International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 08 | Aug 2021 www.irjet.net p-ISSN: 2395-0072

Surface Water Garbage Collector

Sakshi Kannav[1], Siddharth Karambelkar[2], Shreyas Karanjkar[3], Sudaman Katti[4], Rashi Khabiya[5], Prof. Dr. Umesh Chavan[6]

[1,2,3,4,5]Second Year B.tech Student, Dept. Mechanical Engineering, Vishwakarma Institute of Technology, Pune, Maharashtra, India
[6]Professor Dr. Umesh Chavan, Dept. of Mechanical Engineering, Vishwakarma Institute of Technology, Pune, Maharashtra, India

---

Abstract - *Water sources are contaminated by garbage, weeds and plastic wastes. Effective waste removal in water sources such as lakes, ponds and rivers is essential for waste management and control. In India, aquatic waste management and control is of main concern for implementing smart cities and achieving the mission of a cleaner India. Therefore, this work aims at creating an automated system to tackle the problem of water waste removal. Lake cleaning robot system for removing the surface wastes is experimented in this work. In this project we are going to use Solidworks and Proteus software to model and build Arduino Circuit for our water collector bot. It will collect the waste from the surface of water and dump it into the tub placed behind it. With the use of motors the bot and collectors will have to & fro movement. We will simulate the working of our bot virtually in Unity Software. Reviewing the results shows that the project can be used for effective waste removal from the surface of the water*

Key Words: **Aquatic waste, Lake cleaning robot system, Solidworks, Proteus, Arduino Circuit, Unity**

1. INTRODUCTION

Water is an important natural resource vital for all forms of life on this planet. Despite being blessed with an enormous amount of water, water pollution is a major crisis in many countries. As per 'Water aid', an organization striving towards attaining fulfilment in hygiene and water sanitation has reported that 80% of India's water sources are polluted. Water bodies are being polluted by floating garbage, weeds, debris plastic, sewage, effluents and toxic materials from industries. Water pollution with floating garbage is a serious issue that needs immediate attention in developing countries.

In Indian context, the union government is keen on projects such as 'Swachh Bharat' and 'Smart city' for achieving the Clean and Smart India mission [1]. Further projects like 'NamamiGange', 'Narmada Bachao' focus towards rejuvenation of rivers through effective pollution control and management. River surface cleaning for the purpose of removal of the solid floating waste is one of the main goals of the above projects. Indian government has invested an enormous amount towards the river cleaning project. As per the statistics of Central Pollution Control Board (CPCB) [2], there has been a significant rise in water pollution in water bodies over the past few years. Furthermore, the water quality index also claims that the river water is unfit for bathing, drinking and fishing.

Non automatic cleaning of water bodies is not at all ideal due to its. In addition, the health and hygiene of the labourers doing manual cleaning becomes severely affected. Health impacts also include musculoskeletal, intestinal and vector borne diseases in addition to injuries caused as a result of work related accidents. This means that methods which will automate the existing infrastructure for river surface cleaning, in cost effective ways with minimal hardware and can be used general public will be highly effective and our water cleaning bot project will do exactly that. This project aims to provide automatic control to collect the garbage present on the surface of water. We have used Solidworks& Proteus software to model and build Arduino Circuit for our water collector bot. We have used Unity software for the analysis of our model. It will collect the waste from the surface of water and dump it into the tub placed behind the bot. Two motors are added into the circuit for movement of the bot and collector. Testing showed that the bot can be used effectively to collect and remove the waste from the water. The maximum trash load that this bot can bear is up to 7 kg. The project proposed in this article aims to develop a water boat with a collector that can detect, pick, and place garbage from water-bodies into the tub and thereby clean the water bodies.

2. LITERATURE REVIEW

A metallic waste collection robot was proposed in[1]for automating waste removal in factories. An end-to-end robotic system was developed using Arduino Mega microcontroller interfaced with sensors and actuators. A remote controller-based sewage cleaning embedded system is achieved by use of Radio Frequency (RF) transmitter and receiver modules in addition with relays, switches, motors and a metallic casing setup [2]. The robot is autonomous and traverses the path and collects the waste using a recruitment navigation algorithm. A pedal operated boat to clean the surface wastes and debris is described in [3]. The setup in the research consists of a pedal operated boat with propellers attached to a shaft and a conveyer belt for collecting the waste.

