつ突出保持する側を交互に切替る阻害手段を備えた作業車において、前記阻害手段は、前記各接触センサーが突出される前記台車の一端で左右方向に延設され、前記各接触センサーの退入を阻止する干渉部材と、一方が一方の前記接触センサーに対向するとき他方が他方の前記接触センサーに対し位置ずれするように、前記干渉部材に並設された左右一対のセンサー通過部と、前後方向に延びる中心軸を有し、前記干渉部材を左右方向に移動自在に下方から支える複数の転がり部材と、前記各転がり部材の周面が転がり接触する前記干渉部材の下部に設けられ、前記各センサー通過部の一方が一方の前記接触センサーに対向する前記干渉部材の第1の移動位置で前記各転がり部材の周側部の一部を嵌込ませて前記干渉部材を前記第1の移動位置に保持する第1の切欠き及び前記各センサー通過部の他方が他方の前記接触センサーに対向する前記干渉部材の第2の移動位置で前記各転がり部材の周側部の一部を嵌込ませて前記干渉部材を前記第2の移動位置に保持する第2切欠きと、前記台車の左右両側に向かって突出された前記干渉部材の左右端部に取付けられる左右一対の他の接触センサーとを備え、前記他の各接触センサーの接触によって前記干渉部材を前記第1の移動位置と前記第2の移動位置の2位置間で左右方向に往復移動させることを特徴とする作業車。

[2] 前記台車の前記移動方向の他方に向かって突出され、一体的に進退自在とした左右一対の第2接触センサーと、前記各第2接触センサーの進退によって操作される左右一対の移動方向第2切替部材と、前記各第2接触センサーが突出される前記台車の他端で左右方向に延設され、前記台車の左右両側に向かって突出されたセンサー取付アームの左右端部に取付けられる左右一対の他の第2接触センサーとを備え、前記阻害手段は、突出保持した一方の前記接触センサーに近い側の一方の前記他の接触センサーをそれと同方向に突出している一方の前記他の第2接触センサ

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ーの前方又は後方で略同じ突出位置に保持させ、かつ、退入を許容した他方の前記接触センサーに近い側の他方の前記他の接触センサーをそれと同方向に突出している他方の前記他の第2接触センサーの前方又は後方でそれよりも外側の突出位置に保持し、前記台車の前記移動方向の前記一方から前記他方への切替えを前記各移動方向切替部材の何れか一方によって行い、前記台車の前記移動方向の前記他方から前記一方への切替えを前記各移動方向第2切替部材の両方によって行う請求項1に記載の作業車。

[3] 左右の前記接触センサー、左右の前記第2接触センサー、左右の前記他の第2接触センサーは、前記台車の前後方向の中心線を対称軸とする左右対称位置に配置されている請求項2に記載の作業車。

[4] 前記台車の下面に左右方向に延設され、かつ、下方に開口された吸込口と、前記吸込口に吸込側が接続された水中ポンプと、前記水中ポンプの吐出側に接続されるろ過器を備える請求項1乃至請求項3の何れか1項に記載の作業車。

[5] 前記台車は、車体フレームと、前記車体フレームに搭載する原動機と、前記車体フレームに回転自在に横架され、前記原動機によって回転される1本の駆動車軸と、前記駆動車軸上に取付けられ一体に回転する左右の駆動輪と、前記各駆動輪の前方又は後方に配置され、前記車体フレームに左右方向に延びる支軸を介して回転自在に取付けられる左右の従動輪と、前記駆動輪及び従動輪を囲むように前記車体フレームの左右側に配置された左右の軌道帯を備える請求項1乃至請求項4の何れか1項に記載の作業車。

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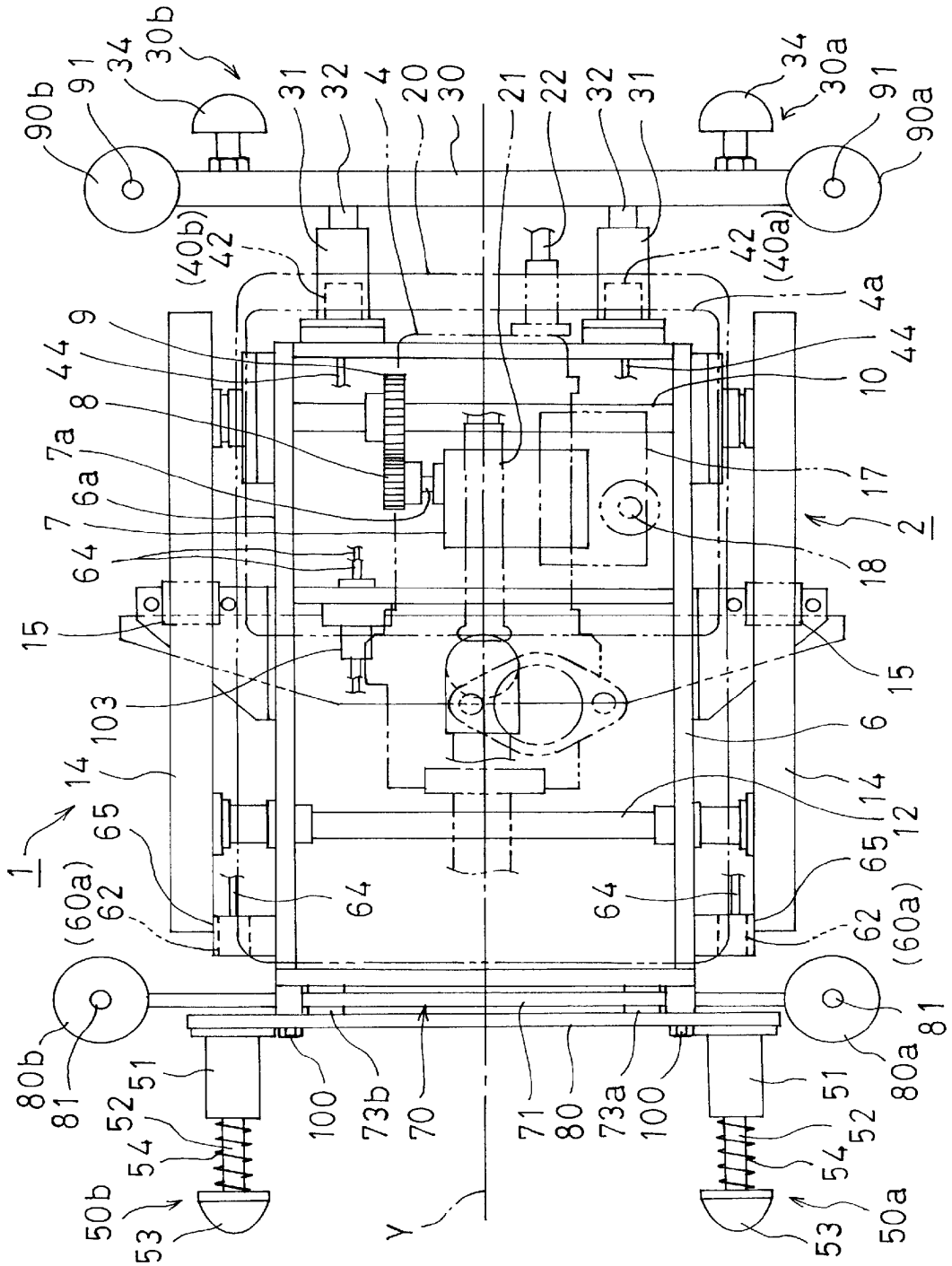
[図1]



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[図2]

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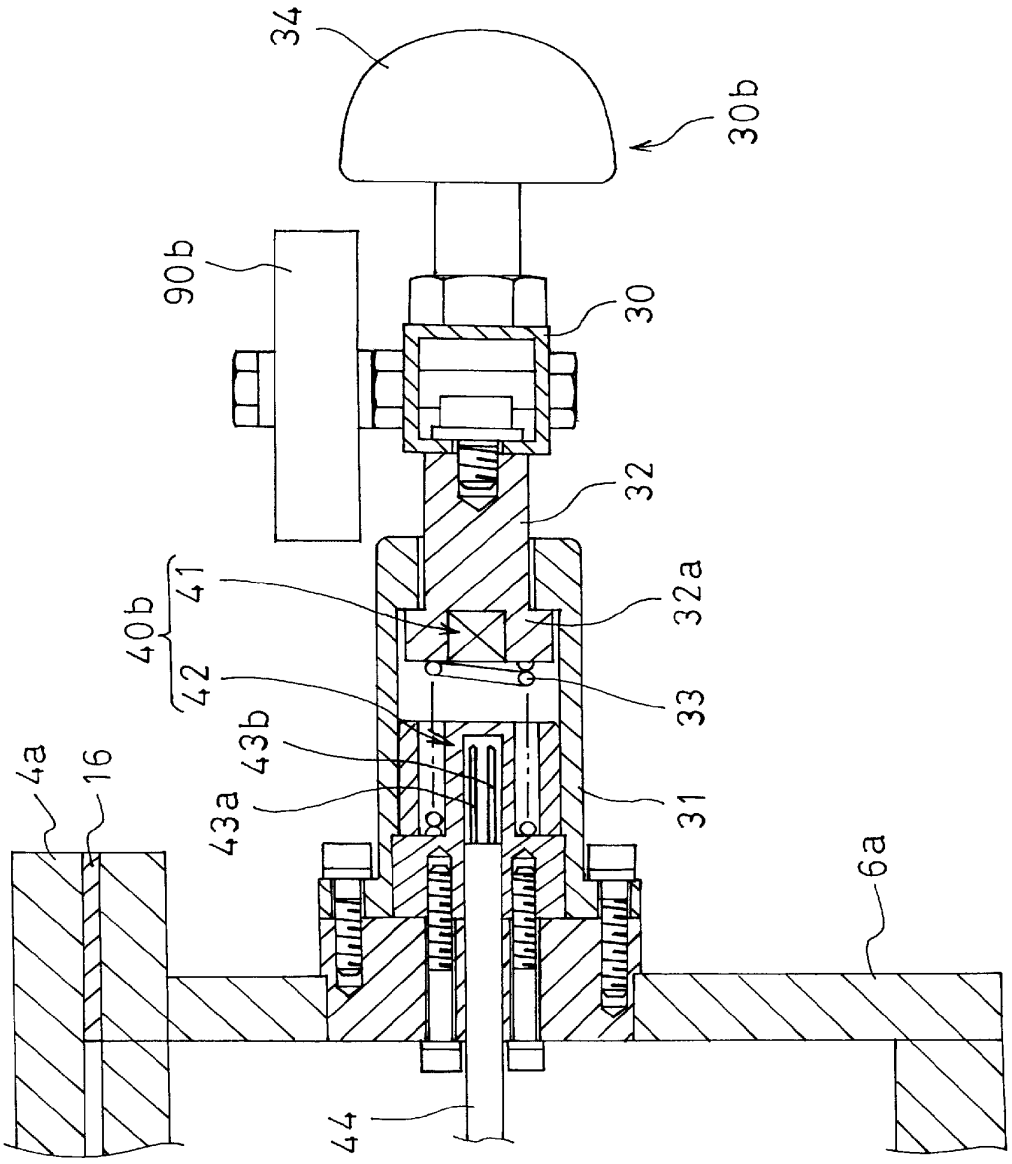
[図3]



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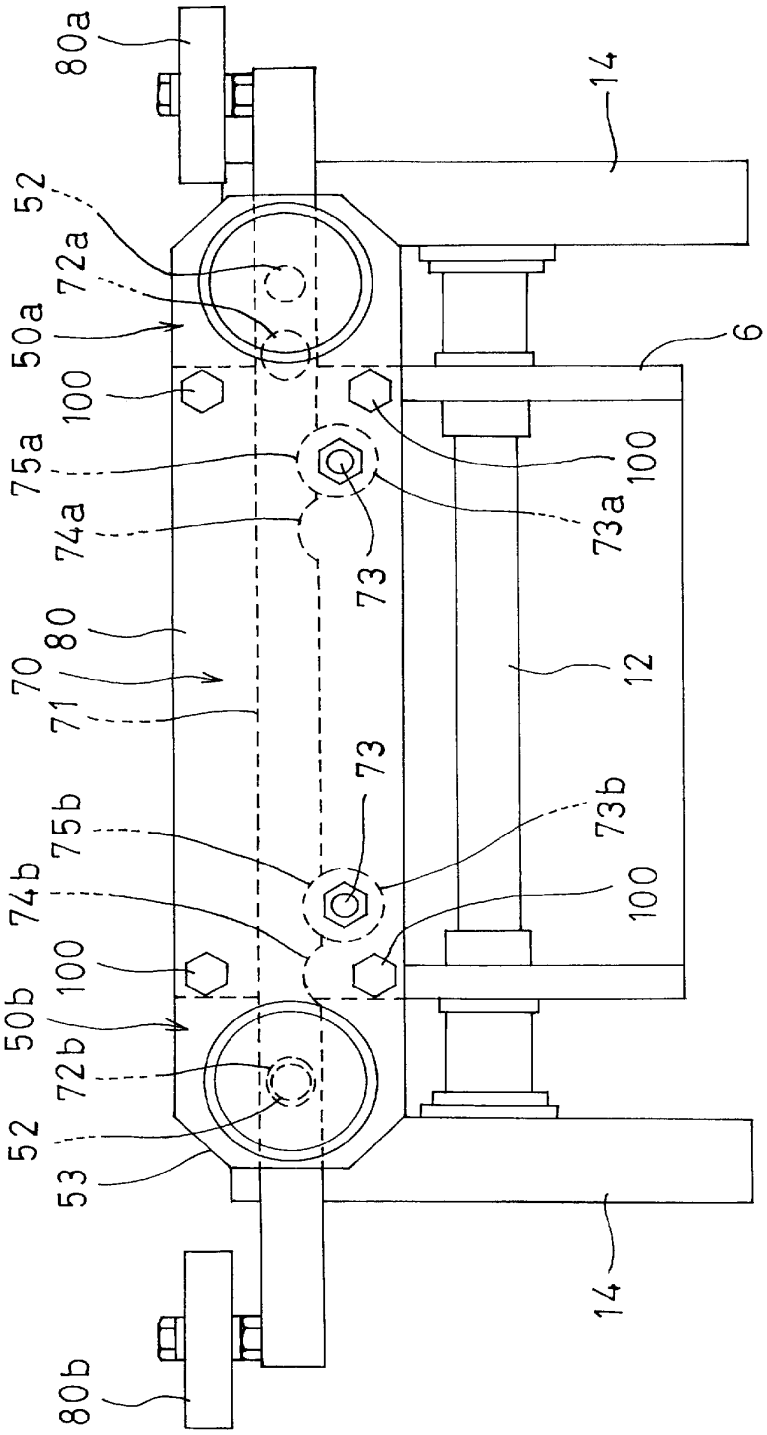
[図4]



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[図5]

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[図6]

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2008/062674

A. CLASSIFICATION OF SUBJECT MATTER
G05D1/02(2006.01)i, *A47L9/00*(2006.01)i, *A47L9/28*(2006.01)i, *B08B5/04*(2006.01)i, *E04H4/16*(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G05D1/02, A47L9/00, A47L9/28, B08B5/04, E04H4/16

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2008
Kokai Jitsuyo Shinan Koho 1971-2008 Toroku Jitsuyo Shinan Koho 1994-2008

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 08-004337 A (Kabushiki Kaisha Yotsuyanagi), 09 January, 1996 (09.01.96), Full text; all drawings (Family: none)	1-5
A	JP 56-085321 A (ShinMaywa Industries, Ltd.), 11 July, 1981 (11.07.81), Full text; all drawings (Family: none)	1-5
A	JP 09-179625 A (Hitachi Electric Systems Co., Ltd.), 11 July, 1997 (11.07.97), Full text; all drawings (Family: none)	1-5

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
01 September, 2008 (01.09.08)	09 September, 2008 (09.09.08)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (April 2007)

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国際調査報告

国際出願番号　ＰＣＴ／ＪＰ２００８／０６２６７４

Ａ．　発明の属する分野の分類（国際特許分類（ＩＰＣ））

Int.Cl.　G05D1/02(2006.01)i, A47L9/00(2006.01)i, A47L9/28(2006.01)i, B08B5/04(2006.01)i, E04H4/16(2006.01)i

Ｂ．　調査を行った分野

調査を行った最小限資料（国際特許分類（ＩＰＣ））

Int.Cl.　G05D1/02, A47L9/00, A47L9/28, B08B5/04, E04H4/16

最小限資料以外の資料で調査を行った分野に含まれるもの

日本国実用新案公報	１９２２－１９９６年
日本国公開実用新案公報	１９７１－２００８年
日本国実用新案登録公報	１９９６－２００８年
日本国登録実用新案公報	１９９４－２００８年

国際調査で使用した電子データベース（データベースの名称、調査に使用した用語）

Ｃ．　関連すると認められる文献

引用文献のカテゴリー＊	引用文献名　及び一部の箇所が関連するときは、その関連する箇所の表示	関連する請求の範囲の番号
A	JP 08-004337 A（株式会社四柳）1996.01.09, 全文全図（ファミリーなし）	1-5
A	JP 56-085321 A（新明和工業株式会社）1981.07.11, 全文全図（ファミリーなし）	1-5
A	JP 09-179625 A（株式会社日立エレクトリックシステムズ）1997.07.11, 全文全図（ファミリーなし）	1-5

☐　Ｃ欄の続きにも文献が列挙されている。

☐　パテントファミリーに関する別紙を参照。

＊　引用文献のカテゴリー
「Ａ」特に関連のある文献ではなく、一般的技術水準を示すもの
「Ｅ」国際出願日前の出願または特許であるが、国際出願日以後に公表されたもの
「Ｌ」優先権主張に疑義を提起する文献又は他の文献の発行日若しくは他の特別な理由を確立するために引用する文献（理由を付す）
「Ｏ」口頭による開示、使用、展示等に言及する文献
「Ｐ」国際出願日前で、かつ優先権の主張の基礎となる出願の日の後に公表された文献
「Ｔ」国際出願日又は優先日後に公表された文献であって出願と矛盾するものではなく、発明の原理又は理論の理解のために引用するもの
「Ｘ」特に関連のある文献であって、当該文献のみで発明の新規性又は進歩性がないと考えられるもの
「Ｙ」特に関連のある文献であって、当該文献と他の１以上の文献との、当業者にとって自明である組合せによって進歩性がないと考えられるもの
「＆」同一パテントファミリー文献

国際調査を完了した日	国際調査報告の発送日
０１．０９．２００８	０９．０９．２００８

国際調査機関の名称及びあて先
日本国特許庁（ＩＳＡ／ＪＰ）
郵便番号１００－８９１５
東京都千代田区霞が関三丁目４番３号

特許庁審査官（権限のある職員）　３Ｕ　３９３６
佐藤　彰洋
電話番号　０３－３５８１－１１０１　内線　３３２４

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28 January 2011 (28.01.2011)

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(74) Agent: **YANG, Moon Ock**; ESSEN Patent & Law Firm, 2F. Samheung Yeoksam Bldg., 735-10 Yeoksam-dong, Gangnam-gu, Seoul 135-080 (KR).

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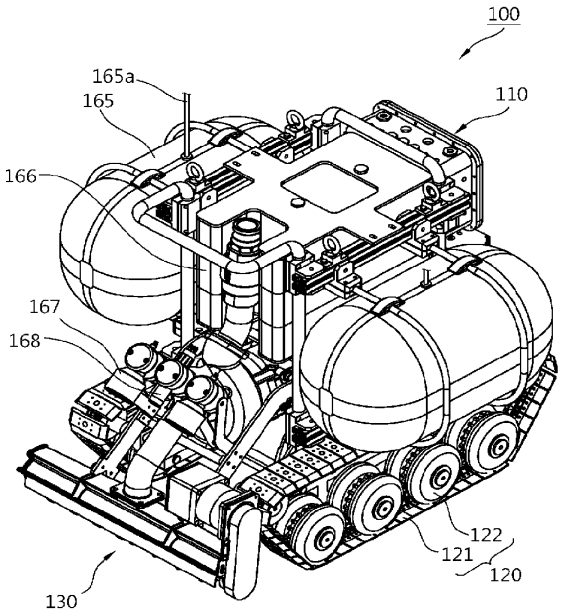
[Continued on next page]

(54) Title: CLEANING ROBOT AND UNDERWATER SEDIMENT CLEANING APPARATUS AND METHOD

[Fig. 1]



(57) Abstract: A cleaning robot capable of cleaning a water tank in an unmanned manner and an underwater sediment cleaning apparatus and method are provided. The cleaning robot includes a body put into a water tank, a driver supporting the body and moving the body, a suction part arranged in front of the body and sucking contaminated water containing sediment in the water tank, and a tilting part supported by the body to support the suction part and rotating the suction part on an axis corresponding to the direction across the moving direction of the body.

