



Inspection and Cleaning of Water using Robot

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ABSTRACT: The main source of water varies from place to place. It may be groundwater, rainwater or water combined from two or more sources. The source of water may be standstill or running condition, when water is exposed to environment there is a possibility of addition of materials like plastics, dry leaves, algae, dust etc into the water. The stored water may also have fine suspended particles or impurities in dissolved form. If water is stored for longer period then here is a possibility of formation of sediments scale and algae get deposited on the walls, ceiling and floor of the storage. Other possibilities of impure water are suspended solids, germs, bacteria, or parasite growth. These depositions contaminate the water and makes it unfit for use. Hence cleaning of water is very important to make it fit for domestic use. For the larger area of water storage, manual cleaning process of water is costlier, time consuming, life risk and tedious job. In order to avoid these problems in this project work we made an attempt to develop a prototype robot based water cleaning system. The proposed robot system cleans the water without much effort. However, a human interference is needed to take the prototype robot to the location of the water to be cleaned and to place it inside the water.

KEYWORDS: arduino nano, robotic grippers, prototype robot, dc motor, ultrasonic sensor.

I. INTRODUCTION

Most existing multi-robot systems use generic domain independent research platforms. While these are ideal for design, development and testing of associated software algorithms, they do not capture real-world constraints and are therefore not practical for deployment. Specialized robotic watercraft have been successfully used in deep sea tasks ranging from mapping deepest underwater caves to tele-supervised sensor fleet for ocean surface and sub-surface studies. Tele-supervised Adaptive Ocean Sensor Fleet is an example of one such deep sea multi-robot science exploration system that combines a group of robotic boats to enable in situ study of phenomena in the ocean-atmosphere interface, as well as on the ocean surface and subsurface.

This project aims at developing a prototype robotic boat, which can perform most of the required work. This invention relates to skimmer boats, i.e., work boats for collecting and disposing of floating solid waste materials in harbours and waterways. The invention is more specifically directed to highly manoeuvrable vessels equipped with means for picking up floating debris, means for storing the debris on the vessel, and means for discharging the debris from the vessel to a storage area, which may be ashore or which may be another vessel such as barge. Many work boats and vessels have been proposed for collection of floating solid waste and other debris. These may typically be formed as a catamaran-type hull, i.e., a pair of pontoons or sponsors, or as a monohull, with paddle wheel or screw driver propulsion, and an operator station. In one typical trash skimmer design, one or more hydraulically powered open mesh conveyors are positioned between the pontoons of a catamaran-type twin-hull vessel. It is industrial working prototype of water cleaning mechanism which can auto collect floating garbage and solid waste from the water surface and collect it into its floating bin. It can be programmed, scaled up to any size and can operate remotely. The method to clean includes cutting the weeds by hand (making them float), collecting them along with other surface wastes with the help of an arm and storing them in a boat. It also includes collecting of plastics, leafy materials and other floating wastes along with cleaning the mud which is accumulated in the stored water using submersible pump motor. The system is indigenous and efficient to tackle river cleaning cause.

II. LITERATURE SURVEY

[1] Design and Analysis of River Water Cleaning Machine

This project emphasis on Design and Analysis of the River Water Cleaning Machine. The work has done looking at the current situation of our national rivers which are dump with core litters of sewage and loaded with pollutants, toxic materials, debris etc. In this project we have fabricated the remote operated river cleaning machine. The main aim of the project is to reduce the man power, time consumption for cleaning the river. In this project we have automated the



operation of river cleaning with help of a motor and chain drive arrangement. Some needs of automation are described below. Here using RF transmitter and receiver are to control the cleaning machine. Automation can be achieved through computers, hydraulics, pneumatics, robotics, etc., of these sources, pneumatics form an attractive medium for low cost automation.

[2]Design and Fabrication of Project on Water Bodies Cleaning Robot

This project emphasis on design and fabrication of the river waste cleaning machine. The work has done looking at the current situation of our national rivers which are dump with crore liters of sewage and loaded with pollutants, toxic materials, debris etc. The government of India has taken charge to clean rivers and invest huge capital in many river cleaning projects like “Namami Gange”, “Narmada Bachao” and many major and medium projects in various cities like Ahmadabad, Varanasi etc. By taking this into consideration, this machine has designed to clean river water surface.