3. METHODOLOGY

3.1 DESIGN

The garbage collector robot needs to be able to float in the water and it also needs to remain floating as its weight increases. The motion of the collector tray will also cause the problem as the weight of the garbage on the collector tray may result in a slight deviation of the center of gravity of the robot. Keeping this in mind, we have decided to implement the shape of a boat/canoe which is bottom heavy, as we have added more mass at the bottom, and has heavy equipments like motors; battery and the collection tub at the back so that forward weight during the dumping of the garbage in tub can be compensated. The base of the boat is made of cedar wood, the tub is made of low-density polymer and the collector tray is made of aluminum. For the motion of the bot, we have decided to take help of propellers which will be connected to the sides of the robot and are actuated using a 1000 rpm geared DC motor. The collector tray is also actuated using the same DC motors and all the motors are getting the power of a 12V battery weighing 0.55 kg.

To control the motion of the robot and that of the collection tray, we need a microcontroller and motor drivers. We are going to use the Arduino Uno as the brain of our robot and the motor driver will be used to actuate the propellers and collector tray.

3.2 COMPONENTS

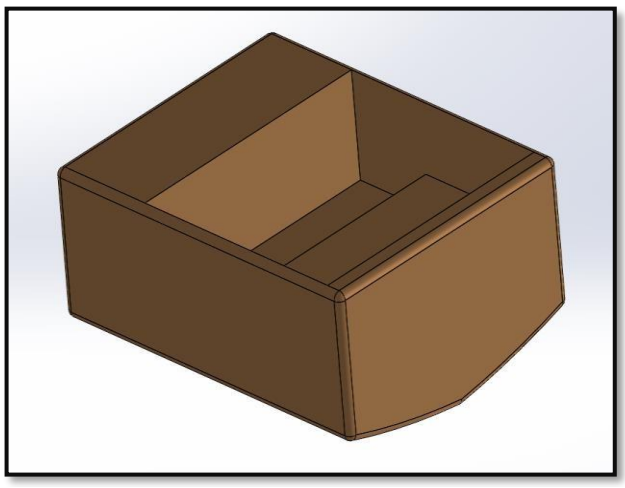

Fig1: Boat/Canoe (base of the robot)

It acts as the main base of the bot. It is made of Cedar wood which has good floating properties. All the other units of the assembly are added on it.

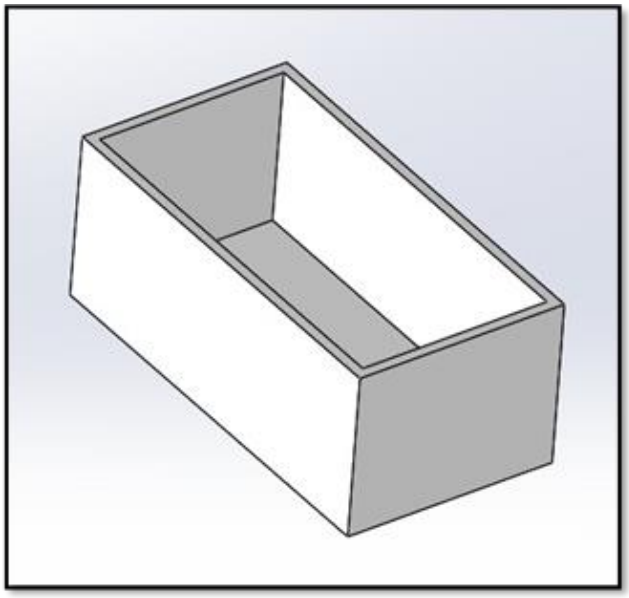

Fig2: Garbage Collection Tub

All the collected garbage is dumped in this tub. It can easily be taken out of the bot for cleaning. It is made out of plastic to reduce the weight of the robot. The capacity of the tub is 7 kg, i.e., it can carry a load of 7 kg.

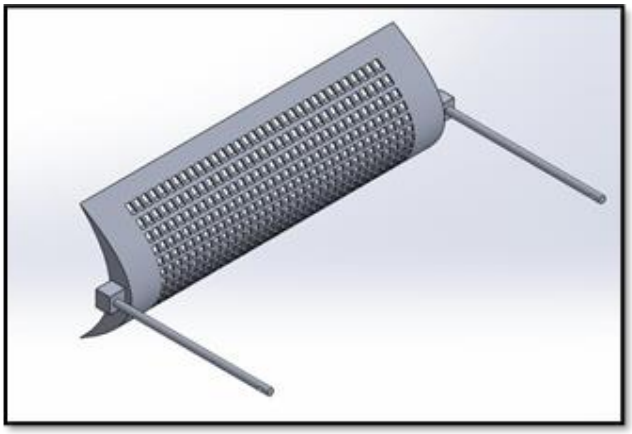

Fig3: Collection Tray

This tray is used to collect the garbage floating on the surface of water. It contains small holes (pores) so that all the water from the collected garbage can be dispelled out and doesn't damage the circuitry. It is made of 1060 aluminum alloy. It can collect around half a kg of waste in a single go.