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SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

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Description

Title of Invention: CLEANING ROBOT AND UNDERWATER SEDIMENT CLEANING APPARATUS AND METHOD

Technical Field

[0001] The present invention relates to a cleaning robot and an underwater sediment cleaning apparatus and method and, more particularly, to a cleaning robot and an underwater sediment cleaning apparatus and method for cleaning sediment accumulated in a water tank.

[0002]

Background Art

[0003] Water is used for various industrial facilities and production facilities, and thus there are a water tank reserving water and facilities for administrating the water tank. Since sediment is accumulated in the water tank, the water tank requires to be periodically cleaned in order to manage water quality and prevent equipment using water from being damaged.

[0004] A conventional water tank cleaning method includes an operation of discharging water reserved in the water tank, an operation of removing sediment from the water tank and an operation of storing water in the water tank.

[0005] The removal operation in the conventional water tank cleaning method is manually performed by operators. Specifically, the removal operation is carried out in such a manner that the operators enter the drained water tank, accumulate sediment using a push rod, a bulldozer, etc., suck the accumulated sediment and discharge the sediment to the outside of the water tank.

[0006]

Summary of Invention

Technical Problem

[0007] This manually performed water tank cleaning method requires a long time for cleaning. Furthermore, it has to stop the operations of facilities using the water of the water tank while the water tank is cleaned. These problems deteriorate production efficiency of industrial facilities or production facilities using the water tank.

[0008] Moreover, since the sediment accumulated in the water tank used for the industrial facilities or production facilities contains toxic materials in many cases, the conventional cleaning method may cause safety accidents when the operators entering the water tank are exposed to the toxic materials.

[0009] Furthermore, the conventional cleaning method does not recycle drained water to result in waste of water resources.

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[0010]

Solution to Problem

[0011] A cleaning robot according to an aspect of the present invention comprises a body put into a water tank, a driver supporting the body and moving the body, a suction part arranged in front of the body and sucking contaminated water containing sediment in the water tank, and a tilting part supported by the body to support the suction part and rotating the suction part on an axis corresponding to the direction across the moving direction of the body.

[0012] The suction part may comprise a suction tube opened to the front of the body, a screw arranged in a direction to the suction tube, located at the front of the suction tube and having screw threads tilted to the suction tube, and a rotary motor connected to the shaft of the screw to rotate the screw.

[0013] The cleaning robot may further comprise a contaminated water discharge pipe connected with the suction tube to form a path for discharging the contaminated water sucked through the suction tube and a swivel joint provided between the contaminated water discharge pipe and the suction tube.

[0014] The cleaning robot may further comprise a suction pump arranged between the suction tube and the swivel joint and a pump hanger set in the body to elastically support the suction pump.

[0015] The tilting part may comprise a support supporting the suction part with its front end, being rotatably combined with the body and rotating from the body on a first supporting pin provided in a direction across the moving direction of the body, a first link joint having a first end connected to the support through a first link pin, a second link joint having a first end connected to a second end of the first link joint through a second link pin and a second end connected to the body through a second supporting pin, being rotatably combined with the body and rotating on the second supporting pin, and a tilt cylinder having an output terminal connected to the second link pin.

[0016] The cleaning robot may further comprise a tilt limit sensing part arranged behind the support to sense the lower limit point and the upper limit point of the support.

[0017] The cleaning robot may further comprise a location information sensing part supported by the body and exposed from the surface of water in the water tank.

[0018] The location information sensing part may comprise a GPS sensor controller supported by the body and a GPS antenna connected to the GPS sensor controller and located above the GPS sensor controller.

[0019] The cleaning robot may further comprise a buoy provided between the body and the GPS sensor controller and floating on the surface of the water in the water tank, and retractable support supporting the GPS sensor controller and the GPS antenna from the

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body and combined with the buoy, the retractable support having a length increasing or decreasing according to the distance between the body and the buoy.

[0020] The cleaning robot may further comprise a balloon connected with the body and a supply pipe connected to the balloon to supply a gas to the balloon.

[0021] The cleaning robot may further comprise a neutral buoy provided to the body to maintain neutral buoyancy.

[0022] The cleaning robot may further comprise a bumper part installed in front of the suction part.

[0023] The bumper part may comprise bumper wheels arranged to roll on an obstruction appearing in front of the body and a supporting frame supporting the bumper wheels.

[0024] The supporting frame may be rotatably combined with the body and rotating on an axis corresponding to the direction across the moving direction of the body, and the cleaning robot may further comprise a rotation angle sensing part arranged behind the supporting frame to sense the rotation angle of the supporting frame.

[0025] An underwater sediment cleaning apparatus according to another aspect of the present invention comprises a cleaning robot put into a water tank to suck contaminated water containing sediment in the water tank, a sediment separator located outside the water tank, receiving the contaminated water from the cleaning robot, filtering the sediment from the contaminated water and discharging clean water obtained by filtering the sediment from the contaminated water to the water tank, and a controller located outside the water tank and connected to the cleaning robot to control the operation of the cleaning robot.

[0026] The sediment separator may comprise a tank having a first side connected with a contaminated water discharge pipe extended from the cleaning robot, an intake pipe having a first end connected to a second side of the tank and a second end opened to the water tank to allow the clean water to flow into the water tank, and a filter set inside the tank to filter the sediment from the contaminated water flowing to the intake pipe.

[0027] The underwater sediment cleaning apparatus may further comprise a sediment discharge pipe having a first end connected to the first side of the tank and a second end opened to the outside of the tank.

[0028] The controller may be installed in an operating room which is located outside the water tank and movable.

[0029] The controller may comprise a power supply connected to the cleaning robot through a power cable to provide power supplied from an external supply source to the cleaning robot, a communication unit connected to the cleaning robot through a communication cable to transmit/receive data to/from the cleaning robot, and a central processing unit controlling the power supplied to the cleaning robot and processing the

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data transmitted/received to/from the cleaning robot.

[0030] The controller may further comprise a wheel driver controlling the moving operation of the cleaning robot, a screw driver controlling the rotation speed and rotation direction of a screw included in the cleaning robot, a tilt driver controlling the tilting angle of a tilting part included in the cleaning robot, and a pump driver controlling the operation of a suction pump included in the cleaning robot. The wheel driver, the screw driver, the tilt driver and the pump driver may be connected to the central processing unit, and the central processing unit may process control commands generated from wheel driver, the screw driver, the tilt driver and the pump driver.

[0031] The controller may further comprise a camera unit controlling an image captured by a camera included in the cleaning robot, a light unit controlling the brightness of a light included in the cleaning robot, a sensor unit controlling a sensing signal generated from sensors included in the cleaning robot, and an automatic cleaning unit receiving location information from the cleaning robot and controlling the location of the cleaning robot. The camera unit, the light unit, the sensor unit and the automatic cleaning unit may be connected to the central processing unit, and the central processing unit may process control commands generated from the camera unit, the light unit, the sensor unit and the automatic cleaning unit.

[0032] The underwater sediment cleaning apparatus may further comprise an operation console set in a bag carried by an operator, connected to the controller and allowing the operator to operate the cleaning robot.

[0033] The operation console may comprise a camera switch turning on/off the camera included in the cleaning robot, a brightness controller controlling the brightness of the light include in the cleaning robot, a status lamp indicating statuses of the sensors included in the cleaning robot, a display displaying the image captured by the camera, the route of the cleaning robot and the location of the cleaning robot, a mode selection switch for selecting one of a manual cleaning mode and an automatic cleaning mode of the cleaning robot, a screw switch for controlling the rotation speed and rotation direction of the screw included in the cleaning robot, a screw tilt joystick controlling the tilting angle of the screw, a pump switch turning on/off the suction pump included in the cleaning robot, a driving joystick steering the cleaning robot, a speed control switch for controlling the moving speed of the cleaning robot, and an emergency stop switch for stopping the cleaning unit.

[0034] The underwater sediment cleaning apparatus may further comprise a generator generating the power supplied to the controller and a compressor connected to a balloon included in the cleaning robot to inject a gas into the balloon.

[0035] An underwater sediment cleaning method according to another aspect of the present invention comprises a preparation step of putting a cleaning robot into a water tank and

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preparing cleaning the water tank, a suction step of sucking contaminated water containing sediment in the water tank by means of the cleaning robot moving in the water tank, a discharging step of discharging the contaminated water to a tank arranged outside the water tank, and filtering step of discharging the sediment contained in the contaminated water to the outside of the tank and making clean water obtained by filtering the sediment from the contaminated water flow into the water tank.

[0036] The preparation step may comprise the steps ofsetting the whole area of the water tank, setting a moving route of the cleaning robot in the whole area of the water tank, controlling the space between neighboring route parts of the moving route of the cleaning robot to set a degree of precision of cleaning the water tank, and selecting one of the automatic cleaning mode and the manual cleaning mode.

[0037] An automatic cleaning operation according to selection of the automatic cleaning mode may comprise a control step of receiving location information from the cleaning robot and controlling the location of the cleaning robot, a moving step of moving the cleaning robot along the route, a target point arrival determination unit of determining whether the cleaning robot arrives at a target point, and a cleaning completion determination step of determining whether the cleaning robot reaches a final target point.

[0038] The control step may comprise the steps of receiving first location information from a GPS sensor included in the cleaning robot and acquiring second location information from a encoder included in the cleaning robot, applying the first location information and the second location information to extended Kalman filter to correct the current location of the cleaning robot, calculating a target point which has to be tracked by the cleaning robot from the current location of the cleaning robot, calculating a difference between the current location of the cleaning robot and the target point, and calculating speed values of left and right wheels of the cleaning robot based on the calculated difference.

[0039] When the cleaning robot does not reach the target point in the target point arrival determination step, the cleaning method may further comprise calculating the current load of the cleaning robot and comparing the current load of the cleaning robot with an optimal load of the cleaning robot to detect the load of the cleaning robot.

[0040] The optimal load of the cleaning robot may be calculated based on the current consumed by the cleaning robot, the speed of the wheels revolving when the cleaning robot is driven and a variation in the location of the cleaning robot.

[0041] A detour of the cleaning robot is generated when the current load of the cleaning robot exceeds the optimal load.

[0042] The operation of generating the detour of the cleaning robot may comprise the steps of detecting a target point at which the cleaning robot cannot arrive from the current location, removing the detected target point from the route of the cleaning robot,

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generating new target point candidates at which the cleaning robot can arrive from the current location, and selecting a new target point from the generated new target point candidates.

[0043] A moving route of the cleaning robot may be secured when the current load of the cleaning robot is less than the optimal load.

[0044] The operation of securing the moving route of the cleaning robot may comprise the steps of moving the cleaning robot forward and moving the cleaning robot backward to return the cleaning robot to the position before being moved forward, and the step of moving the cleaning robot forward and the step of returning the cleaning robot may be repeated for a predetermined operating time.

[0045] When the cleaning robot cannot be moved forward, the cleaning method may further comprise the steps of moving the cleaning robot forward while turning the cleaning robot left or right and moving the cleaning robot backward to return the cleaning robot to the position before being moved forward, and the step of moving the cleaning robot forward and the step of returning the cleaning robot may be repeated for a predetermined operating time.

[0046] When the cleaning robot cannot be turned left or right or moved forward, the cleaning method may further comprise the step of moving the cleaning robot backward to a position behind the position before being moved forward, and the step of moving the cleaning robot forward and the step of moving the cleaning robot backward may be repeated for the predetermined operating time.

[0047]

Advantageous Effects of Invention

[0048] The cleaning robot and underwater sediment cleaning apparatus and method according to the present invention can protect operators from exposure to toxic materials contained in sediment accumulated in the water tank so as to prevent accidents from happening.

[0049] Furthermore, the cleaning robot and underwater sediment cleaning apparatus and method according to the present invention can allow the water tank to be used even when the water tank is being cleaned, and thus water tank utilization efficiency can be improved.

[0050] Moreover, the cleaning robot and underwater sediment cleaning apparatus and method according to the present invention can filter contaminated water to generate clean water to thereby save water resources.

Brief Description of Drawings

[0051] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, il-

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lustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention. In the drawings:

[0052] FIG. 1 is a perspective view of a cleaning robot according to an embodiment of the present invention;

[0053] FIG. 2 is a perspective view of part of the cleaning robot shown in FIG. 1;

[0054] FIG. 3 is a bottom view of part of a suction part of the cleaning robot shown in FIG. 1;

[0055] FIG. 4 is a perspective view of the cleaning robot with a bumper part according to an embodiment of the present invention;

[0056] FIG. 5 is a side view roughly showing a rotation angle sensing part of the cleaning robot shown in FIG. 1;

[0057] FIG. 6 is a perspective view of the cleaning robot including a location information sensing part and a retractable support according to an embodiment of the present invention;

[0058] FIG. 7 is a block diagram of an underwater sediment cleaning apparatus according to an embodiment of the present invention;

[0059] FIG. 8 is a perspective view of a sediment separator of the underwater sediment cleaning apparatus shown in FIG. 7;

[0060] FIG. 9 is a block diagram showing connections among the cleaning robot, a controller and an operation console of the cleaning apparatus according to an embodiment of the present invention;

[0061] FIG. 10 is a front view showing the exterior of the controller of the underwater sediment cleaning apparatus according to an embodiment of the present invention;

[0062] FIG. 11 illustrates the exterior of the operation console of the underwater sediment cleaning apparatus according to an embodiment of the present invention;

[0063] FIG. 12 is a flowchart showing an underwater sediment cleaning method;

[0064] FIG. 13a is a flowchart showing a preparation step in the underwater sediment cleaning method shown in FIG. 12;

[0065] FIGS. 13b, 13c, 13d and 13e are plan views showing coordinates, routes and the space between neighboring route parts, which are set based on the shape of the bottom of a water tank in the underwater sediment cleaning method shown in FIG. 12;

[0066] FIG. 14 is a flowchart showing a cleaning method according to an automatic cleaning mode according to an embodiment of the present invention;

[0067] FIG. 15 is a flowchart showing a control step in the cleaning method according to the automatic cleaning mode, shown in FIG. 14;

[0068] FIG. 16 is a flowchart showing an operation of generating a detour of the cleaning robot in the cleaning method according to the automatic cleaning mode, shown in FIG. 14;

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[0069] FIG. 17 is a view for explaining an algorithm of generating the detour of the cleaning robot in the cleaning method according to the automatic cleaning mode, shown in FIG. 14; and

[0070] FIG. 18 is a flowchart showing an operation of securing a moving route of the cleaning robot when the cleaning robot is moved according to the automatic cleaning mode in the underwater sediment cleaning method according to the present invention.

[0071]

Best Mode for Carrying out the Invention

[0072] Hereinafter, an embodiment of the present invention will be described below with reference to the accompanying drawings.

[0073] FIG. 1 is a perspective view of a cleaning robot 100 according to an embodiment of the present invention.

[0074] Referring to FIG. 1, the cleaning robot 100 includes a body 110, a driver 120, a suction part 130, and a tilting part 140.

[0075] The driver 120 supports and drives the body 110 and includes a caterpillar 121 and a plurality of wheels 122.

[0076] The caterpillar 121 allows the body 110 to show excellent running performance even in a poor operating environment such as the bottom of a water tank, which has an uneven surface or is covered with mud. The shoes of the caterpillar 121 may be made of one of reinforced plastic, urethane and stainless steel and a component such as spikes can be additionally attached to the caterpillar 121.

[0077] The caterpillar 121 generally uses shoes made of reinforced plastics. If the bottom of the water tank is formed of synthetic resin such as a tarpaulin or rubber, the caterpillar 121 can use urethane shoes in order to minimize damage of the bottom of the water tank. When the bottom of the water tank is covered with mud, the caterpillar 121 can use stainless steel shoes to secure the running performance of the body 110 and additionally use spikes attached to the shoes.

[0078] The plurality of wheels 122 support the caterpillar 121. The wheels 122 maintain the grip of the caterpillar 121 even when the caterpillar 121 runs on the uneven surface of the bottom of the water tank. The wheels 122 are configured to absorb shock transferred from the uneven surface of the bottom of the water tank and buffer the load of the body 110. That is, suspensions (not shown) are respectively provided to shafts of the wheels 122 and urethane having adjusted hardness can be molded and used for the shafts.

[0079] The suction part 130 is arranged in front of the body 110 to suck contaminated water containing sediment in the water tank.

[0080] FIG. 2 is a perspective view of part of the cleaning robot shown in FIG. 1 and FIG. 3

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is a bottom view of part of the suction part 130 of the cleaning robot 100 shown in FIG. 1.

[0081] Referring to FIGS. 2 and 3, the suction part 130 includes a suction tube 131, a screw 132 and a rotary motor 133. The suction tube 131 may be configured such that one end thereof is opened to the front of the body 110 and the other end is formed in a shape that comes into closely contact with the bottom of the water tank and is extended to a direction to the moving direction of the body 110 to scrape sediment accumulated on the bottom of the water tank as the body 110 moves. In an alternative embodiment, one end of the suction tube 131 may be combined with a separate scraper opened to a direction across the moving direction of the body 110.

[0082] The screw 132 is arranged in a direction to the suction tube 131 at the front of the body 110. The screw 132 has screw threads 132a arranged at both sides of the suction tube 131 and tilted to the suction tube 131. The screw threads 132a crush the sediment accumulated on the bottom of the water tank such that the sediment can be smoothly sucked through the suction tube 131.

[0083] The screw 132 can be made of stainless steel when the sediment is not easily scraped off the bottom of the water tank due to its high viscosity and a brush made of nylon or urethane can be used to remove the sediment when the sediment is easily scraped off the bottom of the water tank due to its low viscosity.

[0084] The rotary motor 133 is connected to the screw 132 through a power transmission means such as a chain, a timing belt or the like. The rotary motor 133 rotates the screw 132 forward such that sediment dispersed to both sides of the suction tube 131 can be accumulated before the suction tube 131. On the contrary, the rotary motor 133 rotates the screw 132 reversely such that particles which are located in front of the suction tube 131 and obstructed suction of the sediment can be moved to the outside of the screw 132.

[0085] The tilting part 140 supports the suction part 130 against the body 110 and rotates the suction part 130 on an axis corresponding to a direction across the moving direction of the body 110. The tilting part 140 includes a support 141, a first link joint 142, a second link joint 143, and a tilt cylinder 144.

[0086] The support 141 supports the suction part 130 with its front end. The support 141 is rotatably combined with the body 110 and rotates on a first supporting pin 141a provided in a direction across the moving direction of the body 110.

[0087] One end of the first link joint 142 is connected to the support 141 by means of a first link pin 142a and one end of the second link joint 143 is connected to the other end of the first link joint 142 by means of a second link pin 142b. The other end of the second link joint 143 is connected to the body 110 through a second supporting pin 143a. The second link joint 143 is rotatably combined with the body 110 and rotates on the

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second supporting pin 143a. The tilt cylinder 144 has an output terminal connected to the second link pin 142b. The tilt cylinder 144 moves the second link pin 142b forward and backward such that the suction part 130 supported by the support 141 can rotate on the first supporting pin 141a.

[0088] The tilting part 140 controls a sediment suction rate. That is, the tilting part 140 can increase the suction rate by narrowing the distance between the bottom of the water tank and the suction part 130 and decrease the suction rate by widening the distance between the bottom of the water tank and the suction part 130.

