© 2016 IJSRST | Volume 2 | Issue 6 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
Themed Section: Science and Technology

Fish Tank and Swimming Pool Cleaning Robot

A. Mohamed Nazeer
Lecturer, Electrical and Electronics Engineering , PSG Polytechnic College, Coimbatore, Tamil Nadu, India

ABSTRACT

Cleaning big fish tanks and swimming pools has been a very hard and time-consuming task. Although filters can be installed in small aquarium, they must be installed in large numbers. In this process a robotic vehicle is used which revolves around the bottom surface of the tank or pool and collects the sediment dust particles deposited at the bottom within a short period of time. This robot has a moving unit which is remote controlled. The wheels are driven using servo motors whose speed and direction are controlled by a microcontroller. The cleaning unit consists of a DC motor pump and a bio-chemical sponge filter. The DC motor pump sucks the dirt water from the bottom which is mixed with dust particles. This dirt water is made to flow to the sponge filter using tubes where the dust and dirt particles get deposited at the sponge filter and clean water flows out from the cleaning unit. By this process the water gets cleaned. Pressure of the suction is set in such a way that it does not affect the fishes in the fish tank. The sucking operation, movement speed, turning of robot are all controlled remotely by sending signal to the microcontroller. A remote is used to send control signals. Rechargeable 9V batteries are used as the power source. This project has numerous advantages such as time saving, less effort and higher cleaning efficiency. The limitation of this process is it cannot be used breeding tanks where newborn fishes and eggs are present.

Keywords : Robot, Microcontroller

I. INTRODUCTION

Block diagram shows the major blocks of this project. 12V lead acid battery feeds power to all the components except the Arduino board which runs on 5V. Excess power supply of 12V from the lead acid battery can cause damage to the microcontroller even though a 7805 voltage regulator is present on the board. For this purpose, a separate 9V battery is used. The suction pump, relay driver circuit and DC motors through the DPDT relay are connected in parallel to ensure equal supply of voltage. Suction pump is switched directly and there is no control circuit and runs constantly without any change in its operation. Arduino control signals are fed to the control circuit and the control circuit triggers the DPDT relay, The position of the relay decides the polarity of input to motor and hence its direction of rotation, The suction pump is connected to the tube which goes into the filters containing HB-I sponge filter and activated carbon balls. The suction pump is the only electrical device of the cleaning unit.

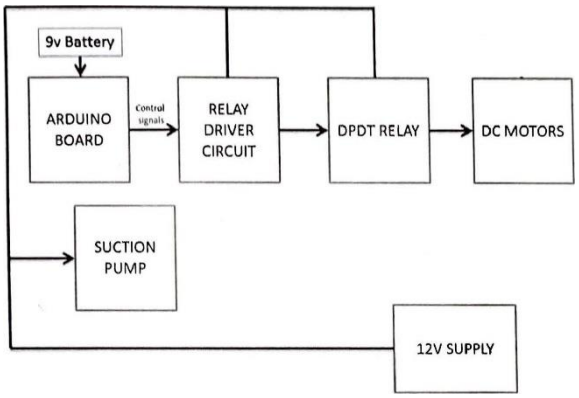


Fig. 1. Block Diagram

II. CIRCUIT DESCRIPTION

The overall circuit diagram comprising of all the circuits explained . Since the Arduino pins are interfaced with the transistor bases, a common ground is provided to the 9V battery and the 12V lead acid battery using a 10K ohm resistor as both the circuit have different potential differences. The diodes and transistors form the control circuit which acts as a bridge between the Arduino board and the DPDT relays In implementing the control signals. The connections are made in the DPDT relay such that when the relay changes from NC to NO position, the polarity of supply reverses resulting in the direction of motion of motor. Two separate switches are provided in which one is for motors and another is for suction pump to ensure more flexibility in usage.