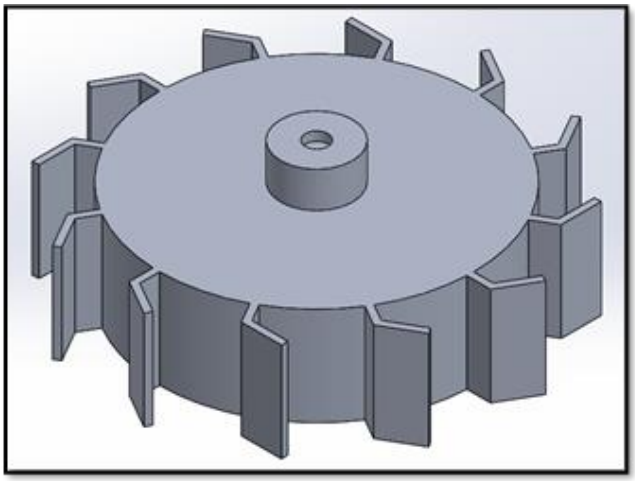

Fig4: Propeller

For swift motion of the robot in the water, we have attached two propellers to the canoe. These propellers are connected with the motor axles and blades for cutting water have been made on the circumference of the propeller wheels.

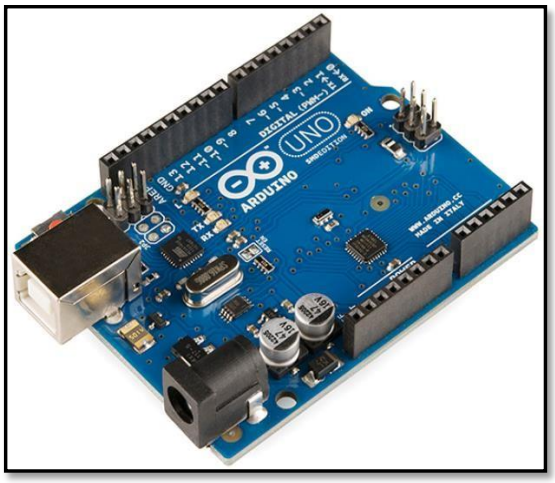

Fig5: Arduino Uno *Source: OL Electronics*

The Arduino Uno is a very popular microcontroller board based on the Microchip ATmega328P microcontroller which was developed by Arduino.cc. It has

a set of digital and analog input/output pins so that it can be interfaced with various expansion boards(shields). The board basically consists of 14 digital I/O pins (six capable of PWM output) and also 6 analog I/O pins. It can be powered by use of a USB cable and also by an external 9-volt battery. It can take voltages between 7 and 20 volts.

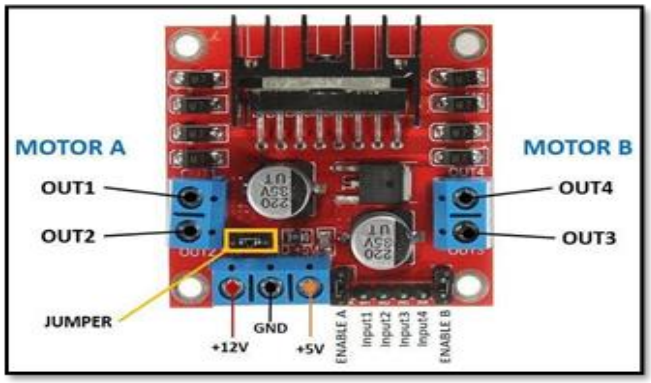

Fig 6: L298N Motor Driver *Source: RoboElements*

In order to connect motors with the Arduino, we have made the use of a motor driver shield - L298N. L298N is both a high current as well as a high voltage IC. It can obtain TTL logic signals and is capable of operating on different loads like motors, solenoid, relays and many more. It is mostly used for designing of the motor driver. It consists of two main pins which serve the purpose of enabling or disabling the particular device which is attached at its output. The L298N is basically a dual H-Bridge motor driver which exists for velocity and/or direction control of two DC motors simultaneously. The module is capable of driving two DC motors that consists of voltages which are between 5 and 35V, along with a peak current up to 2A.