[0089] Here, a tilt limit sensing part 150 that senses the upper limit and lower limit of the support 141 is arranged behind the support 141 to prevent the suction part 130 from excessively tilting. The tilt limit sensing part 150 includes a tilt loader 151 combined with the back end of the support 141 and tilted with the support 141, a lower limit sensor 152 located above the tilt loader 151, and an upper limit sensor 153 arranged under the tilt loader 151.

[0090] The tilt limit sensing part 150 can sense the lower limit point and the upper limit point of the support 141 to prevent the suction part 130 from excessively tilting.

[0091] Meanwhile, the cleaning robot 100 includes a suction pump 161, a pump hanger 162, a contaminated water discharge pipe 163, and a swivel joint 164.

[0092] The suction pump 161 is placed on the body 110 and connected to the other end of the suction tube 131. The suction pump 161 sucks the sediment accumulated before the suction tube 131 through the suction tube 131.

[0093] The pump hanger 162 hangs the suction pump 161 on the body 110 such that the suction pump 161 is supported by the body 110. An elastic member such as rubber, coil spring or the like may be provided to the connecting portion of the pump hanger 162 and the body 110. The elastic member prevents shock caused by vibrations generated from the operation of the suction pump 161 and moving of the body 110 from being transferred to the body 110 and the suction pump 161.

[0094] The contaminated water discharge pipe 163 has a first end connected with the suction tube 131 and a second end extended to the outside of the water tank. The contaminated water discharge pipe 163 forms a contaminated water discharge route through which contaminated water sucked through the suction tube 131 can be discharged to the outside of the water tank.

[0095] The swivel joint 164 is provided between the suction tube 131 and the contaminated water discharge pipe 163. The swivel joint 164 prevents the contaminated water discharge pipe 163 from turning along the suction tube 131 when the body 110 moves, particularly, when the body 110 turns, and thus the contaminated water discharge pipe 163 is not twisted.

[0096] As described above, the suction pump 161 is hung on the pump hanger 162 and

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combined with the body 110. In an alternative embodiment, the suction pump 161 may be located outside the water tank and connected to the contaminated water discharge pipe 163, which is not shown.

[0097] The cleaning robot 100 includes a balloon 165 and a supply pipe 165a, shown in FIG. 1, as means for floating the body 110 located inside the water tank on the surface of the water in the water tank.

[0098] Referring back to FIG. 1, the balloon 165 is connected with the body 110. The supply pipe 165a has a first end connected to the balloon 165 and a second end connected to a compressor 501 located outside the water tank, shown in FIG. 7, which will be explained later, to form a passage for supplying a gas to the balloon 165. The balloon 165 makes the cleaning robot 100 float on the surface of the water in the water tank when the cleaning robot 100 is difficult to move in the water or wrongly operates.

[0099] Here, the number and volume of balloons can be adjusted based on the weight of the cleaning robot 100. Furthermore, a neutral buoy 166 that maintains neutral buoyancy in the cleaning robot 100 when the cleaning robot 100 cannot float may be additionally provided to the body 110.

[0100] In addition, the supply pipe 165a may be placed with a power cable and a communication cable, which will be described later, in a single cable and connected to the cleaning robot 100. The supply pipe 165a may be come out of the cable in the body 110 and connected to the balloon 165.

[0101] The cleaning robot 100 may include a bumper part 170 provided in front of the body 110.

[0102] FIG. 4 is a perspective view of the cleaning robot with the bumper part 170 according to an embodiment of the present invention.

[0103] Referring to FIG. 4, the bumper part 170 includes a supporting frame 171 and bumper wheels 172. The supporting frame 171 supports the bumper wheels 172 and a elevating wheel 181 which will be explained later. The supporting frame 171 rotates on an axis corresponding to a direction across the moving direction of the body 110.

[0104] The bumper wheels 172 are provided to be supported by the supporting frame 171 to roll in contact with obstructions appearing in front of the body 110. The bumper wheels 172 are arranged in a direction across the moving direction of the body 110. The bumper wheels 172 are provided such that the outermost bumper wheels are located outside the front corners of the body 110.

[0105] The bumper wheels 172 absorb shock generated when the cleaning robot 100 moving in the water tank collides with obstructions such as the inner walls of the water tank and a structure installed in the water tank and prevent the inner walls of the water tank, the structure in the water tank and the cleaning robot 100 from being damaged. To complement the shock-absorbing force of the bumper wheels 172, an elastic member

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such as a coil spring or rubber may be provided to shafts of the bumper wheels 172.

[0106] The cleaning robot 100 can detect the height of the sediment on the bottom of the water tank based on the rotation angle of the supporting frame 171 to estimate the quantity of the sediment. Specifically, the cleaning robot 100 can estimate that there is a small quantity of sediment when the rotation angle of the supporting frame 171 is narrow and estimate that there is a large quantity of sediment when the rotation angle of the supporting frame 171 is wide. Accordingly, the cleaning robot 100 may include a rotation angle sensing part 180 for sensing the rotation angle of the supporting frame 171.

[0107] FIG. 5 is a side view roughly showing the rotation angle sensing part of the cleaning robot 100.

[0108] Referring to FIG. 5, the rotation angle sensing part 180 includes an elevating wheel 181, a rotary loader 182 and a plurality of rotation angle sensors 183.

[0109] The elevating wheel 181 is supported by the supporting frame 171 to roll in contact with the bottom of the water tank. As described above, the supporting frame 171 is installed such that it can rotate on the axis corresponding to the direction across the moving direction of the body 110, and thus the elevating wheel 181 rolls on the bottom of the water tank and moves up and down according to the height of the sediment in the water tank. The rotary loader 182 is combined with the back end of the supporting frame 171 and rotates with the supporting frame 171. The rotation angle sensors 183are arranged behind the rotary loader 182and sense the rotation angle of the supporting frame 171.

[0110] The rotation angle sensing part 180 can estimate the quantity of the sediment in the water tank based on the height of the sediment by sensing the rotation angle of the supporting frame 171. The estimated quantity is used to control the tilting angle of the suction part 130 according to the tilting part 140, the power of the suction pump 161, the moving direction of the body 110 and whether the water tank cleaning operation continues.

[0111] Referring back to FIG. 1, the cleaning robot 100 includes a camera 168 and a light 167 installed in front of the body 110.

[0112] The camera 168 photographs the cleaning operation of the cleaning robot 100, the environment where the cleaning robot 100 operates, the overall operating state of the cleaning robot 100, etc. The camera 168 may be constructed in such a manner that a pan/tilt camera is set in a globular waterproof case.

[0113] The light 167 may use one of a high intensity discharge (HID) lamp, tungsten halogen lamp and a light emitting diode (LED).

[0114] The cleaning robot 100 is configured such that it can be aware of the location thereof.

[0115] FIG. 6 is a perspective view of the cleaning robot with a location information sensing

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part 190, a buoy 193 and a retractable support 194 according to an embodiment of the present invention.

[0116] Referring to FIG. 6, the cleaning robot 100 includes the location information sensing part 190, the buoy 193 and the retractable support 194.

[0117] The location information sensing part 190 senses the location of the body 110 in the water tank and includes a global positioning system (GPS) sensor 191 and a GPS antenna 192. The GPS sensor 191 is supported by the retractable support 194 and the GPS antenna 192 is pulled out of the GPS sensor 191 and set up on the GPS sensor 191. Here, the GPS sensor 191 can use a deep GPS (DGPS) sensor having an error range of several dozen meters although it can use a general GPS sensor having an error range of several meters.

[0118] The buoy 193 is located under the GPS sensor 191 and combined with the retractable support 194. The buoy 193 makes the GPS sensor 191 float on the surface of the water in the water tank all the time.

[0119] The retractable support 194 includes a combining rod 194a, elevating rods 194b and rollers 194c. The combining rod 194a is combined with the body 110. The elevating rods 194b are connected with the combining rod 194a and combined with the buoy 193 and the GPS sensor 191 to be elevated from the combining rod 194a according to the level of the water in the water tank. The number of the elevating rods 194b may be increased or decreased. The rollers 194c are provided between the combining rod 194a and the elevating rods 194b and between the elevating rods 194b and roll to support the elevating rods 194b.

[0120] Furthermore, the cleaning robot 100 can estimate its moving range based on the number of revolutions, transmitted from an encoder mounted on a wheel motor 122a (refer to FIG. 6) for driving the wheels 122.

[0121] An underwater sediment cleaning apparatus using the aforementioned cleaning robot according to embodiments of the present invention will now be explained with reference to the attached drawings.

[0122] FIG. 7 is a block diagram of the underwater sediment cleaning apparatus 500 according to the present embodiment and FIG. 8 is a perspective view of a sediment separator 200 of the underwater sediment cleaning apparatus 500 shown in FIG. 7.

[0123] Referring to FIGS. 7 and 8, the underwater sediment cleaning apparatus 500 includes the cleaning robot 100, the sediment separator 200, a controller 300 and an operation console 400.

[0124] The contaminated water discharge pipe 163 connected to the cleaning robot 100 is extended to the sediment separator 200.

[0125] The sediment separator 200 separates sediment from the contaminated water sucked from the cleaning robot 100 and includes a tank 210, a sediment discharge pipe 220, an

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intake pipe 230 and a filter 240. The tank 210 is located outside the water tank and the contaminated discharge pipe 163 is connected to an upper portion of one side of the tank 210. The sediment discharge pipe 220 is connected to a lower portion of one side of the tank 210. The sediment discharge pipe 220 is connected to a vacuum car located outside the tank 210 to form a route for discharging sediment filtered by the filter 240 and left in the tank 210. The intake pipe 230 is connected to the other side of the tank 210 and extended to the water tank 10. The intake pipe 230 has a valve 231 which controls the flow rate of clean water obtained by filtering the sediment of the contaminated water using the filter 240.

[0126] The filter 240 is provided between one side and the other side of the tank 210 and filters the sediment from contaminated water.

[0127] An operating room 20 is arranged outside the water tank 10. The operating room 20 may use a container box such to be movable. The controller 300 for controlling the cleaning robot 100 is installed in the operating room 20. The operating room 20 may have the controller 300, a generator 502 for providing power to the cleaning robot 100 and a compressor 501, which are installed therein.

[0128] FIG. 9 is a block diagram showing connections of the cleaning robot 100, the controller 300 and the operation console 400 of the underwater sediment cleaning apparatus according to the present embodiment.

[0129] Referring to FIG. 9, the controller 300 includes a power supply 310, a communication unit 320 and a central processing unit 330. The power supply 310 and the communication unit 320 are connected to the cleaning robot 100 and the central processing unit 330 through the power cable and the communication cable. The power supply 310 can supply power generated from the generator 502 shown in FIG. 7. Otherwise, the power supply 310 may use power provided by an external power supply source.

[0130] Furthermore, the controller 300 includes a wheel driver 341, a screw driver 342, a pump driver 343, and a tilt driver 344. The wheel driver 341 is connected to the driver 120 of the cleaning robot 100 through the central processing unit 330 and controls the operation of the cleaning robot 100. The screw driver 342 is connected to the motor 133 of the cleaning robot 100 through the central processing unit 330 and controls the rotation speed and rotation direction of the screw 132. The tilt driver 344 is connected to the tilt cylinder 144 of the cleaning robot 100 through the central processing unit 300 and controls the tilting angle of the suction part 130. The pump driver 343 is connected to the suction pump 161 of the cleaning robot 100 through the central processing unit 330 and controls the operation of the suction pump 161 through the central processing unit 330.

[0131] In addition, the controller 300 includes a camera unit 351, a lighting unit 352, a

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sensor unit 353 and an automatic cleaning unit 354. The camera unit 351 is connected to the camera 168 of the cleaning robot 100 through the central processing unit 330, processes images captured by the camera 168 and displays the processed images. The lighting unit 352 is connected to the light 167 of the cleaning robot 100 through the central processing unit 330 and controls the brightness of the light 167. The sensor unit 353 is connected to the tilt limit sensing part 150 and the rotation angle sensing part 180 of the cleaning robot 100 through the central processing unit 330 and processes sensing signals generated from sensors included in the tilt limit sensing part 150 and the rotation angle sensing part 190.

[0132] The automatic cleaning unit 354 is connected to the cleaning robot 100 through the central processing unit 330 analyzes the location of the cleaning robot 100 and controls the cleaning robot 100 to move along a predetermined route. The automatic cleaning unit 354 may use an industrial computer. The automatic cleaning unit 354 has a touch screen which displays the location of the cleaning robot 100 and a cleaning area.

[0133] As described above, the central processing unit 330 is connected to the drivers 341,342,343 and 344 and the units 351, 352, 353 and 354 and linked to the cleaning robot 100 through the power supply 310 and the communication unit 320. The central processing unit 330 controls the power supplied to the cleaning robot 100 and processes data transmitted between the cleaning robot 100 and other components of the cleaning apparatus. Furthermore, the central processing unit 330 processes control commands of the drivers 341, 342, 343 and 344 and the units 351, 352, 353 and 354.

[0134] FIG. 10 is a front view of the exterior of the controller of the underwater sediment cleaning apparatus according to the present embodiment.

[0135] Referring to FIG. 10, the controller 300 includes an input connector 361, an output connector 362, a control connector 363 and a pneumatic connector 364. The input connector 361 is connected to an input cable extended to be provided with power supplied from the generator 502 or the external power supply source. The output connector 362 is connected to an output cable coupled to the cleaning robot 100. The control connector 363 is connected to the cleaning robot 100 to be coupled to a communication cable through which data is transmitted/received between the cleaning robot 100 and other components of the cleaning apparatus. The pneumatic connector 364 is connected to the balloon 165 and the supply pipe 165a supplying a gas to the balloon 165.

[0136] Moreover, the controller 300 includes an operation console connector 400a, a plurality of output plugs 365, a LAN port 366, and an image output port 367. The operation console connector 400a connects the operation console 400and the controller 300. The operation console connector 400a allows the power supplied to the controller 300 to be provided to the operation console 400 and permits the controller 300 and the

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operation console 400 to transmit/receive data to/from each other. There may be a plurality of operation console connectors 400a to connect a plurality of operation consoles to the controller 300.

[0137] The output plugs 365 provide power to a terminal, a portable device, etc. other than the operation console 400 using the power supplied to the controller 300. The LAN port 365 allows the terminal, portable device, etc. and the controller 300 to exchange data. The image output port 367 transmits an image signal corresponding to an image photographed by the camera 168 to the operation console 400 such that a display 414 provided to the operation console 400 displays the image.

[0138] In addition, the controller 300 includes an input power switch 368, an input power state lamp 369, an output power state lamp 370, an operation stand-by state lamp 371, a warning buzzer 372, a first emergency stop switch 373, a reset button 374, an automatic cleaning unit power switch 375, and a first brightness control switch 376.

[0139] The input power switch 368 allows input power applied to a power connector to be supplied to the controller 300 and the cleaning robot 100. The input power state lamp 369 indicates whether or not the input power supplied to the controller 300 is normal. If the cleaning apparatus performs an underwater cleaning work outdoors, the input power may have input current lower than the current used by the controller 300. On the contrary, the input power may have input current higher than the current used by the controller 300. That is, when the input power becomes abnormal, the input power state lamp 369 blinks to warn that the input power is abnormal. The output power state lamp 370 indicates whether or not the power supplied to the cleaning robot 100 is normal. The power cable connected to the cleaning robot 100 may be down due to its abnormal state or excessive current cause by electric leakage or overload may flows. When the output power becomes abnormal, as described, the output power state lamp 370 blinks to warn that the output power state is abnormal. The operation stand-by state lamp 371 indicates that power is supplied to the controller 300 and all of components are ready to operate so that the cleaning robot 100 can be operated. The warning buzzer 372 generates alarm sound when a wrong operation occurs during operator's absence to inform the operator to know the wrong operation. The first emergency stop switch 373 is used to stop the operation of the controller 300 and make the controller 300 to cut power. The reset button 374 is used to reset the cleaning apparatus when the cleaning apparatus cannot normally operate due to overload applied to the controller 300 or the cleaning robot 100 or other unknown causes. The reset button 374 blinks a warning light when the cleaning apparatus cannot normally operate. The automatic cleaning unit power switch 375 is used to select an automatic cleaning mode or a manual cleaning mode. The user can select the manual cleaning mode by turning the automatic cleaning unit power switch 375 to 'manual cleaning mode' and select the automatic

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cleaning mode by turning the automatic cleaning unit power switch 375 to 'automatic cleaning mode'. When the automatic cleaning mode is selected, the automatic cleaning unit 354 starts to operate (for example, activate GPS unit and activates related software).

[0140] The first brightness control switch 376 is configured in the form of a rotary switch and controls the brightness of the light 167 included in the cleaning robot 100.

[0141] Referring back to FIG. 7, the operation console 400 is connected to the controller 300 and used for the operator to manually operate the cleaning robot 100. The operation console 400 may be provided in the form of a bag such that the operator can easily carry the operation console 400.

[0142] FIG. 11 illustrates the exterior of the operation console of the underwater sediment cleaning apparatus according to the present embodiment.

[0143] Referring to FIGS. 9 and 11, the operation console 400 includes a camera switch 411, a second brightness control switch 412, a status lamp 413 and the display 414. The camera switch 411 is connected to the camera unit 351. The camera switch 411 is used to turn on/off the camera 168 included in the cleaning robot 100. The second brightness control switch 412 is connected to the lighting unit 352 and controls the brightness of underwater light. The status lamp 413 is connected to the sensor unit 353 and indicates statuses of the sensors included in the tilt limit sensing part 150 and the rotation angle sensing part 180 of the cleaning robot 100. The display 414 is connected to the camera unit 351, the sensor unit 353 and the automatic cleaning unit 354 and displays an image photographed by the camera 168, signals sensed by the sensors include in the tilt limit sensing part 150 and the rotation angle sensing part 180, the route of the cleaning robot 100, and the current location of the cleaning robot 100.

[0144] In addition, the operation console 400 includes a mode selection switch 415, a screw switch 416, a pump switch 417, a driving joystick 419, a screw tilt joystick 418, a speed control switch 420, and a second emergency stop switch 421 The mode selection switch 415, the screw switch 416, the pump switch 417, the driving joystick 419, the screw tilt joystick 418, the speed control switch 420 and the second emergency stop switch 421 are connected to the central processing unit 330.

[0145] The mode selection switch 415 is used to select one of the manual cleaning mode and the automatic cleaning mode of the cleaning robot 100. The screw switch 416 is used to control the rotation direction and rotation speed of the screw 132. The pump switch 417 used to turn on/off the suction pump 161. The driving joystick 419 is used to steer the cleaning robot 100. The speed control switch 420 is used to control the moving speed of the cleaning robot 100. The second emergency stop switch 421 is used to stop the operation of the cleaning robot 100 when the cleaning robot 100 performs a wrong operation.

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[0146] An underwater sediment cleaning method according to an embodiment of the present invention will now be explained.

[0147] FIG. 12 is a flowchart showing the underwater sediment cleaning method according to an embodiment of the present invention.

[0148] Referring to FIG. 12, the underwater sediment cleaning method includes a preparation step S100, a suction step S200, a discharging step S300 and a filtering step S400.

[0149] The cleaning robot 100 is put into the water tank to prepare an underwater cleaning operation in the preparation step S100. The cleaning robot 100 sucks contaminated water containing sediment while moving in the water tank in the suction step S200. The contaminated water sucked by the cleaning robot 100 is discharged to the outside of the water tank in the discharging step S300. The sediment in the contaminated water is filtered and clean water flows into the water tank in the filtering step S400.

[0150] FIG. 13a is a flowchart showing the preparation step S100 in the underwater sediment cleaning method shown in FIG. 1 and FIGS. 13b, 13c, 13d and 13e are plan views showing coordinates, routes and the space between neighboring route parts which are set based on the shape of the bottom of the water tank and used for the underwater sediment cleaning method shown in FIG. 12.

[0151] Referring to FIGS. 13a though 13e, the preparation step S100 includes an area setting step S110, a route setting step S120, a precision setting step S130 and a mode selection step S140.