[3]Design and Fabrication of Remote Controlled Sewage Cleaning Machine

The motive of the project is to automate the sewage cleaning process in drainage, to reduce the spreading of diseases to human. The black water cleaning process helps to prevent pest infestations by reducing the residues that can attract and support pests. It also improves the shelf life and sensory quality of food products. In the proposed system, the machine is operated with remote control to clean the sewage. Hence, this system avoids the impacts from the sewage waste and its harmful gases.

[4]Design & Fabrication of River Cleaning System

India is holy country & during lots of festival like ganesh visarjan, navratri durga puja & mainly Siahnsth kumbhmela there is lots of water pollution of Godavari River at Nashik. The water pollution is very important problem in rivers, ponds and water bodies near Godavari River at Nashik. Due to increase in water pollution in the form to waste debris; it is hampering the life of aquatic animal and make their life in danger. Similarly sometimes the aquatic animal tends to eats surface waste debris considering it as a food; which ultimately cause the death of animals.

[5]Drainage System Cleaner A Solution to Environmental Hazards

The Drainage system cleaner is a machine which helps to protect the environment from different kinds of environmental hazards through the promotion waste management by the removal of garbage from the drainage system. These wastes when not removed end up settling in residential places where these wastes are burnt thereby causing climate change otherwise these wastes block the drainage systems thereby causing flooding. The machine is designed in such a way that it generates motion for its functions by itself through the action of running water thereby cutting out the dangers of the powering the machine by other sources of power because of the harshness of the rain on these other sources.



III. PROPOSED METHODOLOGY AND DISCUSSION

The block diagram of proposed system is as shown in Figure 1.0 and it consists of following components.