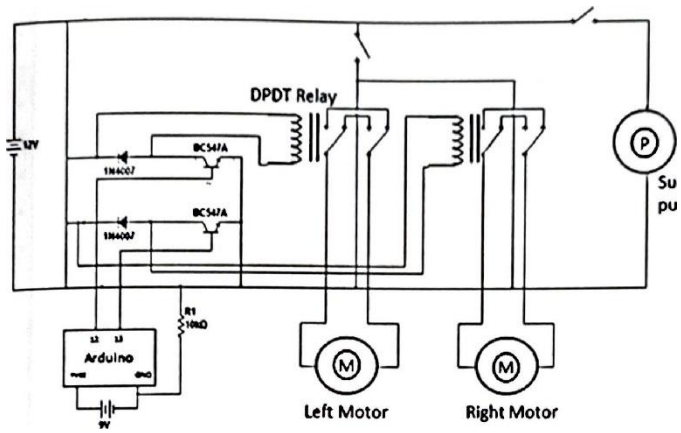


Fig. 2. Circuit Diagram

This model consists of two main units namely moving unit and cleaning unit. Various devices are used are Arduino UNO R3 development board,9 volt battery,IN4007 diodes,BC547 transistors, DPDT relays, DC motors,Wheels,12V lead acid battery, Sheet metal chassis, Holding rods,12V, 500LPH DC pump, HB-I Biochemical sponge filter, Activated carbon balls, Plastic tube, Connecting wires & jumpers. These components can be grouped into three types namely Common components , Moving unit components and cleaning unit components based on their area of application. The Arduino board, power supplies, transistors and relays are kept away from water surface whereas other components operate underwater. The electric components which are used underwater are sealed DC motor and submersible DC pump. Common are used for both moving unit and cleaning unit and serves as a common factor for both moving unit and cleaning unit. It includes 12V lead acid battery, Sheet metal chassis and Connecting wires and jumpers.

Fig .3 shows the major blocks of moving unit and Fig 4 shows the single line diagram of underwater robotic unit. The moving unit consists of an Arduino board, 9V battery, control circuit, two DPDT relays, motors and wheels mounted on a frame. The Arduino board, control circuit, 9V battery and DPDT relays are placed away from water whereas the motor, frame and wheels are placed underwater. The control circuit consists of a pair of BC547 transistors and a pair of 1 N4007 diodes. Single stand wires are mostly used for connection. The Arduino board with 9V battery and the control circuit is the control unit which feeds the DPDT relay. The DPDT relays are connected to the main power supply (Lead acid battery), control unit and to the motors. The Arduino board gives control signals using two wires one for left motor and another for right motor to the control circuit. The control circuit amplifies the signal with power from main supply and feeds this signal to the DPDT relay. The connections are given in DPDT relays such that when the relay is triggered, the motor's polarity gets reversed. The shaft has a threaded hole through which the screw of the wheels is inserted and coupled.