[0152] An area which will be cleaned by the cleaning robot 100 is set in the area setting step S110. In the area setting step S110, coordinates P1, P2, P3, ..., Pn based on the shape of the bottom of the water tank 10 are set. If the bottom of the water tank 10 has a polygonal shape, for example, coordinates P1, P2, P3, ..., Pn corresponding to corners of the bottom of the water tank 10 can be set. If the bottom of the water tank 10 has a circular shape, coordinates P1, P2, P3, ..., Pn corresponding to the edge of the bottom of the water tank 10 can be set.

[0153] The moving route of the cleaning robot 100 is set in the route setting step S120. In this step, the route of the cleaning robot 100 may be set based on the shape of the bottom of the water tank 10. If the bottom of the water tank 10 has a polygonal shape, for example, a zigzag route can be set. If the bottom of the water tank 10 has a circular shape, a spiral route can be set.

[0154] The space between neighboring route parts is controlled in the precision setting step S130. A degree of precision of cleaning increases as the space between neighboring route parts becomes closer to each other and decreases as the space between neighboring route parts becomes apart from each other. The space between neighboring route parts is set to a narrow level when the cleaning robot 100 cleans a

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severely contaminated water tank or intensively cleans part of the route, which is severely contaminated. The space between neighboring route parts is set to a wide level when the cleaning robot 100 cleans a water tank that is not seriously contaminated or performs rough cleaning before thorough cleaning.

[0155] One of the manual cleaning mode and the automatic cleaning mode can be selected according to a degree of contamination of the water stored in the water tank 10 in the mode setting step S140. Specifically, the manual cleaning mode can be selected (S140) when the internal state of the water tank 10 can be recognized with the camera 168 attached to the cleaning robot 100 due to a low degree of contamination. On the contrary, the automatic cleaning mode can be selected (S150) when the internal state of the water tank 10 is difficult to recognize with the camera 168 attached to the cleaning robot 100 due to a high degree of contamination.

[0156] In the preparation step S100, it is possible to display the number of times cleaning is repeated, the area which has been cleaned by the cleaning robot 100 and the area which is not cleaned.

[0157] An underwater sediment cleaning method according to the automatic cleaning mode will now be explained.

[0158] FIG. 14 is a flowchart showing the underwater sediment cleaning method according to the automatic cleaning mode according to an embodiment of the present invention.

[0159] Referring to FIG. 14, the underwater sediment cleaning method according to the automatic cleaning mode includes a control step S161, a moving step S162, a target point arrival determination step S163 and a cleaning completion determination step S168.

[0160] Location information is received from the cleaning robot 100 and the location of the cleaning robot 100 is controlled based on the received location information in the control step S161.

[0161] FIG. 15 is a flowchart showing the control step in the underwater sediment cleaning method according to the automatic cleaning mode, shown in FIG. 14.

[0162] Referring to FIG. 15, the control step S161 includes a location information acquisition step S1611, a correction step S1612, a target point calculating step S1613, a location error calculating step S1614, and a control input calculating step S1615.

[0163] The automatic cleaning unit 354 can acquire first location information and second location information from the cleaning robot 100. The first location information is sensed by the GPS sensor 191 included in the cleaning robot 100 and the second location information is estimated based on the number of revolutions of the wheels 122, transmitted from the encoder set in the wheel motor 122a of the cleaning robot 100.

[0164] The first location information and the second location information are acquired in the

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location information acquisition step S1611. The current location of the cleaning robot 100 is precisely calculated using extended Kalman filter based on the first location information and the second location information in the correction step S1612. In the target point calculating step S1613, a target point on the route generated in the preparation step S100, which has to be tracked in the current location, is calculated and found based on the current location of the cleaning robot 100, calculated in the correction step S1612. A difference between the target point and the current location is calculated in the location error calculating step S1614. In the control input calculating step S1615, speed values of the left and right wheels 122 of the cleaning robot 100 are calculated based on the difference between the target point and the current location, calculated in the location error calculating step S1614.

[0165] Referring back to FIG. 14, in the moving step S162, the cleaning robot 100 moves toward the target point according to a rotation speed of the encoder of the wheel motor 122a based on the speed values of the left and right wheels 122, calculated in the control input calculating step S1615.

[0166] It is determined whether the cleaning robot 100 arrives at the target point in the target point arrival determination step S163. Here, the cleaning robot 100 moving toward the target point may not reach the target point. Specifically, the cleaning robot 100 cannot move due to an obstruction on the moving route or the moving speed of the cleaning robot 100 is reduced since there are large amount of works on the moving route.

[0167] When the cleaning robot 100 cannot arrive at the target point, a predetermined optimal load of the cleaning robot 100 is compared with the current load of the cleaning robot 100 (S165) to detect the load of the cleaning robot 100 (S165). The load of the cleaning robot 100 can be calculated based on the current consumed by the cleaning robot 100 and the rotation speed of the wheels.

[0168] When the cleaning robot 100 cannot reach the target point since the load of the cleaning robot 100 exceeds the optimal load, it can be determined that an obstruction appears on the moving route of the cleaning robot 100.

[0169] FIG. 16 is a flowchart showing an operation of generating a detour of the cleaning robot 100 in the underwater sediment cleaning method according to the automatic cleaning mode, shown in FIG. 14, and FIG. 17 is a view for explaining an algorithm of generating the detour of the cleaning robot 100 in the underwater sediment cleaning method according to the automatic cleaning mode, shown in FIG. 14.

[0170] Referring to FIGS. 16 and 17, when the load of the cleaning robot 100 exceeds the optimal load, the detour of the cleaning robot 100 is generated (S166). The operation of generating the detour includes an unattainable target point search step S1661, an unattainable target point removal step S1662, a new target point candidate generating step S1663, and a new target point selecting step S1664.

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[0171] Specifically, the cleaning robot 100 cannot move toward the target point ($X_{wpt(i)}$, $Y_{wpt(i)}$) in the current location ($X_{robot(i)}$, $Y_{robot(i)}$). Accordingly, it is required to generate a new target point of the cleaning robot 100.

[0172] New target point candidates are generated based on the target point ($X_{wpt(i-1)}$, $Y_{wpt(i-1)}$) through which the cleaning robot 100 passed on the basis of the current location ($X_{robot(i)}$, $Y_{robot(i)}$) of the cleaning robot 100 and a target point ($X_{wpt(i+1)}$, $Y_{wpt(i+1)}$) after the initial target point ($X_{wpt(i)}$, $Y_{wpt(i)}$).

[0173] Here, a circle having a diameter r_1 corresponding to the straight line that connects the two target points ($X_{wpt(i-1)}$, $Y_{wpt(i-1)}$) and ($X_{wpt(i+1)}$, $Y_{wpt(i+1)}$) can be obtained. A normal which intersects the line that passes the center point of the circle and connects the two target points ($X_{wpt(i-1)}$, $Y_{wpt(i-1)}$) and ($X_{wpt(i+1)}$, $Y_{wpt(i+1)}$) is generated and two intersection points of the circle and the normal are generated as new target point candidates ($X_{wpt(i)}^{cadi1}$, $Y_{wpt(i)}^{cadi1}$) and ($X_{wpt(i)}^{cadi2}$, $Y_{wpt(i)}^{cadi2}$).

[0174] In consideration of whether the cleaning robot 100 collides with the working environment and distances between the two target point candidates ($X_{wpt(i)}^{cadi1}$, $Y_{wpt(i)}^{cadi1}$) and ($X_{wpt(i)}^{cadi2}$, $Y_{wpt(i)}^{cadi2}$) and the following target point ($X_{wpt(i+2)}$, $Y_{wpt(i+2)}$), the final target point is selected from the two new target point candidates ($X_{wpt(i)}^{cadi1}$, $Y_{wpt(i)}^{cadi1}$) and ($X_{wpt(i)}^{cadi2}$, $Y_{wpt(i)}^{cadi2}$). The final target point becomes a new target point and a route to the new target point becomes a detour around the initial target point at which the cleaning robot 100 cannot arrive.

[0175] When the cleaning robot 100 cannot reach the target point even though the load of the cleaning robot 100 is less than the optimal load, it can be determined that there is a large amount of works.

[0176] FIG. 18 is a flowchart showing an operation of securing a moving route of the cleaning robot when the cleaning robot moves in the automatic cleaning mode in the underwater sediment cleaning method shown in FIG. 14.

[0177] Referring to FIG. 18, when the load of the cleaning robot 100 is less than the optimal load, the operation of securing the moving route of the cleaning robot 100 is performed (S167). That is, when the load of the cleaning robot 100 is determined to be less than the optimal load and the moving speed of the cleaning robot 100 is reduced, a forward movement command is inputted to the cleaning robot 100 (S1671).

[0178] If the cleaning robot 100 can move according to the forward movement command (S1672), the cleaning robot 100 moves forward. Here, although the cleaning robot 100 moves toward the target point at a speed lower than an input speed value since the cleaning robot 100 is moving forward on the route having a large amount of works, the cleaning robot 100 cannot arrive at the target point. A command of returning to the original position toward the target point is inputted to the cleaning robot 100 moving toward the target point according to the forward movement command, and the cleaning

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robot 100 moves backward to the original position (S1676).

[0179] The forward movement command and the command of returning to the original position are repeated for a predetermined operating time. Accordingly, the cleaning robot 100 can repeat forward movement and backward movement toward the target point on the route having a large amount of works to handle the works.

[0180] When the cleaning robot 100 cannot move even though the forward movement command is inputted to the cleaning robot 100 (S1672), a left-turn command or a right-turn command based on the direction to the target point is inputted. The cleaning robot 100 moves to a left or right direction at 30° from the direction to the target point according to the left-turn or right-turn command (S1673).

[0181] If the cleaning robot 100 can move according to the left-turn or right-turn command (S1674), the cleaning robot 100 turns left or right according to the left-turn or right-turn command. The command of returning to the original position toward the target point is inputted to the cleaning robot 100 turning left or right, and thus the cleaning robot 100 moves backward to the original position before the forward movement command is inputted thereto.

[0182] In this manner, the left-turn or right-turn command and the command of returning to the original position toward the target point are inputted to the cleaning robot 100 that cannot move toward the target point, and thus the large amount of works around the route to the target point is gradually reduced and the cleaning robot 100 becomes a state that the cleaning robot 100 can move toward the target point when the works are handled to some degree by the cleaning robot 100.

[0183] When the cleaning robot 100 cannot move even though the left-turn or right-turn command is inputted to the cleaning robot 100 (S1674), the cleaning robot 100 is moved backward from the current location of the cleaning robot 100. Then, the cleaning robot 100 moves backward to a position behind the position where the forward movement command is inputted to the cleaning robot 100 (S1675). When the left-turn or right-turn command is inputted to the cleaning robot 100 moved backward, the cleaning robot 100 turns left or right according to the left-turn or right-turn command (S1673).

[0184] In this manner, the backward movement command is inputted to the cleaning robot 100 that cannot move toward the target point and turn left or right to gradually reduce the large amount works around the route to the target point and make the cleaning robot 100 be in a state that the cleaning robot 100 can move toward the target point when the works are handled to some extent by the cleaning robot 100.

[0185] The forward movement command (S1671) and the command of returning to the original position toward the target point (S1676) are repeated for a predetermined operating time (S1677). Accordingly, the cleaning robot 100 can repeat forward

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movement and backward movement on the route having the large amount of works to handle the works.

[0186] That is, the cleaning robot 100 having a load determined to be less than the optimal load can repeatedly secure the moving route for the predetermined operating time to handle a large amount of works.

[0187] After the lapse of the predetermined operating time (S1677), the cleaning robot 100 returns to the control step S161 and moves to find the target point.

[0188] Referring back to FIG. 14, when the cleaning robot 100 reaches the target point in the target point arrival determination step S163, speed values of the left and right wheels for the next target point are inputted to the cleaning robot 100. The cleaning robot 100 moves toward the next target point according to the speed values of the left and right wheels.

[0189] When the control step S161 and the moving step S162 are repeated, the cleaning robot 100 can arrive at the final target point (S163). Then, the operation of discharging the contaminated water from the water tank 10 is finished.

[0190] Referring back to FIG. 13a, when the manual cleaning mode is selected in the mode selection step S140 (S150), the user can operate the operation console 400 while observing the image photographed by the camera 167 to control the cleaning robot 100.

[0191] The contaminated water sucked by the cleaning robot 100 is discharged to the tank 210 of the sediment separator 200. The contaminated water discharged to the tank 210 passes through the filter 240. Here, the sediment contained in the contaminated water is left at one side of the tank 210 and clean water flows to the other side of the tank 210. The sediment left in the tank 210 is discharged to the outside of the tank 210 through the sediment discharge pipe 220 and the clean water flows into the water tank.

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Claims

[Claim 1] A cleaning robot comprising:
a body put into a water tank;
a driver supporting the body and moving the body;
a suction part arranged in front of the body and sucking contaminated water containing sediment in the water tank; and
a tilting part supported by the body to support the suction part and rotating the suction part on an axis corresponding to the direction across the moving direction of the body.

[Claim 2] The cleaning robot of claim 1, wherein the suction part comprises:
a suction tube opened to the front of the body;
a screw arranged in a direction across the suction tube, located at the front of the suction tube and having screw threads tilted to the suction tube; and
a rotary motor connected to the shaft of the screw to rotate the screw.

[Claim 3] The cleaning robot of claim 2, further comprising:
a contaminated water discharge pipe connected with the suction tube to form a path for discharging the contaminated water sucked through the suction tube; and
a swivel joint provided between the contaminated water discharge pipe and the suction tube.

[Claim 4] The cleaning robot of claim 3, further comprising:
a suction pump arranged between the suction tube and the swivel joint; and
a pump hanger set in the body to elastically support the suction pump.

[Claim 5] The cleaning robot of claim 1, wherein the tilting part comprises:
a support supporting the suction part with its front end, being rotatably combined with the body and rotating from the body on a first supporting pin provided in a direction across the moving direction of the body;
a first link joint having a first end connected to the support through a first link pin;
a second link joint having a first end connected to a second end of the first link joint through a second link pin and a second end connected to the body through a second supporting pin, being rotatably combined with the body and rotating on the second supporting pin; and
a tilt cylinder having an output terminal connected to the second link

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pin.

[Claim 6] The cleaning robot of claim 5, further comprising a tilt limit sensing part arranged behind the support to sense the lower limit point and the upper limit point of the support.

[Claim 7] The cleaning robot of claim 1, further comprising a location information sensing part supported by the body and exposed from the surface of water in the water tank.

[Claim 8] The cleaning robot of claim 7, wherein the location information sensing part comprises:
a GPS sensor controller supported by the body; and
a GPS antenna connected to the GPS sensor controller and located above the GPS sensor controller.

[Claim 9] The cleaning robot of claim 8, further comprising:
a buoy provided between the body and the GPS sensor controller and floating on the surface of the water in the water tank; and
retractable support supporting the GPS sensor controller and the GPS antenna from the body and combined with the buoy, the retractable support having a length increasing or decreasing according to the distance between the body and the buoy.

[Claim 10] The cleaning robot of claim 1, further comprising:
a balloon connected with the body; and
a supply pipe connected to the balloon to supply a gas to the balloon.

[Claim 11] The cleaning robot of claim 1, further comprising a neutral buoy provided to the body to maintain neutral buoyancy.

[Claim 12] The cleaning robot of claim 1, further comprising a bumper part installed in front of the suction part.

[Claim 13] The cleaning robot of claim 12, wherein the bumper part comprises:
bumper wheels arranged to roll on an obstruction appearing in front of the body; and
a supporting frame supporting the bumper wheels.

[Claim 14] The cleaning robot of claim 13, wherein the supporting frame is rotatably combined with the body and rotating on an axis corresponding to the direction across the moving direction of the body, further comprising a rotation angle sensing part arranged behind the supporting frame to sense the rotation angle of the supporting frame.

[Claim 15] An underwater sediment cleaning apparatus comprising:
a cleaning robot put into a water tank to suck contaminated water containing sediment in the water tank;

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a sediment separator located outside the water tank, receiving the contaminated water from the cleaning robot, filtering the sediment from the contaminated water and discharging clean water obtained by filtering the sediment from the contaminated water to the water tank; and
a controller located outside the water tank and connected to the cleaning robot to control the operation of the cleaning robot.

[Claim 16] The underwater sediment cleaning apparatus of claim 15, wherein the sediment separator comprises:
a tank having a first side connected with a contaminated water discharge pipe extended from the cleaning robot;
an intake pipe having a first end connected to a second side of the tank and a second end opened to the water tank to allow the clean water to flow into the water tank; and
a filter set inside the tank to filter the sediment from the contaminated water flowing to the intake pipe.

[Claim 17] The underwater sediment cleaning apparatus of claim 16, further comprising a sediment discharge pipe having a first end connected to the first side of the tank and a second end opened to the outside of the tank.

[Claim 18] The underwater sediment cleaning apparatus of claim 15, wherein the controller is installed in an operating room which is located outside the water tank and movable.

[Claim 19] The underwater sediment cleaning apparatus of claim 15, wherein the controller comprises:
a power supply connected to the cleaning robot through a power cable to provide power supplied from an external supply source to the cleaning robot;
a communication unit connected to the cleaning robot through a communication cable to transmit/receive data to/from the cleaning robot; and
a central processing unit controlling the power supplied to the cleaning robot and processing the data transmitted/received to/from the cleaning robot.

[Claim 20] The underwater sediment cleaning apparatus of claim 19, wherein the controller further comprises:
a wheel driver controlling the moving operation of the cleaning robot;
a screw driver controlling the rotation speed and rotation direction of a screw included in the cleaning robot;

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a tilt driver controlling the tilting angle of a tilting part included in the cleaning robot; and

a pump driver controlling the operation of a suction pump included in the cleaning robot,

wherein the wheel driver, the screw driver, the tilt driver and the pump driver are connected to the central processing unit, and the central processing unit processes control commands generated from wheel driver, the screw driver, the tilt driver and the pump driver.

[Claim 21] The underwater sediment cleaning apparatus of claim 19, wherein the controller further comprises:

a camera unit controlling an image captured by a camera included in the cleaning robot;

a light unit controlling the brightness of a light included in the cleaning robot;

a sensor unit controlling a sensing signal generated from sensors included in the cleaning robot; and

an automatic cleaning unit receiving location information from the cleaning robot and controlling the location of the cleaning robot,

wherein the camera unit, the light unit, the sensor unit and the automatic cleaning unit are connected to the central processing unit, and the central processing unit processes control commands generated from the camera unit, the light unit, the sensor unit and the automatic cleaning unit.

[Claim 22] The underwater sediment cleaning apparatus of claim 15, further comprising an operation console set in a bag carried by an operator, connected to the controller and allowing the operator to operate the cleaning robot.

[Claim 23] The underwater sediment cleaning apparatus of claim 22, wherein the operation console comprises:

a camera switch turning on/off the camera included in the cleaning robot;

a brightness controller controlling the brightness of the light include in the cleaning robot;

a status lamp indicating statuses of the sensors included in the cleaning robot;

a display displaying the image captured by the camera, the route of the cleaning robot and the location of the cleaning robot;

a mode selection switch for selecting one of a manual cleaning mode

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and an automatic cleaning mode of the cleaning robot;
a screw switch for controlling the rotation speed and rotation direction of the screw included in the cleaning robot;
a screw tilt joystick controlling the tilting angle of the screw;
a pump switch turning on/off the suction pump included in the cleaning robot;
a driving joystick steering the cleaning robot;
a speed control switch for controlling the moving speed of the cleaning robot; and
an emergency stop switch for stopping the cleaning unit.

[Claim 24] The underwater sediment cleaning apparatus of claim of claim 15, further comprising:
a generator generating the power supplied to the controller; and
a compressor connected to a balloon included in the cleaning robot to inject a gas into the balloon.

[Claim 25] An underwater sediment cleaning method, comprising:
a preparation step of putting a cleaning robot into a water tank and preparing cleaning the water tank;
a suction step of sucking contaminated water containing sediment in the water tank by means of the cleaning robot moving in the water tank;
a discharging step of discharging the contaminated water to a tank arranged outside the water tank; and
filtering step of discharging the sediment contained in the contaminated water to the outside of the tank and making clean water obtained by filtering the sediment from the contaminated water flow into the water tank.