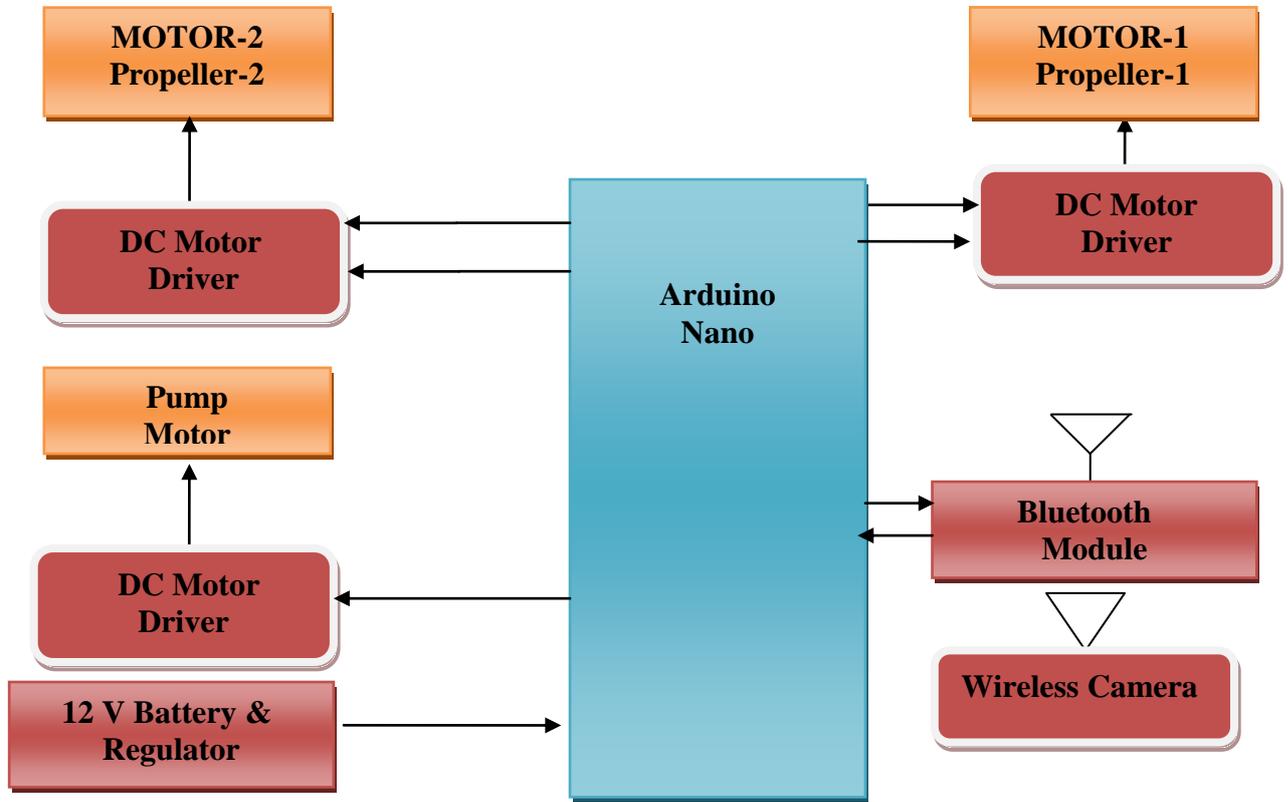


Fig 1.0. Block Diagram of Proposed System

3.1 Arduino Nano

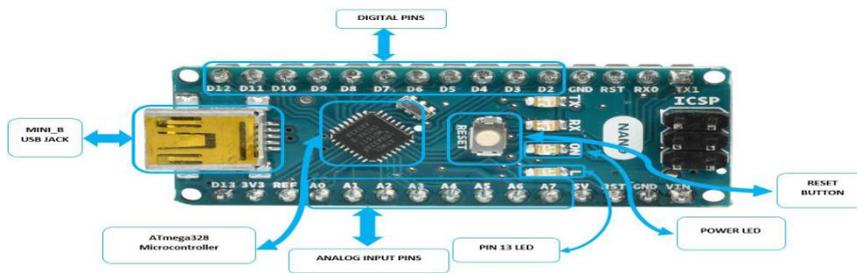


Fig.1.1 Arduino Nano

3.1.1 Peripheral Features of Arduino

- Two 8-bit Timer/Counters with Separate Pre-scaler and Compare Mode
- One 16-bit Timer/Counter with Separate Pre-scaler, Compare Mode, and Capture Mode
- Real Time Counter with Separate Oscillator
- Six PWM Channels
- 8-channel 10-bit ADC in TQFP and QFN/MLF package
- 6-channel 10-bit ADC in PDIP Package
- Temperature Measurement



SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language.

LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

I2C: 4 (SDA) and 5 (SCL). Support I2C (TWI) communication using the Wire library (documentation on the Wiring website).

There are a couple of other pins on the board:

AREF: Reference voltage for the analog inputs. Used with analog-Reference ().

Reset: Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

3.2 DC Gear Motor Drive

Geared DC motor has a gear assembly attached to the motor. The speed of motor is measured in terms of RPM. The gear assembly helps in increasing the torque and reducing the speed. Using the correct combination of gears in a gear motor, its speed can be reduced to any desirable value by using gear reduction.

3.2.2 PWM Technique

A pulse width modulator (PWM) is a device that may be used as an efficient light dimmer or DC motor speed controller. A PWM works by making a square wave with a variable on-to-off ratio; the average on time may be varied from 0 to 100 percent. In this manner, a variable amount of power can be transferred to the load. The main advantage of a PWM circuit over a resistive power controller is the efficiency, at a 50% level, the PWM will use about 50% of full power, almost all of which is transferred to the load, a resistive controller at 50% load power would consume about 71% of full power, 50% of the power goes to the load and the other 21% is wasted in terms of heating the series resistor. Finally, in a PWM circuits, common small potentiometers may be used to control a wide variety of loads whereas large and expensive high power variable resistors are needed for resistive controllers.

3.3 Propeller

Thruster Technology

The T200 Thruster uses our patented underwater thruster design consisting of a fully-flooded brushless motor with encapsulated motor windings and stator as well as coated magnets and rotor. The thruster body and propeller are made from tough polycarbonate plastic and the only exposed metal components are made from marine grade 316 stainless steel. The fully-flooded design is unique compared to thrusters existing before the T200. It allows the motor to be water-cooled and the plastic bushings to be water-lubricated. It eliminates the need for shaft seals, magnetic couplings, and air- or oil-filled compartments, making the thruster naturally pressure tolerant. The design is compact and has a minimal number of parts so that we can offer it at an affordable price.