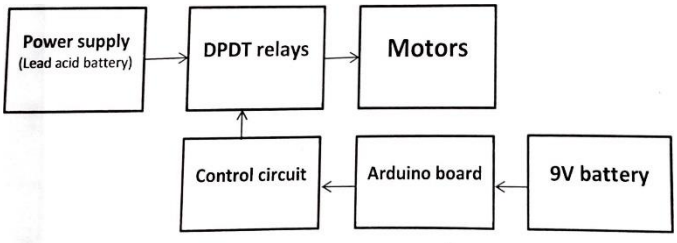


Fig. 3 Electrical Block Diagram of Moving Unit

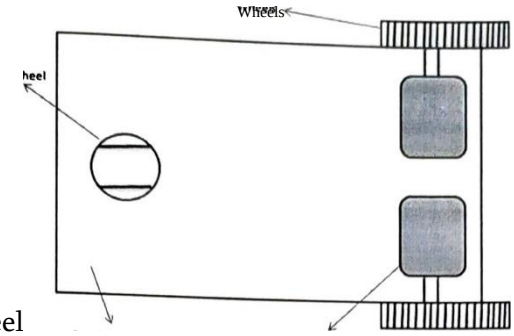


Fig 4. Single Line Diagram of Underwater Robotic Unit

The cleaning unit consists of components such as DC pump, HB-I biochemical sponge filter, activated carbon balls and plastic tube. The pump is used for suction and activated carbon balls and sponge filters are used for filtration. The pump is placed on the top of the frame and is fixed using adhesive. A tube is connected to the inlet of the pump and is sent to the filters through a hole drilled on the frame. It is sealed on the other end and holes are made in the part of the tube inside the filters through which the water is sucked. Three layers of HB-I biochemical sponge filter is fixed in the bottom through holding rods. Five activated carbon balls are placed on the upper space between the sponge filters in the front side and another five balls are placed in the lower space in the back. The purpose of this type of design is to ensure ground clearance of the robotic unit .The pump is fixed to the main frame using flex adhesive. Two holding rods are liked between the two holes in the front and back. Using them as support, another four holding rods are hooked up on one end and their other end are pierced to the bottom sponge filter and hooked to it two on each side.

Arduino Control Circuit:

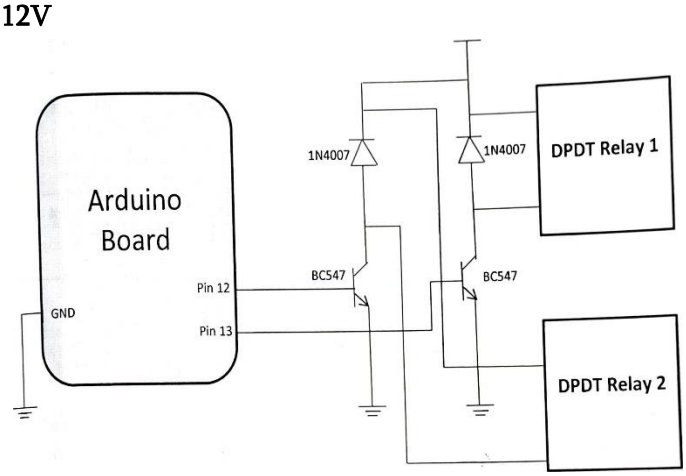


Fig. 5 Control Circuit

Control circuit mentioned in Fig 5 consists of an Arduino board, a pair of BC547 NPN transistors, IN4007 diodes and DPDT relays. The control signals are given by pin 12 and pin 13 from the Arduino. These pins are connected to the base of each transistor. A reverse biased IN4007 diode is connected in series with the collector of the transistors and these diodes connect to the main power supply from lead acid battery. A DPDT relay is connected in parallel to the diodes. The emitter of the transistor is directly grounded and a common ground is made with transistors and Arduino board. When a control signal is given from an Arduino pin, it is given to the base of the transistor and due to this the transistor gets saturated. When the transistor attains saturation, conduction takes place between the collector and emitter and hence the transistor acts as a switch. When it starts conducting the relay gets grounded and the circuit is closed. As a result the relay is triggered and it changes its position from NC to NO. The reverse biased diode is used to protect the transistor from the high fly back voltage which occurs when the relay is turned off and hence it is also known as fly back diode or freewheeling diode.

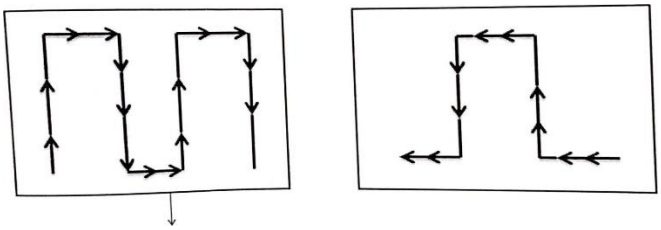
Motor Polarity Changing Circuit

Motor polarity changing circuit comprises of a DPDT relay and a motor. The points A and B are connected to the control circuit. The anode of the supply is connected to the points NC1 and NO2. The cathode is connected to the point NC2 and NOl . PI and P2 are connected to the motor. The connections are made in such a way that when the relay changes position, the polarity of the supply gets reversed When the points A and B are energised from the control circuit, the internal coil gets magnetised and it attracts the contactor stud to change position. As a result, the relay changes its position from NC1 and Nc2 to NOl and NO2. Due to this the polarity of the supply gets reversed and the motor starts rotating in a different direction. Here the circuit is set in such a way that when the relay is triggered, the motor rotates in reverse direction.