[Claim 26] The underwater sediment cleaning method of claim 25, wherein the preparation step comprises the steps of:
setting the whole area of the water tank;
setting a moving route of the cleaning robot in the whole area of the water tank;
controlling the space between neighboring route parts of the moving route of the cleaning robot to set a degree of precision of cleaning the water tank; and
selecting one of the automatic cleaning mode and the manual cleaning mode.

[Claim 27] The underwater sediment cleaning method of claim 26, wherein an automatic cleaning operation according to selection of the automatic

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cleaning mode comprises:
a control step of receiving location information from the cleaning robot and controlling the location of the cleaning robot;
a moving step of moving the cleaning robot along the route;
a target point arrival determination unit of determining whether the cleaning robot arrives at a target point; and
a cleaning completion determination step of determining whether the cleaning robot reaches a final target point.

[Claim 28] The underwater sediment cleaning method of claim 27, wherein the control step comprises the steps of:
receiving first location information from a GPS sensor included in the cleaning robot and acquiring second location information from a encoder included in the cleaning robot;
applying the first location information and the second location information to extended Kalman filter to correct the current location of the cleaning robot;
calculating a target point which has to be tracked by the cleaning robot from the current location of the cleaning robot;
calculating a difference between the current location of the cleaning robot and the target point; and
calculating speed values of left and right wheels of the cleaning robot based on the calculated difference.

[Claim 29] The underwater sediment cleaning method of claim 27, when the cleaning robot does not reach the target point in the target point arrival determination step, further comprising:
calculating the current load of the cleaning robot; and
comparing the current load of the cleaning robot with an optimal load of the cleaning robot to detect the load of the cleaning robot

[Claim 30] The underwater sediment cleaning method of claim 29, wherein the optimal load of the cleaning robot is calculated based on the current consumed by the cleaning robot, the speed of the wheels revolving when the cleaning robot is driven and a variation in the location of the cleaning robot.

[Claim 31] The underwater sediment cleaning method of claim 29, wherein a detour of the cleaning robot is generated when the current load of the cleaning robot exceeds the optimal load.

[Claim 32] The underwater sediment cleaning method of claim 31, wherein the operation of generating the detour of the cleaning robot comprises the

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steps of:
detecting a target point at which the cleaning robot cannot arrive from the current location;
removing the detected target point from the route of the cleaning robot;
generating new target point candidates at which the cleaning robot can arrive from the current location; and
selecting a new target point from the generated new target point candidates.

[Claim 33] The underwater sediment cleaning method of claim 29, wherein a moving route of the cleaning robot is secured when the current load of the cleaning robot is less than the optimal load.

[Claim 34] The underwater sediment cleaning method of claim 33, wherein the operation of securing the moving route of the cleaning robot comprising the steps of:
moving the cleaning robot forward; and
moving the cleaning robot backward to return the cleaning robot to the position before being moved forward, the step of moving the cleaning robot forward and the step of returning the cleaning robot are repeated for a predetermined operating time.

[Claim 35] The underwater sediment cleaning method of claim 34, when the cleaning robot cannot be moved forward, further comprising the steps of:
moving the cleaning robot forward while turning the cleaning robot left or right; and
moving the cleaning robot backward to return the cleaning robot to the position before being moved forward, the step of moving the cleaning robot forward and the step of returning the cleaning robot are repeated for a predetermined operating time.

[Claim 36] The underwater sediment cleaning method of claim 35, when the cleaning robot cannot be turned left or right or moved forward, further comprising the step of moving the cleaning robot backward to a position behind the position before being moved forward, the step of moving the cleaning robot forward and the step of moving the cleaning robot backward are repeated for the predetermined operating time.

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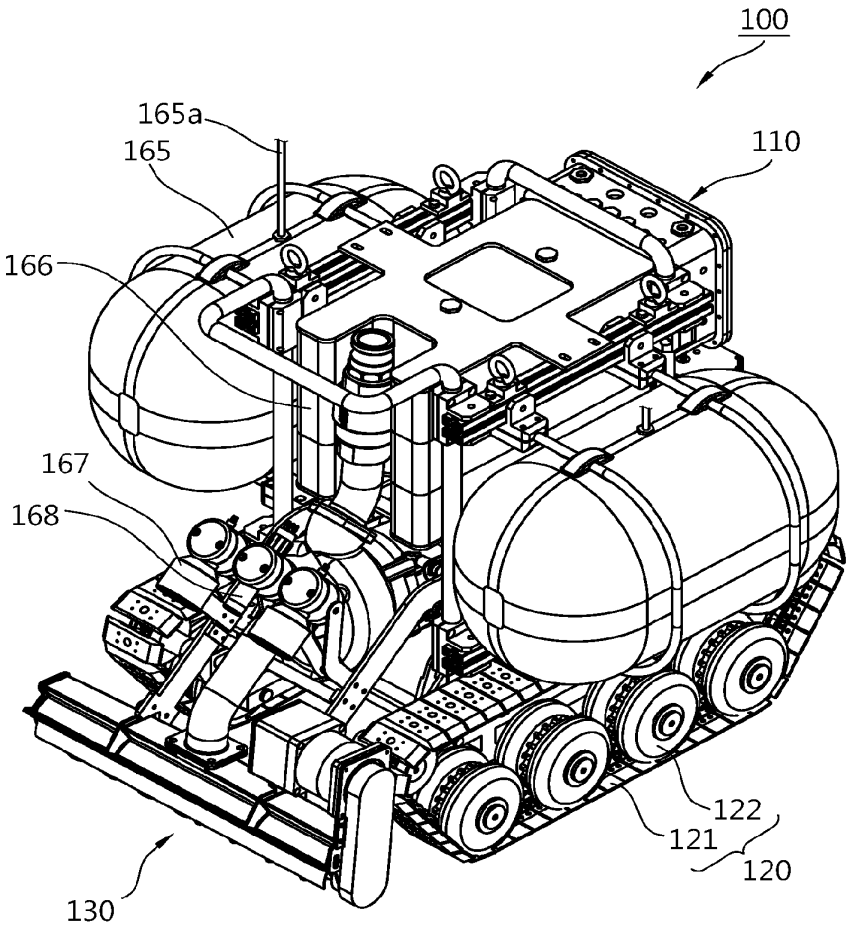
[Fig. 1]



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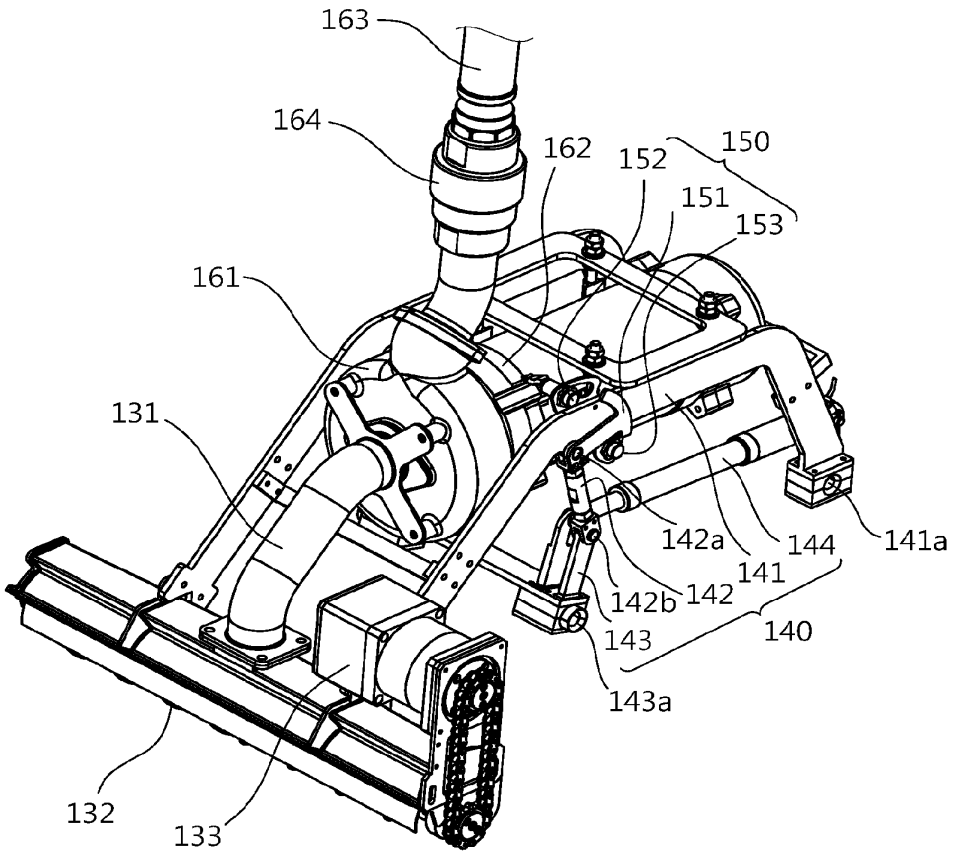
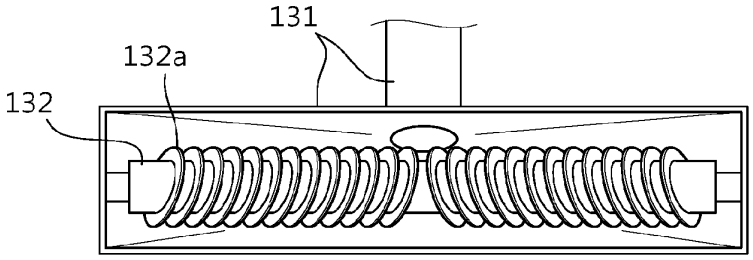
[Fig. 2]



[Fig. 3]



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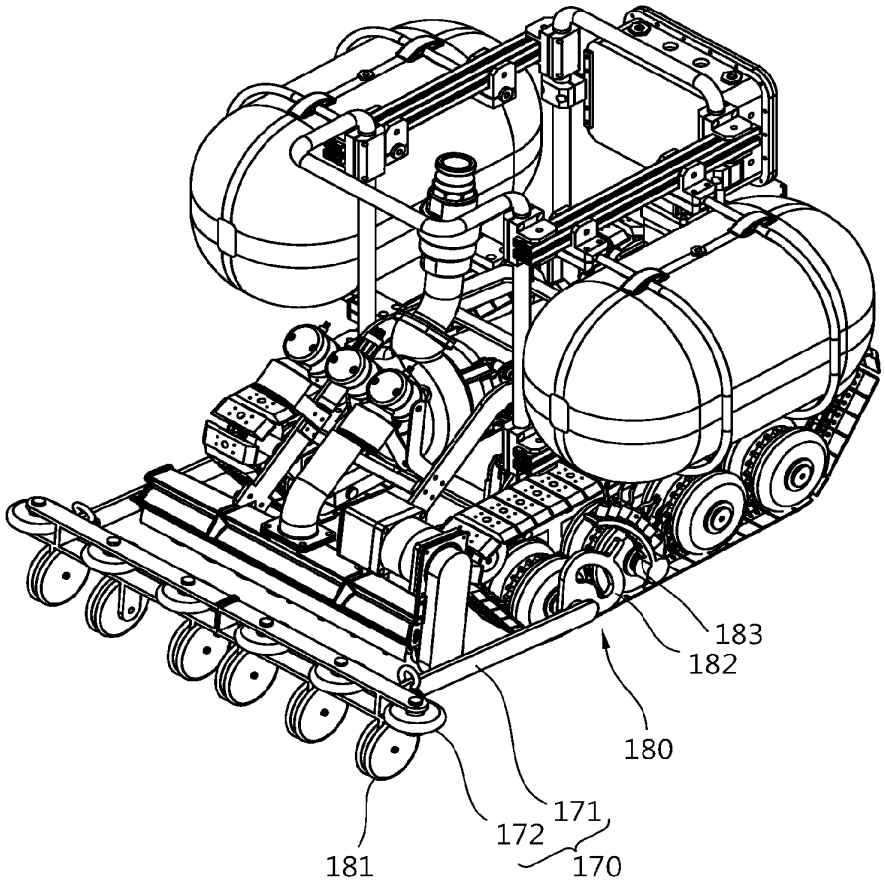
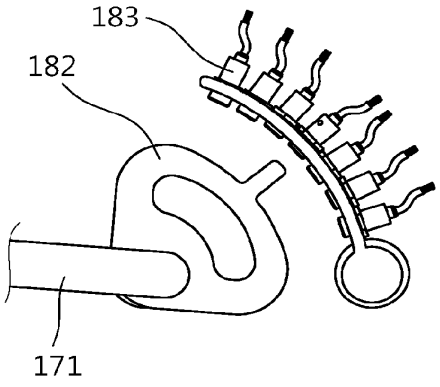
[Fig. 4]



[Fig. 5]



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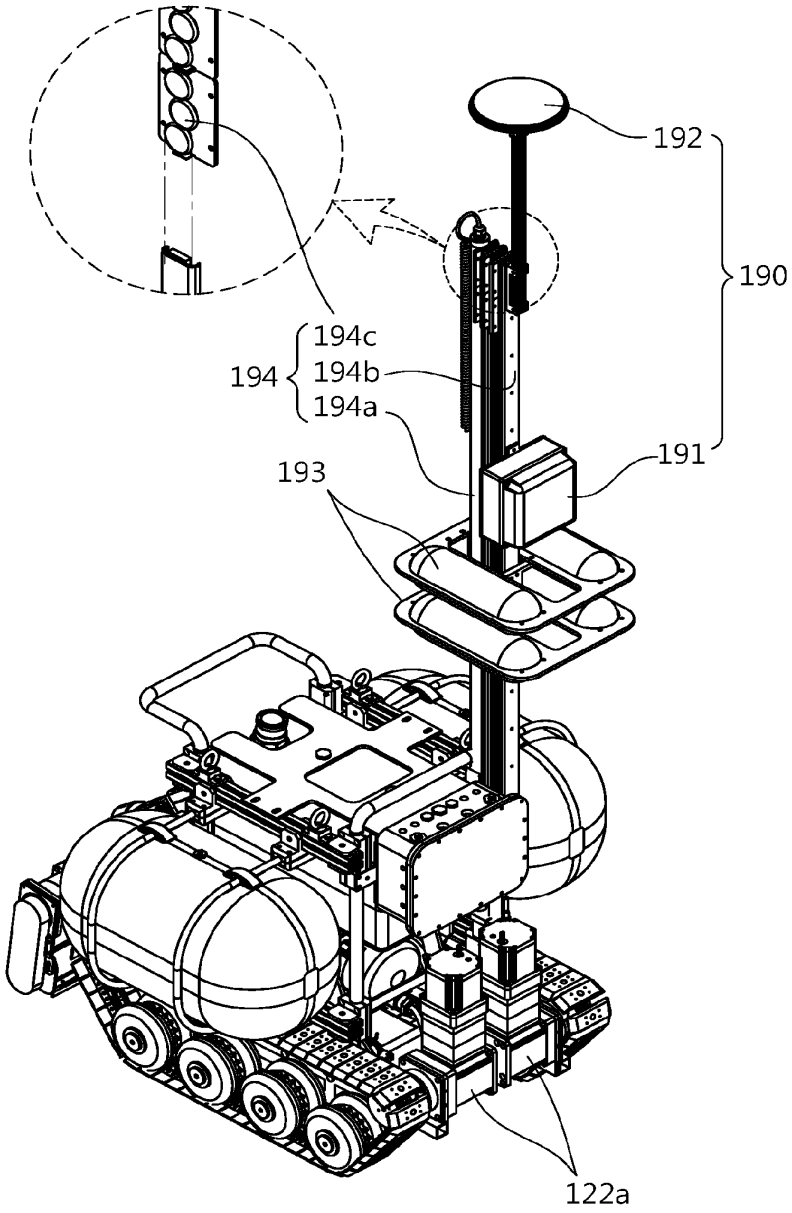
[Fig. 6]



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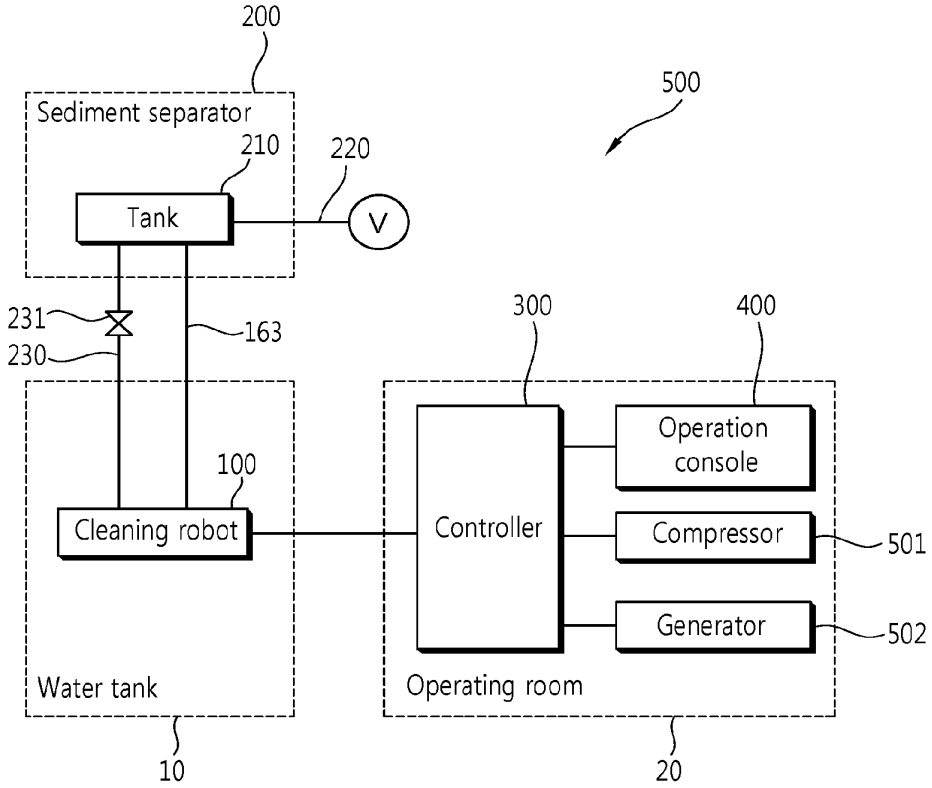
Beatbot v. Zodiac, IPR2026-00200

[Fig. 7]



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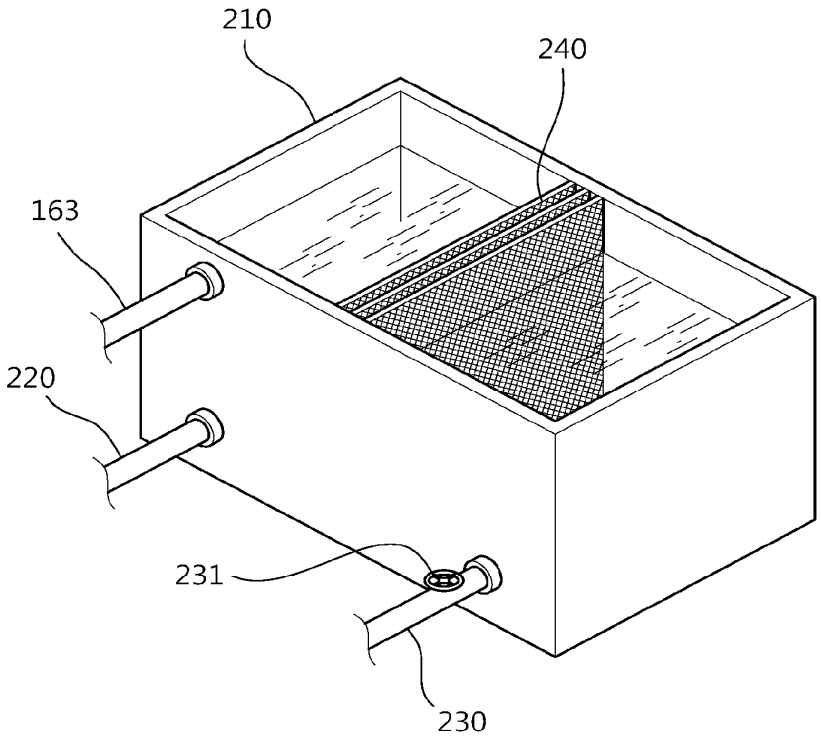
Beatbot v. Zodiac, IPR2026-00200