3.4 Bluetooth Module

The important features of Bluetooth:

1. It is wireless system.
2. It is inexpensive.
3. The devices find one another and connect without any input at all.

It is a wireless protocol that is used to communicate from one device to another in a small area usually less than 30 feet. Bluetooth communicates on a frequency of 2.45 gigahertz, which has been set aside by international agreement for the use of industrial, scientific and medical devices (ISM). Bluetooth communication occurs in the unlicensed ISM band at 2.4 GHz, this unlicensed band in most countries, includes the frequency range from 2400 to 2483.5 MHz A typical Bluetooth device has a range of about 10 meters

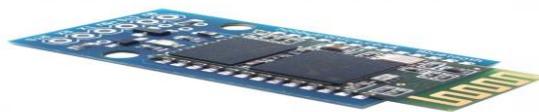


Fig.4 Bluetooth Transceiver

3.5 Submersible Water Pump

An electrical submersible pump is a device which has a hermetically sealed motor close-coupled to the pump body. The whole assembly is submerged in the fluid to be pumped. The main advantage of this type of pump is that, it prevents



pump cavitations, a problem associated with a high elevation difference between pump and the fluid surface. Small DC Submersible water pumps push fluid to the surface as opposed to jet pumps having to pull fluids. Submersibles are more efficient than jet pumps. It is usually operated between 3v to 12v.

Specifications:

- Voltage: 2.5-10V
- Maximum lift: 40-110cm / 15.75"-43.4"
- Flow rate: 80-120L/H
- Outside diameter: 7.5mm / 0.3"
- Inside diameter: 5mm / 0.2"
- Diameter: Approx. 24mm / 0.95"
- Length: Approx. 45mm / 1.8"
- Height: Approx. 30mm / 1.2"
- Material: Engineering plastic
- Driving mode: DC design, magnetic driving
- Continuous working life for 500 hours

3.6 Battery

The Electric battery is an array of electrochemical cells for electricity storage, either individually linked or housed in a single unit. An electrical battery is a combination of one or more electrochemical cells, used to convert stored chemical energy into electrical energy. Batteries may be used once and discarded, or recharged for years as in standby power applications. Larger batteries provide standby power for telephone exchanges or computer data centers.

3.6.1 Lead-acid batteries

These are the most common in PV systems because their initial cost is low and they are readily available. There are many different sizes and designs of lead-acid batteries, but the most important designation is that they are deep cycle batteries. Lead-acid batteries are available in both wet-cell (requires maintenance) and sealed no-maintenance versions. Lead acid batteries are reliable, cost effective with an exceptionally long life and have high reliability because of their ability to withstand overcharge, over discharge vibration and shock. The use of special sealing techniques ensures that the batteries are leak proof and non-spoilable. The batteries have exceptional charge acceptance, large electrolyte volume and low self-discharge, which make them ideal as zero- maintenance batteries lead acid batteries. These batteries are used in Inverter & UPS Systems and have the proven ability to perform under extreme conditions. The batteries have electrolyte volume, use PE Separators and are sealed in sturdy containers, which give them excellent protection against leakage and corrosion.

3.6.2 Features:

- Manufactured/tested using CAD
- Electrolyte volume
- PE separators are used for protection against leakage

3.7 Voltage Regulator

As the name itself implies, it regulates the input applied to it. A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level. In this project, power supply of 5V and 12V are required. In order to obtain these voltage levels, 7805 and 7812 voltage regulators are used. The first number 78 represents positive supply and the numbers 05, 12 represent the required output voltage levels. The L78xx series of three-terminal positive regulators is available in TO-220, TO-220FP, TO-3, D2PAK and DPAK packages and several fixed output voltages, making it useful in a wide range of applications.



3.8 Wireless Camera



Fig 5 Wireless Camera

Mini wireless audio and video PAL camera and receiver security set, operating on the long range 1.2GHz transmitting frequency. Perfect for indoor use, this handy wireless set features a camera with low light 3Lux lens and the ability to be used as a wireless or a wired RCA camera, and an AV OUT for easy connection to such devices as a LCD screen or a VCR for recording live audio and video feeds.