Motor Directions at Various Areas of Motion

UNIT LOCATION	RIGHT MOTOR	LEFT MOTOR
A-B	FORWARD	FORWARD
B	REVERSE	FORWARD
B-C	FORWARD	FORWARD
C	REVERSE	FORWARD
C-D	FORWARD	FORWARD
D	FORWARD	REVERSE

FORWARD MOVEMENT : RETURN MOVEMENT



III. OUTPUT AND RESULT

When the pump and DC motors are turned on and the Arduino board is reset, The unit starts moving and the outlet of the pump starts expelling of water indicating the working of cleaning unit. The DC motors have a speed of 10 RPM and makes the unit move finely aiding more efficient cleaning of the cleaning unit. After a particular time delay, The Arduino pin which is configured for right gets high as a result, the control circuit triggers the DPDT relay which is connected to the right motor. When the DPDT relay is triggered, the right motor starts running in reverse. When the right motor runs in reverse, the other motor runs forward resulting in the change of direction of the motor. After the unit completes a rotation of 90^0 , the Arduino is programmed such that the DPDT relay of the right motor gets low and both motors rotate in the same direction resulting in forward movement. In this way the moving unit performs its movement according to the movement pattern programmed to the Arduino depending on the shape and size of the water containment area. The cleaning unit sweeps the settled dust in the bottom. Primary processes such as mechanical filtration and biological filtration start occurring over a certain period of time.

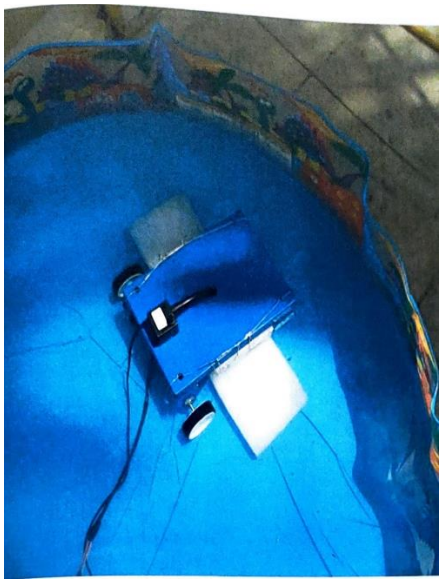


Fig 6. Hardware Working Model

The resultant motion can be programmed to any pattern. The zigzag pattern is explained below. This type of movement is used for cleaning large water

storage areas where every part must be accessed. For each count, the turning operation is initiated and at the end of count, the turning is made in the opposite direction to initiate return movement. During return movement, the count decremented by one and is set to two. For water bodies with small area, square movement is used. Assuming that the Forward movement time is set to 12 seconds and rotation time is 5.6 seconds and the side moving time is 8 seconds and the count value (number of turns) is set 3 as programmed in the Arduino. The movement pattern is specified below.