[Fig. 8]



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Beatbot v. Zodiac, IPR2026-00200

[Fig. 9]

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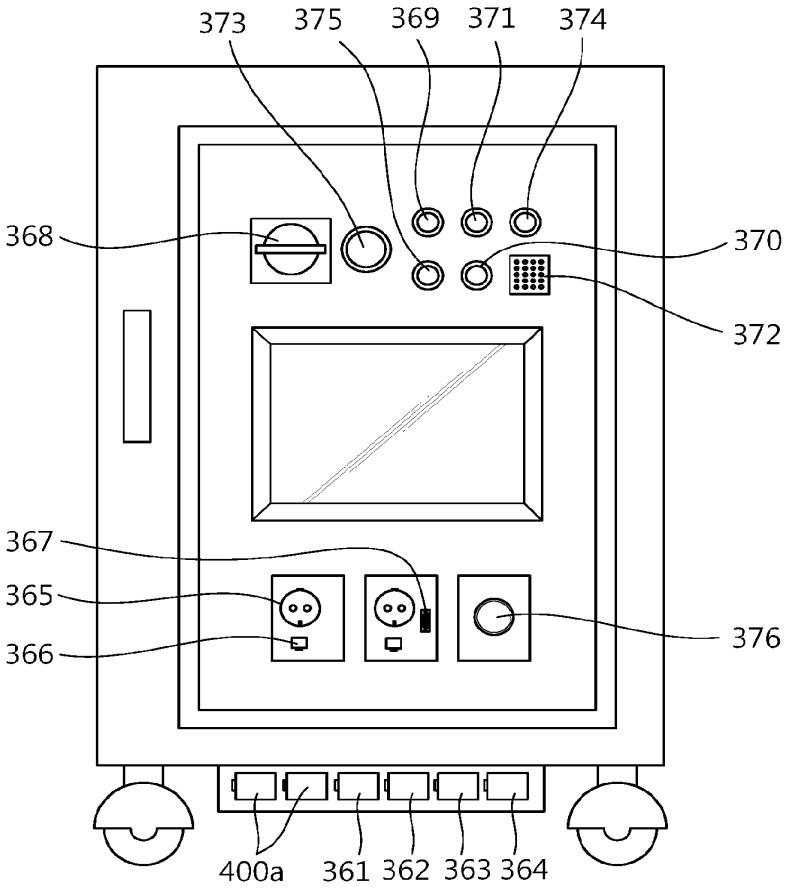
Beatbot v. Zodiac, IPR2026-00200

[Fig. 10]



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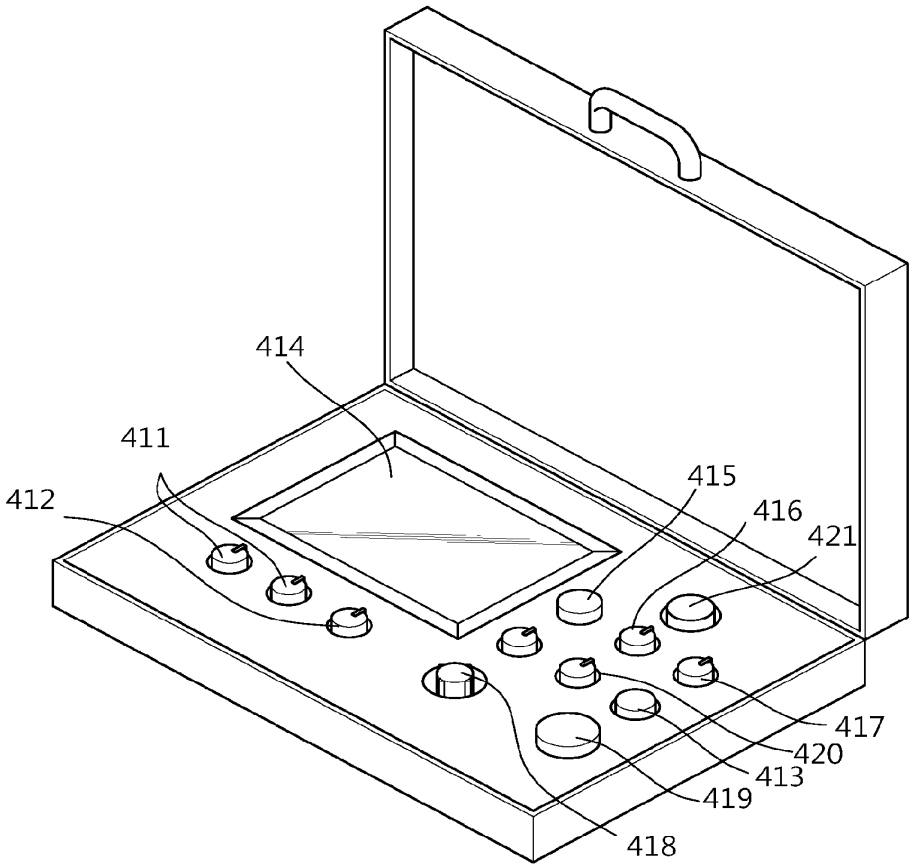
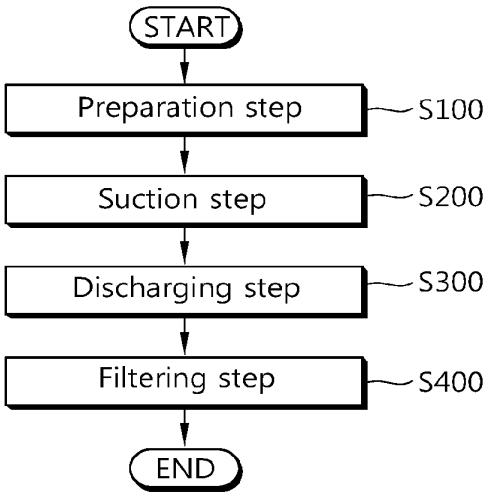
Beatbot v. Zodiac, IPR2026-00200

[Fig. 11]



[Fig. 12]



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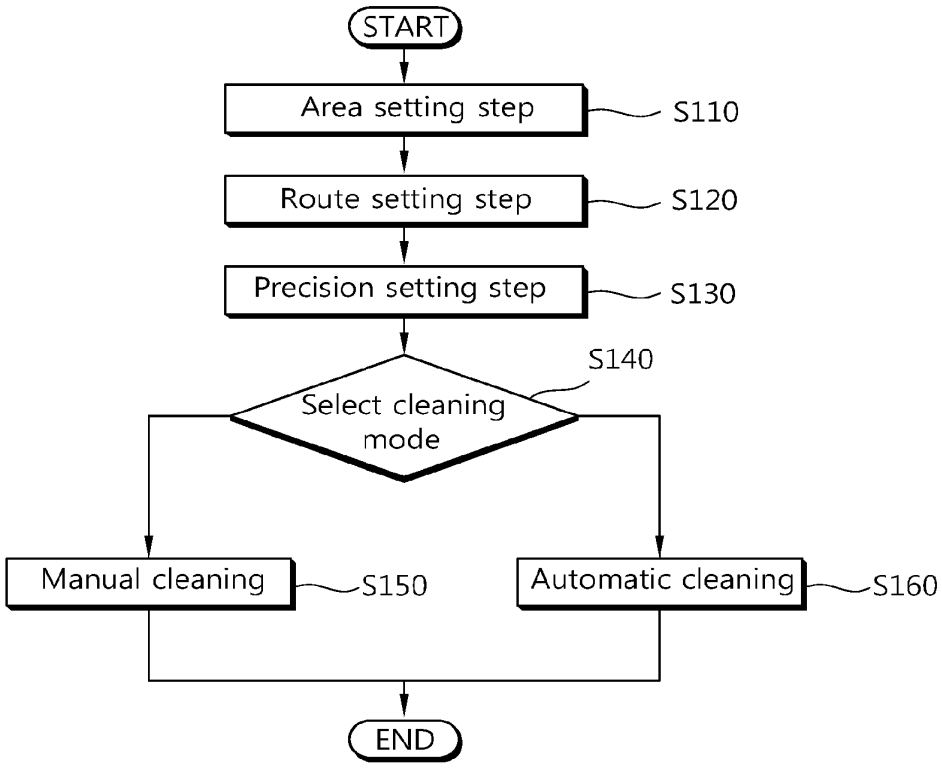
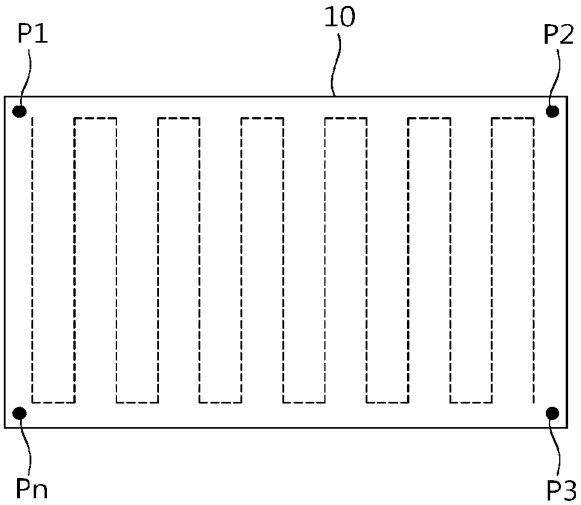
Beatbot v. Zodiac, IPR2026-00200

[Fig. 13a]



[Fig. 13b]



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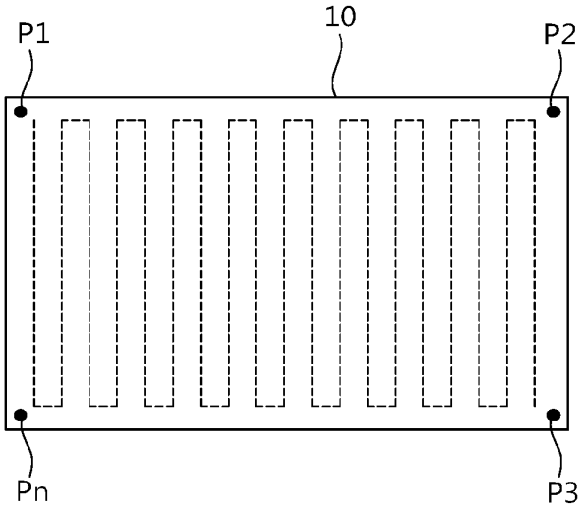
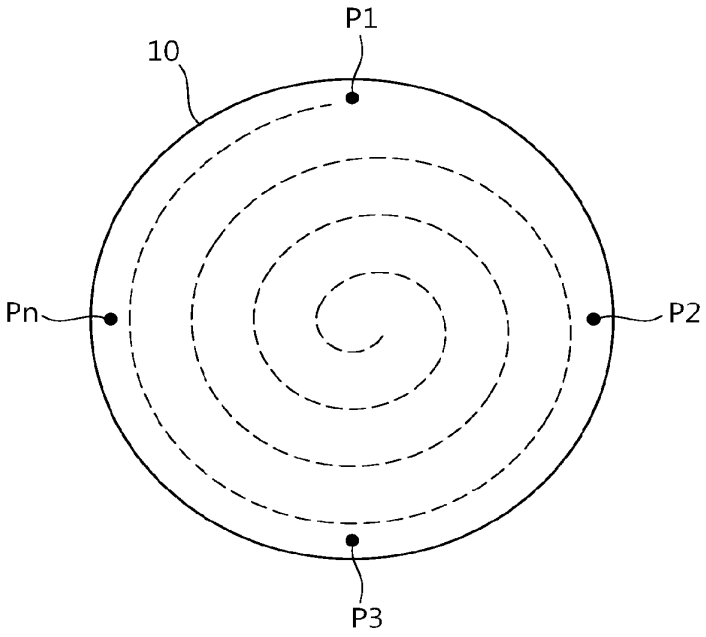
Beatbot v. Zodiac, IPR2026-00200

[Fig. 13c]



[Fig. 13d]



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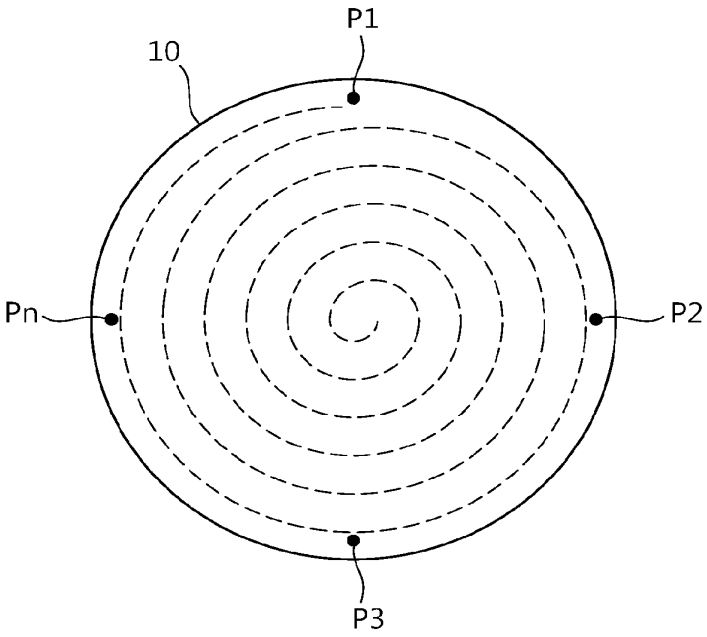
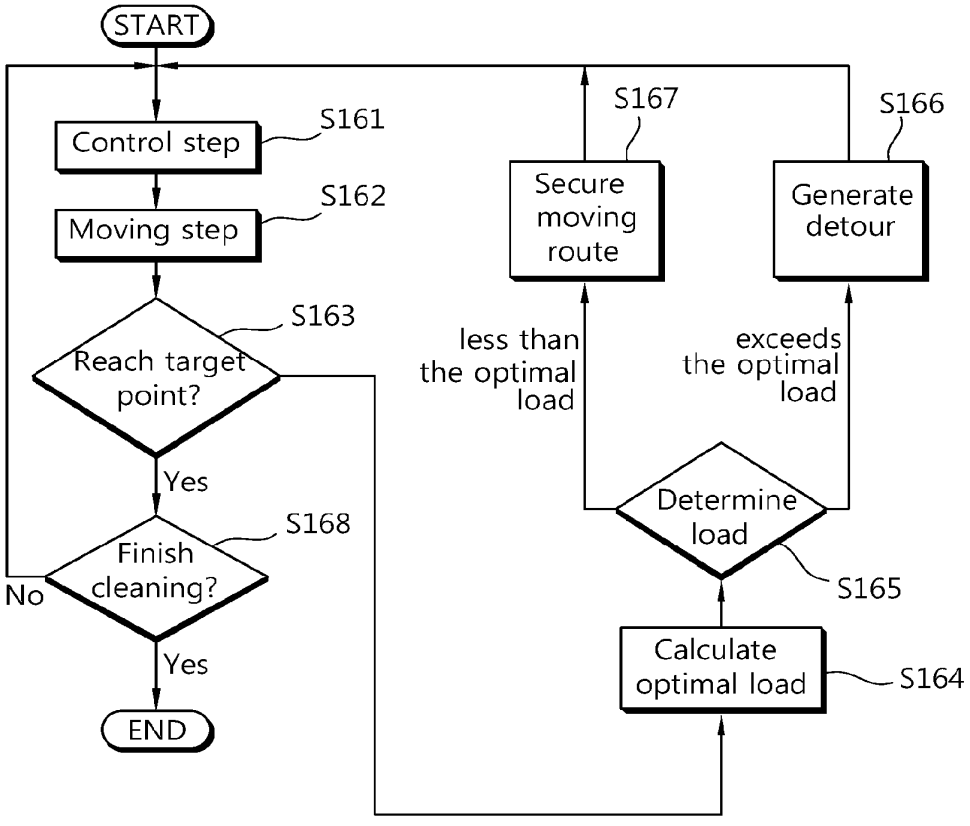
Beatbot v. Zodiac, IPR2026-00200

[Fig. 13e]



[Fig. 14]



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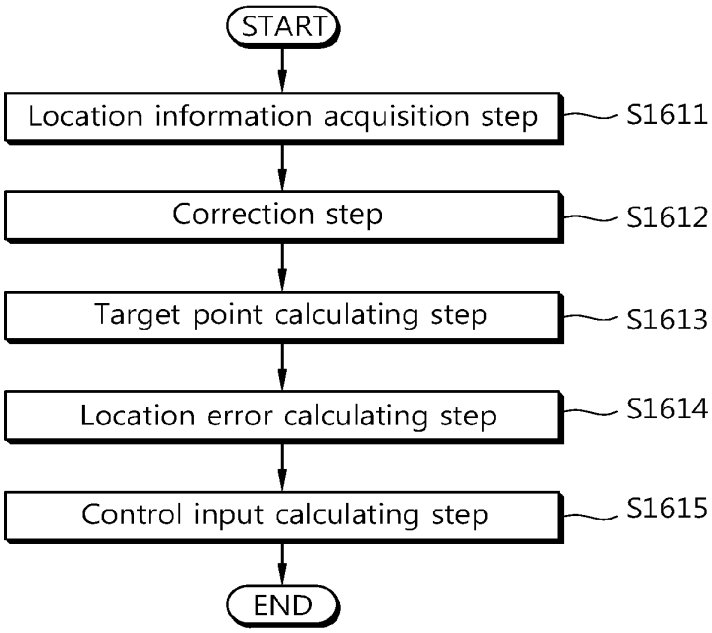
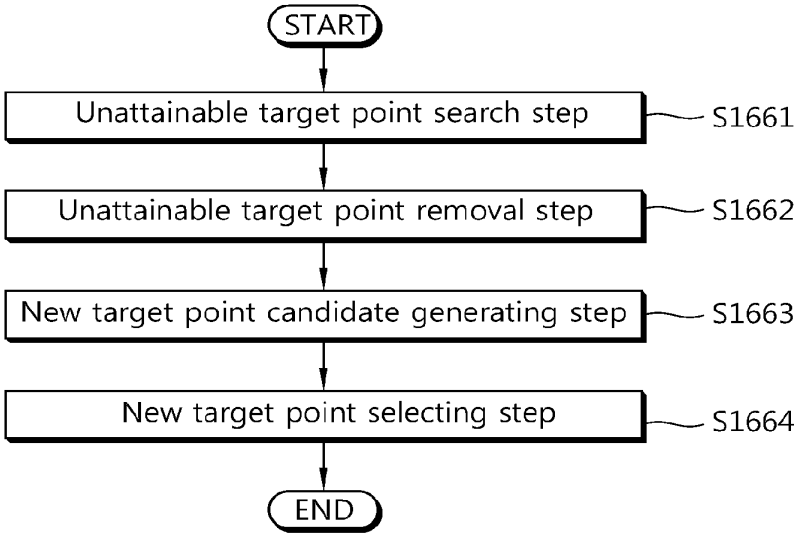
[Fig. 15]



[Fig. 16]