3.8.1 Receiver Specifications:

1. Receiving Frequency: 1.2GHz
2. Intermediate Frequency: 480Mhz
3. Frequency Stabilization: +/-100Khz
4. Demodulation Mode: FM
5. Antenna: 50ohm SMA
6. Receiving Sensitivity: <-85dBm
7. Power Source: DC 9V
8. Dimension: 120x81x20mm (L*W*D)
9. Channels Available: 1
10. Channel Tuning for Multiple Cameras
11. AV OUT

3.8.2 Camera Specifications:

1. Image Device: 1/3 CMOS
2. TV system: PAL
3. Horizontal Definition: 380TV Lines
4. Angular Field of View: 38 deg
5. Minimum Illumination: 3.0 Lux
6. Synchronization System: Internal
7. Backlight Compensation: Auto
8. White Balance: Auto
9. S/N Ratio: >48dB
10. Operation Temperature: 0~35 deg C
11. Transmission Frequency: 1.2GHz
12. Locked Frequency
13. Power Adapter: DC 9V or 9V Battery
14. Power Adapter input voltage: 110-240V
15. Dimension: 20x20x22mm (L*W*D)
16. Recommended Max Range for Objects: 5 Meters
17. Transmission Range: 12~15 Meters
18. Built In Microphone: Max Audio Range 1~2 Meters
19. Wireless or Wired RCA A/V Transmission
20. JMK Manufacturer Ref.: MH7YRWL3Y9CY

IV. HARDWARE DESIGN AND DEVELOPMENT

A hardware design is primarily concerned with the internal electrical (and, more rarely, the mechanical) interfaces among the system's components and the interface between the system and its external environment, especially the devices operated by or the electronic displays viewed by a user.



The hardware design of our prototype robot consists of

4.1 Regulated power supply

The power supplies are designed to convert high voltage AC mains electricity in to a suitable low voltage supply for electronic circuits and other devices. A RPS (Regulated Power Supply) is the Power Supply with Rectification, Filtering and Regulation being done on the AC mains to get a Regulated power supply for Microcontroller and for the other devices being interfaced to it.

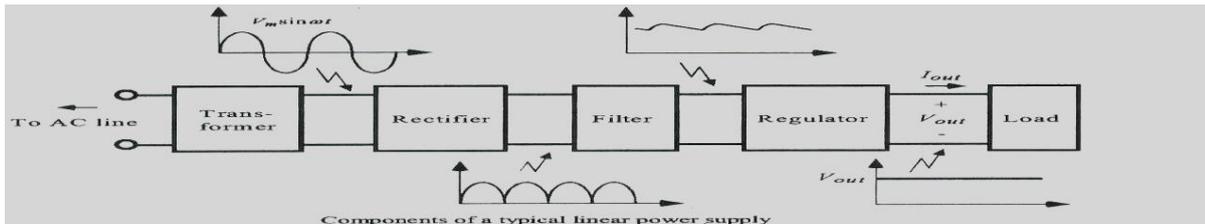


Fig.6 Regulated Power Supply

4.1.1 Transformer

A transformer is an electrical device which is used to convert electrical power from one Electrical circuit to another without change in frequency.

Turns ratio = $V_p / V_s = N_p / N_s$

Power Out= Power In

$V_s \times I_s = V_p \times I_p$

V_p = primary (input) voltage

N_p = number of turns on primary coil

I_p = primary (input) current

4.1.2 Rectifier

A circuit which is used to convert ac to dc is known as RECTIFIER.

The full wave bridge rectifier has more advantages when compared to half wave rectifier and full wave rectifier. So, in our project we are using full wave bridge rectifier circuit.

Bridge Rectifier

A bridge rectifier makes use of four diodes in a bridge arrangement as shown in fig (a) to achieve full-wave rectification.

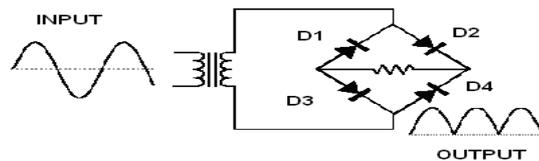


Fig (A)

Operation:

During positive half cycle of secondary, the diodes D2 and D3 are in forward biased while D1 and D4 are in reverse biased as shown in the fig(b). The current flow direction is shown in the fig (b) with dotted arrows.

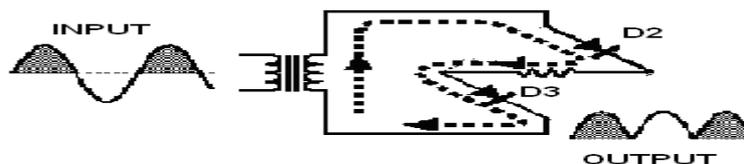
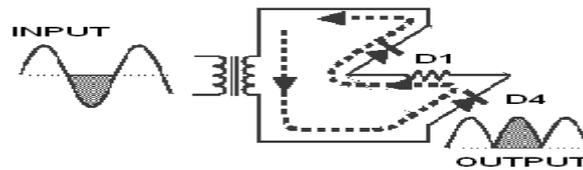


Fig (B)

During negative half cycle of secondary voltage, the diodes D1 and D4 are in forward biased while D2 and D3 are in reverse biased as shown in the fig(c). The current flow direction is shown in the fig (c) with dotted arrows.