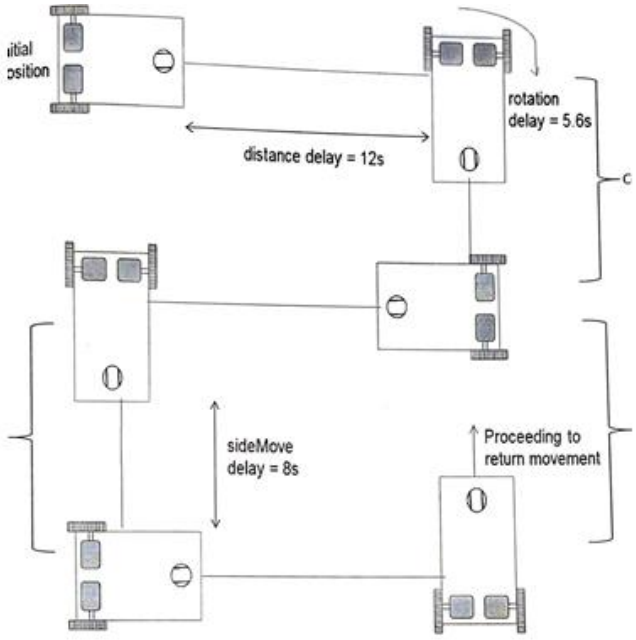


Fig 7.Square movement pattern

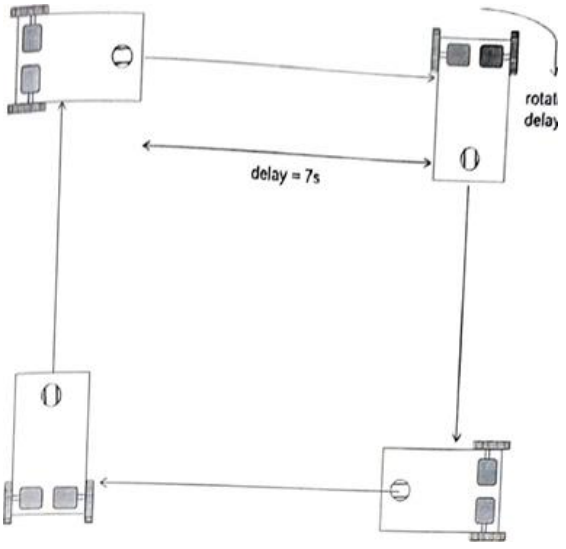


Fig 8. Zigzag Movement Pattern

In square movement pattern, the program is simplified and only one DPDT relay is controlled and hence only one motor gets reversed. Assuming that a delay period of 7 seconds and rotation delay of 5.6 seconds is set.

IV. CONCLUSION

The major blocks of this proposed model is such as its electrical circuitry, mechanical design, biological processes etc. have simple designs and can be easily learnt by the user. Sanitation of water surfaces is an important safety measure both humans and aquatic animals since most of the harmful diseases can be easily spread through them .Deployment of robotic units is much safer and requires less effort and since simple and cheap materials are used, it is also of very low cost. This adds the advantage for the user to add two or more robotic units to achieve even faster cleaning. Modifications such as re-programming, adding different control systems such as manual joystick, smart phones, IOT etc. can also be done depending upon the user's requirement. Hence this model has large potential for future development. Commercialization of this prototype with certain industrial research and developments would make it ever lesser of cost due to mass production and finds useful and vast areas of application.

V. REFERENCES

[1]. Yuan Fu-cai, Sun Hai-liang, Wang Li-zhu, "Designing of cleaning robot for swimming pools" MIES,2011

[2]. H. Albitar, A. Ananiev and I. Kalaykov, "New concept of in- water surface cleaning robot," 2013 IEEE International Conference on Mechatronics and Automation, Takamatsu, 2013, pp. 1582-1587.

[3]. Aakash Sinha, Prashant Bhardwaj, Bipul Vaibhav, and Noor Mohommad "Research and development of Ro-boat: an autonomous river cleaning robot", Proc. SPIE 9025, Intelligent Robots and Computer Vision XXXI: Algorithms and Techniques, 90250Q (3 February 2014).
[4]. Basant Rai, “Polltution and Conservation of ganga river in modern India”, International Journal of Scientific and Research Publications, Volume 3, Issue 4, April 2013 1 ISSN 2250-315.
[5]. Emaad Mohamed H. Zahugi, Mohamed M. Shanta and T. V. Prasad,“Design Of Multi-Robot System For Cleaning Up Marine Oil Spill”, IJAIT Vol. 2, No.4, August 2012.

Cite this article as :

A. Mohamed Nazeer, "Fish Tank and Swimming Pool Cleaning Robot", International Journal of Scientific Research in Science and Technology (IJSRST), Online ISSN : 2395-602X, Print ISSN : 2395-6011, Volume 2 Issue 6 , pp. 632-637, November-December 2016.
Journal URL : https://ijsrst.com/IJSRST21827