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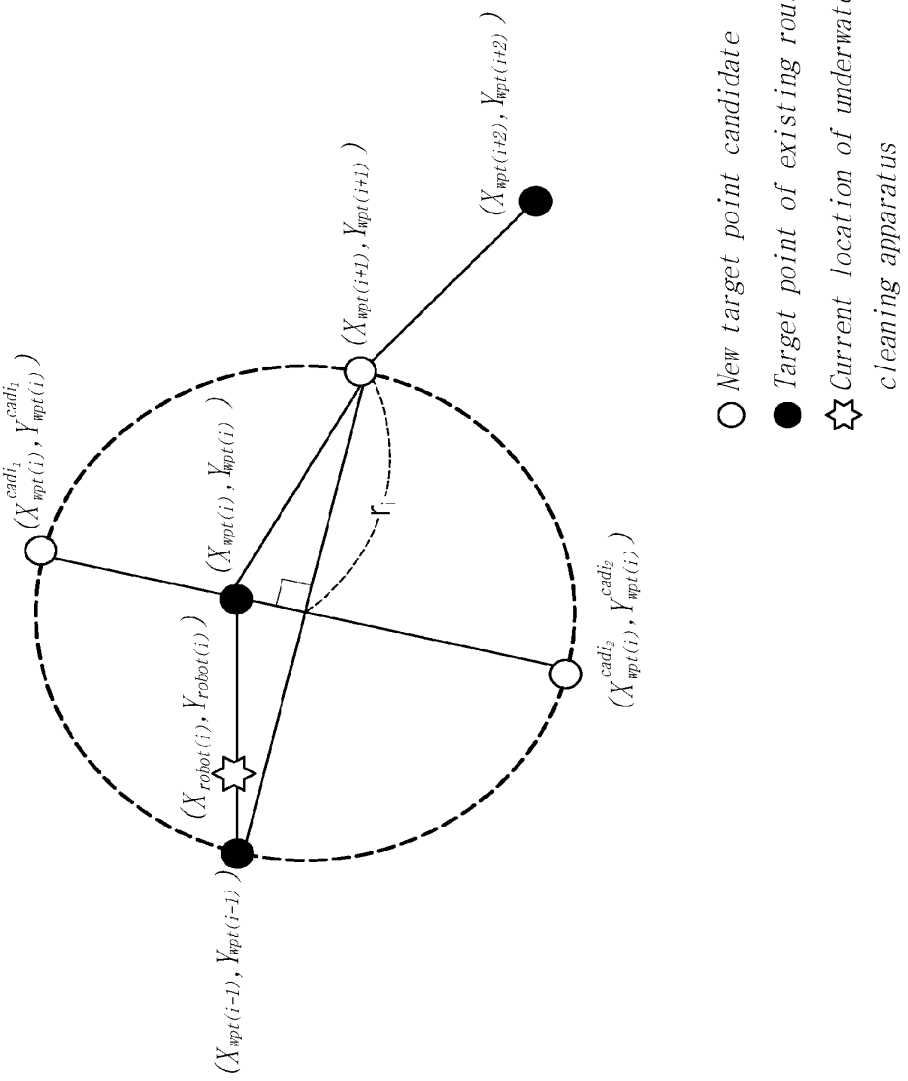
[Fig. 17]



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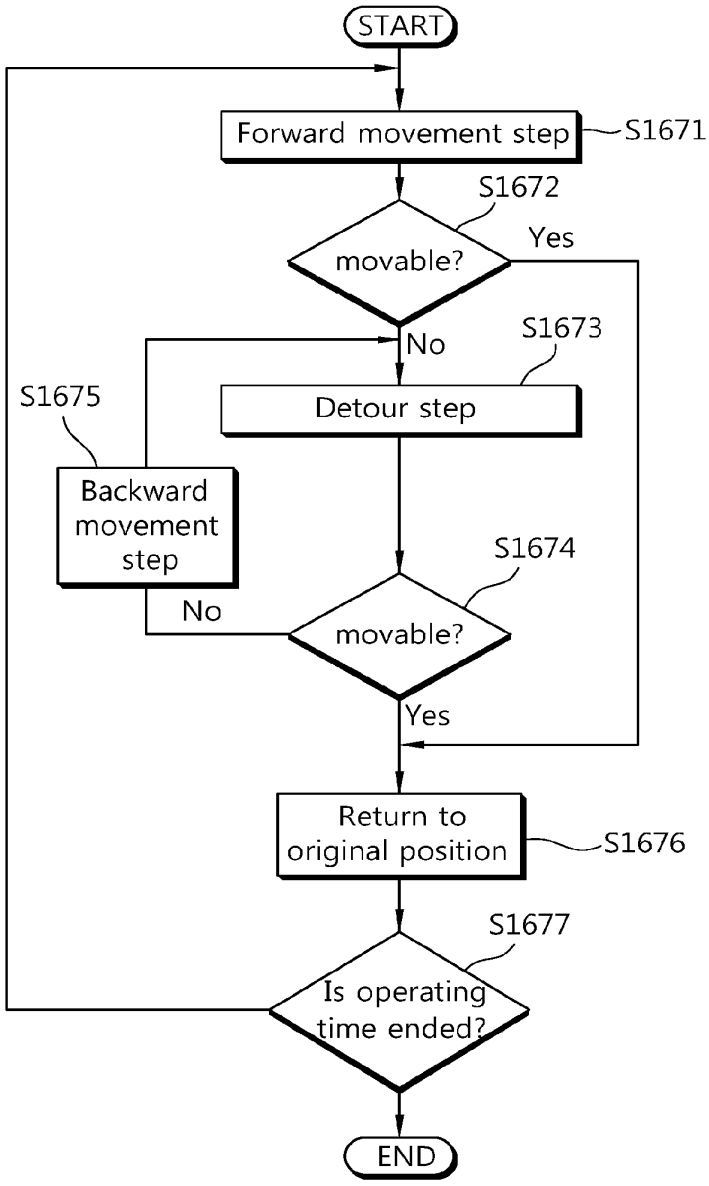
Beatbot v. Zodiac, IPR2026-00200

[Fig. 18]



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Beatbot v. Zodiac, IPR2026-00200

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2011/000598

A. CLASSIFICATION OF SUBJECT MATTER

B08B 9/087(2006.01)i, E04H 4/16(2006.01)i, B25J 5/00(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B08B 9/087; B01D 21/00; B08B 1/02; B08B 1/04; A47L 11/20; G05B 19/10; G05D 1/02; A47L 11/30; B08B 9/08; A47L 11/24

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

Korean utility models and applications for utility models
Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: robot, bumper, recycle, route, control

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	JP 06-285448 A (HITACHI ZOSEN CORP) 11 October 1994 See the abstact; claims 1,2; paragraph 12-18.	1-6,10,11 7-9,12,26,27,29-36 13,14
Y	US 2004-0021439 A1 (JOSEPH PORAT et al.) 05 February 2004 See Fig.4; paragraph 5, 56, 92-94.	7-9
Y	JP 06-081677 U (MITSUBISHI HEAVY INDUSTRIES, LTD.) 22 November 1994 See the abstract.	12
X Y	JP 2001-029910 A (TOKYO ELECTRIC POWER CO INC:THE et al.) 06 February 2001 See the abstract; claims 1, 4; Fig.1.	15-19,22,25 26,27,29-36
A	JP 2002-312035 A (TOSHIBA TEC CORP) 25 October 2002 See the abstract; claims 1-3.	25-27,29-36
A	JP 2004-243202 A (MATSUSHITA ELECTRIC IND CO LTD) 02 September 2004 See paragraphs 10-14.	25-27,29-36

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 OCTOBER 2011 (17.10.2011)	**18 OCTOBER 2011 (18.10.2011)**

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office Government Complex-Daejeon, 189 Cheongsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea	PARK, Youg Ju
Facsimile No. 82-42-472-7140	Telephone No. 82-42-481-5512

Form PCT/ISA/210 (second sheet) (July 2009)

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2011/000598

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 20, 21, 23, 24, 28
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

Drivers in claim 20, a camera, a light and sensors in claim 21 and 23, a balloon in claim 24, and a GPS sensor and wheels in claim 28 are merely listed in the claims without giving a specific structure of the subject matter as a whole, thereby rendering the definiteness of the subject matter of the claim unclear.

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required addtional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (July 2009)

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/KR2011/000598

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 06-285448 A	11.10.1994	None	
US 2004-0021439 A1	05.02.2004	EP 1302611 A2	16.04.2003
		EP 1302611 A3	16.04.2003
		EP 1302611 B1	01.12.2004
		EP 1512810 A2	09.03.2005
		EP 1512810 A3	25.05.2005
		EP 1512810 B1	26.11.2008
		IL145930D0	25.07.2002
		US 6815918 B2	09.11.2004
JP 06-081677 U	22.11.1994	JP H0-681677 U	22.11.1994
JP 2001-029910 A	06.02.2001	None	
JP 2002-312035 A	25.10.2002	None	
JP 2004-243202 A	02.09.2004	None	

Form PCT/ISA/210 (patent family annex) (July 2009)

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Electronic Patent Application Fee Transmittal	
Application Number:	13545918
Filing Date:	10-Jul-2012
Title of Invention:	POOL CLEANING SYSTEM AND METHOD TO AUTOMATICALLY CLEAN SURFACES OF A POOL USING IMAGES FROM A CAMERA
First Named Inventor/Applicant Name:	Kameshwar Durvasula
Filer:	Steven M. Hertzberg/Steven Ortiz
Attorney Docket Number:	316.091
Filed as Large Entity	

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

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Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Request for Continued Examination	1801	1	1200	1200
		Total in USD ($)		**1200**

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

Electronic Acknowledgement Receipt	
EFS ID:	24676833
Application Number:	13545918
International Application Number:	
Confirmation Number:	9590
Title of Invention:	POOL CLEANING SYSTEM AND METHOD TO AUTOMATICALLY CLEAN SURFACES OF A POOL USING IMAGES FROM A CAMERA
First Named Inventor/Applicant Name:	Kameshwar Durvasula
Customer Number:	38137
Filer:	Steven M. Hertzberg/Steven Ortiz
Filer Authorized By:	Steven M. Hertzberg
Attorney Docket Number:	316.091
Receipt Date:	20-JAN-2016
Filing Date:	10-JUL-2012
Time Stamp:	16:57:15
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$1200
RAM confirmation Number	3898
Deposit Account	010035
Authorized User	HERTZBERG, STEVEN
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Request for Continued Examination (RCE)	316091-RCE-1-20-2016.pdf	1363810 189553ea1b3cc39c3f68536949887 6fbebf32646	no	3
Warnings:					
Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	316091_IDS_1.pdf	1035626 587a3d9b0c1ff280b74fb5b766ee753ab0ce5188	no	4
Warnings:					
Information:					
3	Other Reference-Patent/App/Search documents	US5205174.pdf	1133703 37b3270d32086fa256fb1d301369c086fdb5dc51	no	16
Warnings:					
Information:					
4	Other Reference-Patent/App/Search documents	US20040025268.pdf	1045741 8f7c094951ace16aecd24a575ba62c136ea80509	no	13
Warnings:					
Information:					
5	Other Reference-Patent/App/Search documents	US20100299016.pdf	1074792 2fb29b2a1a3a1251bd37993d665abed3d564180b	no	9
Warnings:					
Information:					
6	Foreign Reference	EP0687964B1.pdf	466159 d35190f7ac0d7ca7a5ff342802c3ad9ea4ef8cd4	no	10
Warnings:					
Information:					
7	Foreign Reference	EP0811432B1.pdf	100645 7b10c4629c702a39c5f41f884b0e14536b369879	no	4
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Information:					

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8	Foreign Reference	CN101139007A_with_english_transl.pdf	2216049 91c3eece6f9c7ac0f48aa9036c94b26b364a7496	no	33
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9	Foreign Reference	JPS6162905A-eng_abstract.pdf	390875 a772640cdee6f5a3fa917e02e0bc3aeaf21eda61	no	8
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Information:					
13	Non Patent Literature	spanish_search_report.pdf	145534 10659b9b6240c4205226f877cefa65e935c7a53a	no	1
Warnings:					
Information:					
14	Fee Worksheet (SB06)	fee-info.pdf	30936 b4e95ac94cd5f24d192cd17cece7cccae856caba	no	2
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Information:					
		Total Files Size (in bytes):	14042456		

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This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a 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.

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NOTICE OF ALLOWANCE AND FEE(S) DUE

38137 7590 03/09/2016
ABELMAN, FRAYNE & SCHWAB
666 THIRD AVENUE, 10TH FLOOR
NEW YORK, NY 10017

EXAMINER
WONG, ALLEN C

ART UNIT	PAPER NUMBER
2488	

DATE MAILED: 03/09/2016

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/545,918	07/10/2012	Kameshwar Durvasula	316.091	9590

TITLE OF INVENTION: POOL CLEANING SYSTEM AND METHOD TO AUTOMATICALLY CLEAN SURFACES OF A POOL USING IMAGES FROM A CAMERA

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	06/09/2016

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

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Beatbot v. Zodiac, IPR2026-00200

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
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INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

38137 7590 03/09/2016
ABELMAN, FRAYNE & SCHWAB
666 THIRD AVENUE, 10TH FLOOR
NEW YORK, NY 10017

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I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/545,918	07/10/2012	Kameshwar Durvasula	316.091	9590

TITLE OF INVENTION: POOL CLEANING SYSTEM AND METHOD TO AUTOMATICALLY CLEAN SURFACES OF A POOL USING IMAGES FROM A CAMERA

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	06/09/2016

EXAMINER	ART UNIT	CLASS-SUBCLASS
WONG, ALLEN C	2488	348-114000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:
❑ Issue Fee
❑ Publication Fee (No small entity discount permitted)
❑ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
❑ A check is enclosed.
❑ Payment by credit card. Form PTO-2038 is attached.
❑ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
❑ Applicant certifying micro entity status. See 37 CFR 1.29 — NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
❑ Applicant asserting small entity status. See 37 CFR 1.27 — NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
❑ Applicant changing to regular undiscounted fee status. — NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/545,918	07/10/2012	Kameshwar Durvasula	316.091	9590

38137 7590 03/09/2016

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NEW YORK, NY 10017

EXAMINER	
WONG, ALLEN C	
ART UNIT	PAPER NUMBER
2488	

DATE MAILED: 03/09/2016

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

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Beatbot v. Zodiac, IPR2026-00200

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. 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 12 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, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. 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.

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.

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Beatbot v. Zodiac, IPR2026-00200

Notice of Allowability	Application No. 13/545,918	Applicant(s) DURVASULA ET AL.	
	Examiner ALLEN WONG	Art Unit 2488	AIA (First Inventor to File) Status No

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

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *RCE filed 1/20/16*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ 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.
3. ☒ The allowed claim(s) is/are *1-10 and 12-23*. As a result of the allowed claim(s), 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 .
4. ☐ 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)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
5. ☐ Examiner's Amendment/Comment
6. ☒ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/ALLEN WONG/
Primary Examiner, Art Unit 2488

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

DETAILED ACTION

The present application is being examined under the pre-AIA first to invent provisions.

Continued Examination Under 37 CFR 1.114

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after allowance or after an Office action under *Ex Parte Quayle*, 25 USPQ 74, 453 O.G. 213 (Comm'r Pat. 1935). Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, prosecution in this application has been reopened pursuant to 37 CFR 1.114. Applicant's submission filed on 1/20/16 has been entered.

Information Disclosure Statement

The information disclosure statement (IDS) submitted on 1/20/16 is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement has been considered by the examiner.

Allowable Subject Matter

Claims 1-10 and 12-23 are allowed.

The following is an examiner's statement of reasons for allowance: the present invention pertains to robotic pool cleaning.

Hong (WO 2012/023676 A1) discloses an apparatus comprising: a non-transitory computer-readable medium comprising code configured to cause a processor (paragraph 130, element 330) to:

generate first control signals for moving a robotic pool cleaning vehicle so as to clean water containing surfaces of a pool (paragraph 178-179);

capturing images of a pool being cleaned with a robotic pool cleaning vehicle operating according to a steering algorithm (paragraph 137, camera 168; paragraph 68, operating according to a steering algorithm for cleaning pool);

obtain signals from a camera representing water containing surfaces of a pool and movement of a robotic pool cleaning vehicle adjacent to and along the water containing surfaces of the pool (paragraph 1, 178-179, pool cleaning robot for cleaning pool, paragraph 137, camera 168);

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identify portions of the water containing surfaces of the pool that have not been cleaned by the pool cleaning vehicle to satisfy a predefined threshold (paragraph 31 and 137);

a powered robotic surface cleaning vehicle to travel adjacent water containing surfaces of a pool while submerged within the pool (abstract and paragraph [1]);

a camera configured to capture movement of the vehicle (paragraph 111, element 168);

a controller in electronic communication with the camera to generate control signals to steer the vehicle based on the signals from the camera (paragraph 31 and 36).

Meniere (US 7,362,351) discloses a camera adapted to be mounted external the pool to capture movement of the vehicle while submerged within the pool (col.6, ln.21-30).

The prior art, either singularly or in combination, does not disclose the limitation "automatically generate second control signals to steer the robotic pool cleaning vehicle to reclean the identified portions of the water containing surfaces based upon the signals from the camera" of claim 12.

Thus, the prior art does not disclose the aforementioned limitation used in combination with all of the other limitations of claim 12. Claim 15 is patentable for at least similar reasons as claim 12. Also, peruse pages 9-12 of Applicant's remarks filed 10/26/15.

Also, the prior art, either singularly or in combination, does not disclose the limitation "sensors, in electronic communication with the controller and carried by the vehicle, to sense the water containing surfaces of the pool after the water containing surfaces of the pool have been cleaned by the vehicle during the pass of the water under control of a pool coverage algorithm, wherein the control signals steer the vehicle so as to reclean the water containing surfaces having a cleanliness characteristic that is sensed by the sensors and fails to satisfy a predetermined threshold" of claim 1.

Thus, the prior art does not disclose the aforementioned limitation used in combination with all of the other limitations of claim 1. Also, peruse pages 12-14 of Applicant's remarks filed 10/26/15.

And, the prior art, either singularly or in combination, does not disclose the limitation "wherein the controller automatically steers the robotic pool cleaning vehicle to reclean identified portions of the water containing surfaces still having debris based on the signals from the camera" of claim 17.

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Thus, the prior art does not disclose the aforementioned limitation used in combination with all of the other limitations of claim 17. Also, peruse pages 18-19 of Applicant's remarks filed 10/26/15.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Contact Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to ALLEN WONG whose telephone number is (571)272-7341. The examiner can normally be reached on Flex Monday to Thursday 8am-6pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, SATH PERUNGAVOOR can be reached on (571) 272-7455. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/ALLEN WONG/
Primary Examiner, Art Unit 2488

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Beatbot v. Zodiac, IPR2026-00200

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BIB DATA SHEET

CONFIRMATION NO. 9590

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
13/545,918	07/10/2012 RULE	348	2488	316.091

APPLICANTS

INVENTORS

Kameshwar Durvasula, Lyndhurst, NJ;
William Londono Correa, Bloomfield, NJ;

** CONTINUING DATA **********

** FOREIGN APPLICATIONS **********

** IF REQUIRED, FOREIGN FILING LICENSE GRANTED **
07/20/2012

Foreign Priority claimed	☐ Yes ☑ No	☐ Met after Allowance	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
35 USC 119(a-d) conditions met	☐ Yes ☑ No					
Verified and Acknowledged	/ALLEN C WONG/ Examiner's Signature	Initials	NJ	4	20	4

ADDRESS

ABELMAN, FRAYNE & SCHWAB
666 THIRD AVENUE, 10TH FLOOR
NEW YORK, NY 10017
UNITED STATES

TITLE

POOL CLEANING SYSTEM AND METHOD TO AUTOMATICALLY CLEAN SURFACES OF A POOL USING IMAGES FROM A CAMERA

FILING FEE RECEIVED		
1660	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

BIB (Rev. 05/07).

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13545918	DURVASULA ET AL.
	Examiner	Art Unit
	ALLEN WONG	2488

CPC- SEARCHED		
Symbol	Date	Examiner
E04H 4/1654, H04N 5/23203, H04N 7/18, H04N 2005/2255	6/25/15	AW
search updated	12/16/15	AW
search updated	2/25/16	AW

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
348	114, 143, 159	6/25/15	AW
382	103	6/25/15	AW
356	4.03	6/25/15	AW
search	updated	12/16/15	AW
search	updated	2/25/16	AW

SEARCH NOTES		
Search Notes	Date	Examiner

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
348	114	12/16/15	AW
E04H	4/1654	12/16/15	AW
H04N	7/18, 5/23203, 2005/2255	12/16/15	AW
search	updated	2/25/16	AW

	/ALLEN WONG/ Primary Examiner.Art Unit 2488

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
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.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	13545918
Filing Date	2012-07-10
First Named Inventor	DURVASULA
Art Unit	2488
Examiner Name	Allen C. WONG
Attorney Docket Number	316091

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5205174	A	1993-04-27	Silverman et al.	