Fig(C)

4.1.3 Filter

A Filter is a device which removes the ac component of rectifier output but allows the dc component to reach the load. Filtering is performed by a large value electrolytic capacitor connected across the DC supply to act as a reservoir, supplying current to the output when the varying DC voltage from the rectifier is falling. The capacitor charges quickly near the peak of the varying DC, and then discharges as it supplies current to the output. Filtering significantly increases the average DC voltage to almost the peak value ($1.4 \times \text{RMS value}$).

To calculate the value of capacitor(C),
 $C = \frac{1}{4} \cdot \sqrt{3} \cdot f \cdot r \cdot R_l$

Where, f = supply frequency,
 r = ripple factor,
 R_l = load resistance

4.1.4 Regulator

Voltage regulator ICs is available with fixed (typically 5, 12 and 15V) or variable output voltages. The maximum current they can pass also rates them.. Most regulators include some automatic protection from excessive current ('overload protection') and overheating ('thermal protection')

The Linear LM78XX is integrated linear positive regulator with three terminals. The LM78XX is available in the TO-252, TO-220 & TO-263 packages,

Features:

- Output Current of 1.5A
- Output Voltage Tolerance of 5%
- Internal thermal overload protection
- Internal Short-Circuit Limited
- Output Voltage 5.0V, 6V, 8V, 9V, 10V, 12V, 15V, 18V, 24V.

LM78XX Series Voltage Regulator

A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level.

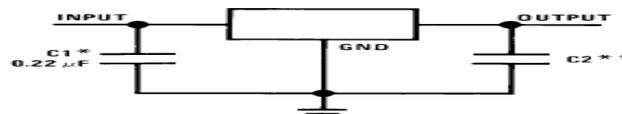


Fig 7 Voltage Regulator Circuit

In this project, power supply of 5V and 12V are required. In order to obtain these voltage levels, 7805 and 7812 voltage regulators are to be used. The first number 78 represents positive supply and the numbers 05, 12 represent the required output voltage levels. These regulators can provide local on-card regulation, eliminating the distribution problems associated with single point regulation. Each type employs internal current limiting, thermal shut-down and safe area protection, making it essentially indestructible. The LM78XX series is available in an aluminum TO-3 package which will allow over 1.0A load current if adequate heat sinking is provided. Current limiting is included to limit the peak output current to a safe value. Safe area protection for the output transistor is provided to limit internal power dissipation. If internal power dissipation becomes too high for the heat sinking provided, the thermal shutdown circuit takes over preventing the IC from overheating. Input bypassing is needed only if the regulator is located far from the filter capacitor of the power supply. For output voltage other than 5V, 12V and 15V the LM117 series provides an output voltage range from 1.2V to 57V.



4.1.5 Ultrasonic Sensor HC-SR04:



Fig 8 Ultrasonic Sensor

An Ultrasonic sensor is a device that can measure the distance to an object by using sound waves. It measures distance by sending out a sound wave at a specific frequency and listening for that sound wave to bounce back.

Product features: Ultrasonic ranging module HC-SR04 provides 2cm-400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules includes ultrasonic transmitters, receiver and control circuit. The basic principle of work:

- (1) Using IO trigger for atleast 10us high level signal.
- (2) The Module automatically sends eight 40kHz and detect whether there is a pulse signal back.
- (3) IF the signal back, through high level time of high output IO duration is the time from sending ultrasonic to returning.

Test distance=(high level time*velocity of sound(340M/S)/2).