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U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20040025268	A1	2004-02-12	Porat	
	2	20100299016	A1	2010-11-25	Benzler Ulrich-Lorenze et al.	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	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]
	1	0687964	EP	A1	1995-12-20	Zeltron SPA		
	2	0811432	EP	A2	1997-12-10	Pehrson Jonas		

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /AW/

Examiner Signature /Allen Wong/ Date Considered 02/25/2016

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Receipt date: 01/20/2016	Application Number	13545918 13545918 - GAU: 2488
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2012-07-10
(Not for submission under 37 CFR 1.99)	First Named Inventor	DURVASULA
	Art Unit	2488
	Examiner Name	Allen C. WONG
	Attorney Docket Number	316091

	3	101139007	CN	A	2008-03-12	Bejing Inst. Technology		
	4	S6162905	JP	A	1986-03-31	Komatsu MFG Co		
	5	2004019295	WO	A1	2004-03-04	Aqua Products Inc.		
	6	2009031361	WO	A1	2009-30-12	Yotsuyanagi Co. Ltd		
	7	2012023676	WO	A1	2012-02-23	Pohang Inst. of Intelligent Robotics		

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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]
	1	Spanish Patent No. P201331047 - State of Art Search Report from the ES Patent and Trademark Office; mailed 2015-02-03; 1 page.	

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EXAMINER SIGNATURE

Examiner Signature	/Allen Wong/	Date Considered	02/25/2016

*EXAMINER: Initial if reference considered, 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.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /AW/

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13545918	DURVASULA ET AL.
	Examiner	Art Unit
	ALLEN WONG	2488

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

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	06/25/2015	12/17/2015	02/25/2016						
1	1	✓	=	=						
2	2	✓	=	=						
3	3	✓	=	=						
4	4	✓	=	=						
5	5	✓	=	=						
6	6	✓	=	=						
7	7	✓	=	=						
8	8	✓	=	=						
9	9	✓	=	=						
10	10	✓	=	=						
	11	✓	-	-						
11	12	✓	=	=						
12	13	✓	=	=						
13	14	✓	=	=						
14	15	✓	=	=						
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18	19	✓	=	=						
19	20	✓	=	=						
20	21		=	=						
21	22		=	=						
22	23		=	=						

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13545918	DURVASULA ET AL.
	Examiner	**Art Unit**
	ALLEN WONG	2488

CPC							
Symbol						**Type**	**Version**
E04H		4	/	1654		F	2013-01-01
H04N		7	/	18		I	2013-01-01
H04N		5	/	23203		I	2013-01-01
H04N		2005	/	2255		A	2013-01-01
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CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
			/					
			/					

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	22	
/ALLEN WONG/ Primary Examiner.Art Unit 2488	02/25/2016	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office — Part of Paper No. 20160225

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13545918	DURVASULA ET AL.
	Examiner	Art Unit
	ALLEN WONG	2488

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION										
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED					
348	114	H	0	4	N	7 / 18 (2006.01.01)						

CROSS REFERENCE(S)					
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	22	
/ALLEN WONG/ Primary Examiner.Art Unit 2488	02/25/2016	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office

Part of Paper No. 20160225

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13545918	DURVASULA ET AL.
	Examiner	**Art Unit**
	ALLEN WONG	2488

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	16	17												
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11	12														
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14	15														
15	16														

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	22	
/ALLEN WONG/ Primary Examiner.Art Unit 2488	02/25/2016	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office Part of Paper No. 20160225

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

PRINTER RUSH

(PTO ASSISTANCE)

Application:	13/545918	**Examiner:**	Wong	**GAU:**	2488
From:	Almaz Gezahegn	**Location:**	RTFM / FMF	**Date:**	05/26/16

Tracking #: _____ Week Date: _____

DOC CODE	DOC DATE	MISCELLANEOUS
☐ 1449		☐ Continuing Data
☒ IDS	05/25/16	☐ Foreign Priority
☐ CLM		☐ Document Legibility
☐ IIFW/FWCLM		☒ Fees
☐ SRFW		☐ Petition (TC)
☐ DRW		☐ Other
☐ OATH		
☐ 312		
☐ SPEC		

[RUSH] Message:

Please charge the IDS fee for the 05/25/16 IDS to Deposit Account No 01-0035.

Thank you,
AG

[XRUSH] Response:

done

Initials: BJT

NOTE: This form will be included as part of the official USPTO record with the response document coded as XRUSH.
REV: JUL 15

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
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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.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	13545918
	Filing Date	2012-07-10
	First Named Inventor	DURVASULA et al.
	Art Unit	2488
	Examiner Name	WONG, A.C.
	Attorney Docket Number	316,091

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5613261	A	1997-03-25	KAWAKAMI et al.	

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	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]
	1							

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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]

EFS Web 2.1.17

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13545918
	Filing Date	2012-07-10
	First Named Inventor	DURVASULA et al.
	Art Unit	2488
	Examiner Name	WONG, A.C.
	Attorney Docket Number	316,091

	1	NOTIFICATION REGARDING THE RESPONSE TO THE SUBSTANTIVE EXAMINATION issued by the Spanish Patent and Trademark Office dated 5 May 2016 in corresponding application ES 2527883 (in Spanish with English translation).	

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, 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 (Not for submission under 37 CFR 1.99)		
	Application Number	13545918
	Filing Date	2012-07-10
	First Named Inventor	DURVASULA et al.
	Art Unit	2488
	Examiner Name	WONG, A.C.
	Attorney Docket Number	316,091

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 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 certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Steven M. Hertzberg/	Date (YYYY-MM-DD)	2016-05-25
Name/Print	Steven M. Hertzberg	Registration Number	41,834

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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Beatbot v. Zodiac, IPR2026-00200

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 record s.

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 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.

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Beatbot v. Zodiac, IPR2026-00200

Electronic Acknowledgement Receipt	
EFS ID:	25880685
Application Number:	13545918
International Application Number:	
Confirmation Number:	9590
Title of Invention:	POOL CLEANING SYSTEM AND METHOD TO AUTOMATICALLY CLEAN SURFACES OF A POOL USING IMAGES FROM A CAMERA
First Named Inventor/Applicant Name:	Kameshwar Durvasula
Customer Number:	38137
Filer:	Steven M. Hertzberg/Lori Valdes
Filer Authorized By:	Steven M. Hertzberg
Attorney Docket Number:	316.091
Receipt Date:	25-MAY-2016
Filing Date:	10-JUL-2012
Time Stamp:	13:08:05
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	IDS_Transmittal.pdf	249139 b119abf1d24246acd76faf0800e32d9255d2fb3a	no	5
Warnings:					
Information:					

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Beatbot v. Zodiac, IPR2026-00200

2	Information Disclosure Statement (IDS) Form (SB08)	316091_IDS08a.pdf	612360 7b5b3b926114921fc4416c431e648bc544b5891e	no	4
Warnings:					
Information:					
3	Other Reference-Patent/App/Search documents	Notification_Spain.pdf	797062 a1d3b38f3de72018192e097e69b91f4548f8a0cf	no	13
Warnings:					
Information:					
			Total Files Size (in bytes):	1658561	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a 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.

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

Docket No: 316,091

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT:	DURVASULA et al.	EXAMINER: WONG, A.C.
SERIAL NO.:	13/545,918	ART UNIT: 2488
FILED:	July 10, 2012	CONFIRMATION NO.: 9590
FOR:	POOL CLEANING SYSTEM AND METHOD TO AUTOMATICALLY CLEAN SURFACES OF A POOL USING IMAGES FROM A CAMERA	

INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

Dated: May 25, 2016

Commissioner:

This Information Disclosure Statement (hereinafter sometimes referred to as "IDS") is submitted in accordance with 37 C.F.R. §§1.97, 1.98, and it is requested that the information set forth in this statement and in the listed documents be considered during the pendency of the above-identified application, and any other application relying on the filing date of the above-identified application or cross-referencing it as a related application.

1. This IDS should be considered, in accordance with 37 C.F.R. §1.97, as it is filed:

(Check one of the boxes opposite A-E)

[ ] A. within three months of the filing date of the above-identified national application, or within three months of the date of entry of the national stage as set forth in 37 C.F.R. §1.491 in the above-identified international application.

[ ] B. before the mailing date of a first office action on the merits.

[ ] C. before the mailing of a first Office action after the filing of a request for continued examination (RCE) under §1.114.

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

[ ] D. after the times set forth in (A), (B) and (C) above, but before the mailing date of either a final action under 37 C.F.R. §1.113 or a notice of allowance under 37 C.F.R. §1.311, and the necessary statement pursuant to 37 C.F.R. §1.97(e) appears below (see box "i") or the necessary fee is enclosed (see box "ii" below).

(check one of the boxes opposite "i" or "ii" below)

[ ] i. (check the applicable statement)

[ ] I, the undersigned, hereby state that each item of information contained in this Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this Information Disclosure Statement.

[ ] I, the undersigned, hereby state that no item of information in this Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application and, to my knowledge after making reasonable inquiry, was known to any individual designated in 37 C.F.R. §1.56(c) more than three months prior to the filing of this Information Disclosure Statement.

[ ] ii. A check for the fee set forth in 37 C.F.R. §1.17(p), presently believed to be $180.00, is enclosed.

OR

[ ] ii. A deposit account authorization for the fee set forth in 37 C.F.R. §1.17(p), presently believed to be $180.00, is enclosed with the electronic submission of these papers.

[X] E. after the times set forth in (A), (B), (C) and (D) above, but before payment of the issue fee, since Applicant petitions for the consideration of this Information Disclosure Statement by a petition enclosed herewith pursuant to 37 C.F.R. §1.97(d)(2), a check for the petition fee set forth in 37 C.F.R. §1.17(i), presently believed to be $ 130.00, is enclosed, and the necessary statement pursuant to 37 C.F.R. §1.97(e) appears below:

(check the applicable statement)

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

[X] I, the undersigned, hereby state that each item of information contained in this Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this Information Disclosure Statement.

[ ] I, the undersigned, hereby state that no item of information contained in this Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application and, to my knowledge after making reasonable inquiry, no item of information contained in this Information Disclosure Statement was known to any individual designated in 37 C.F.R. §1.56(c) more than three months prior to the filing of this Information Disclosure Statement.

2. In accordance with 37 C.F.R. §1.98(a)(1), this IDS includes a list on form PTO/SB/08a of all patents, publications, or other information submitted for consideration by the Office, incorporated into this IDS as an attachment hereto. Pursuant to 37 C.F.R. §1.98(b): (i) each U.S. patent listed is identified by patentee, patent number, and issue date; (ii) each foreign patent or published foreign patent application is identified by the country or patent office which issued the patent or published the application, an appropriate document number, and the publication date indicated on the patent or published application; and (iii) each publication is identified by author (if any), title, relevant pages of the publication, date, and place of publication. A legible copy of each document listed is attached and incorporated into this IDS, except that no copy of any U.S. patent application is included pursuant to 37 C.F.R. §1.98(a)(2)(iii) and except as explained below.

(check the boxes opposite A and/or B and fill in blanks, if appropriate)

[ ] A. Document(s) _____ is (are) substantively cumulative to document(s) ____, and, in accordance with 37 C.F.R. §1.98(c), only a copy of each of the latter document(s) is (are) attached.

[ ] B. Certain documents were previously cited by or submitted to the Office in the following prior application(s), which are relied upon for an earlier filing date under 35 U.S.C. §120:

These documents are identified by attaching hereto copies of the forms PTO-892, PTO-1449 and/or PTO/SB/08A from the files of the prior application(s) and Applicant requests that they

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

be considered and made of record in this application in accordance with 37 C.F.R. §1.98(d). Pursuant to 37 C.F.R. §1.98(d), copies of these documents need not be provided with this IDS.

(check paragraphs 3 and/or 4, if applicable)

[ ] 3. Document(s) _____ is not in the English language. In accordance with 37 C.F.R. §§1.98(a)(3),1.98(c), it is stated that:

(check the applicable statement(s))

[ ] English-language abstract of the document(s) _____ are enclosed.

[ ] English translation(s) of the document(s) _____ (or of the pertinent portions thereof) is (are) enclosed and, thus no concise explanation of their relevance is required, (see M.P.E.P., §609, p. 600-92).

[ ] English-language equivalent(s) of the document(s) _____(or of the pertinent portions thereof) which is (are) in fact translation(s) of the document(s) is (are) enclosed.

[ ] The attached English-language version of a search report or other action by a foreign patent office in a counterpart foreign application _____ which cites document(s) __ and which indicates the degree of relevance found by the foreign office is submitted to satisfy the requirement for a concise explanation of the relevance of the document(s), (see M.P.E.P., §609, p. 600-93).

[ ] A concise explanation of the relevance of document(s) _____ is set forth as follows:

[insert concise explanation of relevance]

[ ] A concise explanation of the relevance of document(s) _____ can be found on page(s) _____ of the specification.

[ ] A concise explanation of the relevance of document(s) _____ can be found on the attached sheet.

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

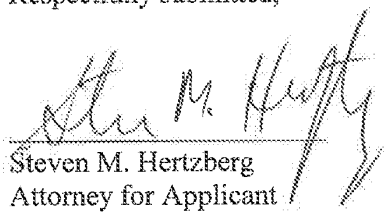
[X] 4. Other information being provided for the Examiner's consideration follows:

[X] Copy of the Notification Regarding the Response to the Substantive Examination (in Spanish with English translation) dated May 5, 2016 issued by the Spanish Patent and Trademark Office, in counterpart Spanish application no. ES 2527883 are submitted with this Information Disclosure Statement.

5. In accordance with 37 C.F.R. §§1.97(g),1.97(h), the filing of this IDS shall not be construed as a representation that a search has been made or as an admission that information cited in this IDS is, or is considered to be, material to patentability as defined in 37 C.F.R. §1.56(b). Unless otherwise indicated, the date of publication indicated for an item is taken from the face of the item and Applicant reserves the right to prove that the date of publication is in fact different.

6. Please charge any deficiency or other fees or credit any refund or overpayment to Deposit Account No. 01-0035.

Respectfully submitted,



Steven M. Hertzberg
Attorney for Applicant
Reg. No. 41,834

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Beatbot v. Zodiac, IPR2026-00200

Document code: WFEE

United States Patent and Trademark Office
Sales Receipt for Accounting Date: 05/31/2016

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01 FC : 1806 180.00 DA

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Beatbot v. Zodiac, IPR2026-00200

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United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/545,918	07/10/2012	Kameshwar Durvasula	316.091	9590

38137 7590 06/08/2016

ABELMAN, FRAYNE & SCHWAB
666 THIRD AVENUE, 10TH FLOOR
NEW YORK, NY 10017

EXAMINER	
WONG, ALLEN C	

ART UNIT	PAPER NUMBER
2488	

MAIL DATE	DELIVERY MODE
06/08/2016	PAPER

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.

Corrected Notice of Allowability	Application No. 13/545,918	Applicant(s) DURVASULA ET AL.	
	Examiner ALLEN WONG	Art Unit 2488	AIA (First Inventor to File) Status No

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

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *IDS filed 5/25/16*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ 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.
3. ☒ The allowed claim(s) is/are *1-10 and 12-23*. As a result of the allowed claim(s), 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 .
4. ☐ 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)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
5. ☐ Examiner's Amendment/Comment
6. ☐ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/ALLEN WONG/
Primary Examiner, Art Unit 2488

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	13545918
Filing Date	2012-07-10
First Named Inventor	DURVASULA et al.
Art Unit	2488
Examiner Name	WONG, A.C.
Attorney Docket Number	316,091

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5613261	A	1997-03-25	KAWAKAMI et al.	

If you wish to add additional U.S. Patent citation information please click the Add button. Add

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

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FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	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]
	1							

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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]

/Allen Wong/ 06/06/2016

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /AW/

Ltrs wait 2 mt

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

Receipt date: 05/25/2016	Application Number	13545918 13545918 - GAU: 2488
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2012-07-10
	First Named Inventor	DURVASULA et al.
(Not for submission under 37 CFR 1.99)	Art Unit	2488
	Examiner Name	WONG, A.C.
	Attorney Docket Number	316,091

	1	NOTIFICATION REGARDING THE RESPONSE TO THE SUBSTANTIVE EXAMINATION issued by the Spanish Patent and Trademark Office dated 5 May 2016 in corresponding application ES 2527883 (in Spanish with English translation).	

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature	/Allen Wong/	Date Considered	06/06/2016

*EXAMINER: Initial if reference considered, 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.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /AW/

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

38137 7590 03/09/2016
ABELMAN, FRAYNE & SCHWAB
666 THIRD AVENUE, 10TH FLOOR
NEW YORK, NY 10017

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/545,918	07/10/2012	Kameshwar Durvasula	316.091	9590

TITLE OF INVENTION: POOL CLEANING SYSTEM AND METHOD TO AUTOMATICALLY CLEAN SURFACES OF A POOL USING IMAGES FROM A CAMERA

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	06/09/2016

EXAMINER	ART UNIT	CLASS-SUBCLASS
WONG, ALLEN C	2488	348-114000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 ABELMAN, FRAYNE &
2 SCHWAB
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: Aqua Products, Inc.

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Cedar Grove, New Jersey

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:
☒ Issue Fee
☒ Publication Fee (No small entity discount permitted)
☐ Advance Order - # of Copies

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
☐ A check is enclosed.
☐ Payment by credit card. Form PTO-2038 is attached.
☒ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number 01-0035 (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
☐ Applicant certifying micro entity status. See 37 CFR 1.29
NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
☐ Applicant asserting small entity status. See 37 CFR 1.27
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
☐ Applicant changing to regular undiscounted fee status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature
Typed or printed name Steven M. Hertzberg
Date June 9, 2016
Registration No. 41,834

PTOL-85 Part B (10-13) Approved for use through 10/31/2013 OMB 0651-0033 U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

Electronic Patent Application Fee Transmittal

Application Number:	13545918
Filing Date:	10-Jul-2012
Title of Invention:	POOL CLEANING SYSTEM AND METHOD TO AUTOMATICALLY CLEAN SURFACES OF A POOL USING IMAGES FROM A CAMERA
First Named Inventor/Applicant Name:	Kameshwar Durvasula
Filer:	Steven M. Hertzberg/Steven Ortiz
Attorney Docket Number:	316.091

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Utility Appl Issue Fee	1501	1	960	960
Publ. Fee- Early, Voluntary, or Normal	1504	1	0	0
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**960**

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

Electronic Acknowledgement Receipt	
EFS ID:	26014353
Application Number:	13545918
International Application Number:	
Confirmation Number:	9590
Title of Invention:	POOL CLEANING SYSTEM AND METHOD TO AUTOMATICALLY CLEAN SURFACES OF A POOL USING IMAGES FROM A CAMERA
First Named Inventor/Applicant Name:	Kameshwar Durvasula
Customer Number:	38137
Filer:	Steven M. Hertzberg/Steven Ortiz
Filer Authorized By:	Steven M. Hertzberg
Attorney Docket Number:	316.091
Receipt Date:	09-JUN-2016
Filing Date:	10-JUL-2012
Time Stamp:	11:53:25
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$960
RAM confirmation Number	11267
Deposit Account	010035
Authorized User	HERTZBERG, STEVEN
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	316091_IssueFee.pdf	475752 5bd6c21b4176f7f3d84ef31f2f27ccf6a5bdb8a8	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	32583 0d908452978caa4cf48c86356df819f946c221a8	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	508335		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a 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.

Beatbot, Ex. 1011
Beatbot v. Zodiac, IPR2026-00200

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/545,918	07/12/2016	9388595	316.091	9590

38137 7590 06/22/2016

ABELMAN, FRAYNE & SCHWAB
666 THIRD AVENUE, 10TH FLOOR
NEW YORK, NY 10017

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 909 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Kameshwar Durvasula, Lyndhurst, NJ;
William Londono Correa, Bloomfield, NJ;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

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Beatbot v. Zodiac, IPR2026-00200