Wire connecting direct as following:

- 5V Supply
- Trigger Pulse Input
- Echo Pulse Output
- 0V Ground

Electrical Parameter

Working Voltage	DC 5V
Working Current	15Ma
Working Frequency	40Hz
Maximum Range	4m
Minimum Range	2cm
Measuring Angle	15 degree
Trigger Input Signal	10us TIL Pulse
Echo Output Signal	Input TIL lever signal and the range in proportion
Dimension	45*20*15mm

4.1.6 Robotic Grippers

A gripper is a device that holds objects for manipulation and has the ability of grasping and releasing objects while some action is being performed. Usually, a gripper is a custom - engineered part, which grasps one or few objects similar in shape, size, and weight in repetitive or specific operations. An industrial robot can be defined as a manipulator, one with reprogramming possibility which is able to perform multiple functions as like moving materials, parts, tools, and specialized devices through variable programmed motions for the performance of a variety of tasks

Robot consists of a robotic manipulator and an end – effector. A robotic manipulator is an electronically controlled mechanism, consisting of multiple segments, that performs tasks by interacting with the environment. End – effector of a robot is in direct contact with the object and hence its role is critical. The end – effectors used to handle work pieces are called grippers. They are active link between the handling equipment and the work piece to be grasped.

The joint in the kinematic chain between robotic arm and the hand or tool is referred to as robot wrist. Depending on the application, wrist may have one or more DOF. The arm and wrist assemblies of a robot are used for positioning the end-effector. It is the end – effector that actually performs the work. It must grasp, lift and manipulate the work piece without causing damage to it and without letting it go. The simplest form of end-effector is the gripper. Being less adaptable than human hand/artificial hands, it needs to be designed specifically for a particular application.



4.2 Software Requirement

4.2.1 Arduino

An Arduino board consists of an Atmel 8, 16 or 32-bit AVR microcontroller with complementary components that facilitate programming and incorporation into other circuits. An important aspect of the Arduino is its standard connectors, which leads to users connect the CPU board to a variety of interchangeable add-on modules known as shields. Some shields communicate with the Arduino board directly over various pins, but many shields are individually addressable via an I²C serial bus so many shields can be stacked and used in parallel. Official Arduino's have used the mega AVR series of chips, specifically the ATmega8, ATmega168.

An Arduino's microcontroller is also pre-programmed with a boot loader that simplifies uploading of programs to the on-chip flash memory, compared with other devices that typically need an external programmer. This makes using an Arduino more straightforward by allowing the use of an ordinary computer as the programmer. Currently, opti boot loader is the default boot loader installed on Arduino UNO. An Arduino's microcontroller is also pre-programmed with a boot loader that simplifies uploading of programs to the on-chip flash memory, compared with other devices that typically need an external programmer. This makes using an Arduino more straightforward by allowing the use of an ordinary computer as the programmer.

4.2.2 Mobile App- Bluetooth terminal.

The description of Arduino Bluetooth Terminal

The easiest way to visualize Arduino Sensor-Data directly on Android-Device in REALTIME. The App is able to display the values of up to 10 Sensors simultaneously (in Receiver-Mode).With the new Terminal-Mode even can send data to your Arduino. The responds will also be shown in the App. Only required is to load some Code to your Arduino-Board, wire a Bluetooth-Module (like the HC-05) to the Arduino and couple Android-Device and Bluetooth-Module in the System- Preferences. The App will establish a wireless Bluetooth-Serial-Connection between Arduino and Smartphone.

V. CONCLUSION

About 71 percent of the Earth's surface is water-covered and only about 0.3 percent of our fresh water is found in the surface water of lakes, rivers, and swamps. In developing countries, 70 percent of industrial wastes are dumped untreated into waters, polluting the usable water supply. The prototype robot was designed in such a way that it requires the least maintenance, human interference and does most of the work autonomously but also have the option to be controlled manually. The control system was designed in such a way that the boat can be changed into manual mode whenever required and vice versa. The testing showed us that though the boat did not have a lot of speed, it produced great amount of thrust, which was needed as a lot of drag was created by the system. The total collection area of the boat is 7875cm³. Thus it can remove a maximum of 7875cm³ of algae and weeds in a single run. Assuming an average density of 311kg/m³, it comes out to 2.4kg. A lot of ideas can be incorporated within this prototype robot to significantly improve its performance. The prototype robot was designed with an intention of cleaning the water debris floating on the water, by using our drone we can collect many floating wastes like plastic bottles, bags, flowers without any human interference and then dispose of the waste easily, one can clean the water with this prototype robot autonomously or just by operating it with the help of remote control. Also, our product helps in reducing the water pollutants to a certain extent. The major advantage is the safety provided by our product that is one need not risk his life while he is cleaning the water and we just need one person to control the robot. The product is economically viable. If the product is used in large numbers, it would be a perfect example for "Technological application in environmental protection".

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