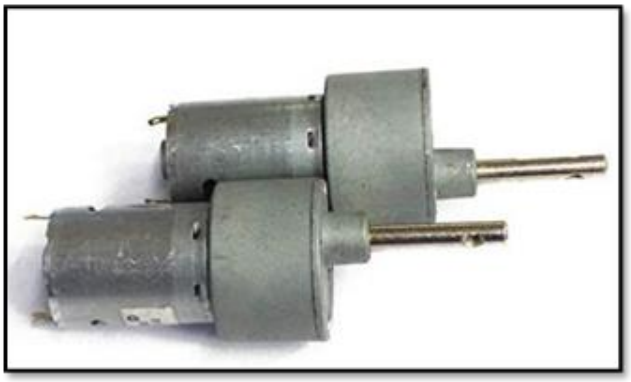

Fig7: DC Motors *Source: Indiamart*

We have made the use of DC motors at two locations. The first application is for rotating the propellers. The rpm considered for those motors is about 1000 rpm. Secondly we have also made the use of motors in the collecting arms of the tray, to simulate to and fro movement. The designated rpm for these motors is 150 rpm and works in a range of 4-12V

Fig 8: 12V Battery *Source: Amazon India*

In this project, we have used a 12 volt battery to power the motors. This battery is rechargeable and can be easily disconnected.

3.3 ALGORITHM AND STEPS

1) The bot will start and its propellers will be activated

2) Its motion will be controlled remotely by use of circuitry

3) The bot will then collect all the garbage and dumb it in the tub using

4) The bot will move towards the polluted area by use of propellers

5) The bot will now return to its starting point and empty the tub

3.4 CALCULATIONS

a. Calculation for the Flotation of bot:

Mass of the wooden chassis	14 kg
Volume of the wooden chassis	0.0305 m^3
Approx. base area of the wooden chassis	0.2 m^2
Mass of the tub	2.1 kg
Volume of the tub	0.002328 m^3
Mass of the collector	0.543 kg
Volume of the wooden chassis	0.000201208 m^3
Density of cedar wood	0.45g/cm^3
Density of water	1g/cm^3
Total mass of the assembly	26kg
ρw/ρwood =total volume/Vs Vs= Volume submerged	Vs= 0.013725 m^3
Initial submerged height of the bot= Vs/base area	68.625mm
Vr * ρw * g =Total mass * g Vr=Volume required to be submerged	Vr =0.026 m^3
H=Vr/base area H= Height submerged after adding the load	H= 130 mm

Therefore the robot will submerge maximum till 130 mm of its height whereas the total height of the robot from its lowermost surface is 225mm and so it will float.

b. Calculation to check the torque requirements of the motor:

Length of arm of the tray	0.543 kg
Maximum capacity of the garbage	1.043 kg
Acceleration due to gravity	9.81 m/s^2
Downward force on tray	10.23 N
Factor of Safety	1.5
Force on each motor	7.67 N
Minimum torque of motor required	153.4 N-cm
Torque (kg-cm)	15.6 kg-cm

Therefore any motor with a stall torque greater than 15.6 kg-cm can be used for rotating the tray.

The DC motor used also has a stall torque of 15.6 kg-cm so we can use it to rotate the tray

4. RESULTS AND DISCUSSIONS

A. Circuit in Proteus

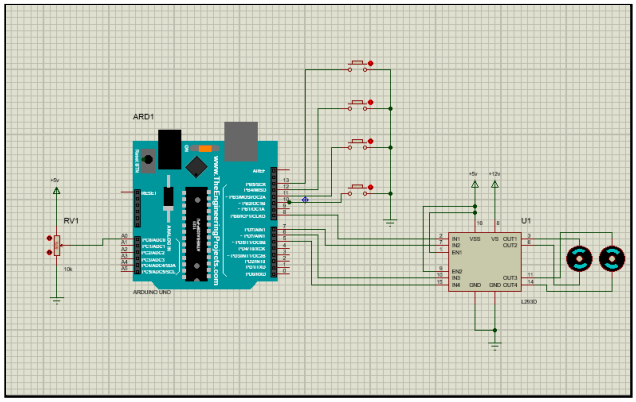

Fig9: Motor control circuit in proteus

In this circuit, two motors are added to OUTPUT 1, 2 & OUTPUT 3, 4 correspondingly. The power given to circuit is 5V. When the switch 1 is pressed i.e. connected to pin 13 then both the motors will rotate in clockwise direction. Whereas, the pin12 is pressed then both the motors will rotate in anticlockwise direction. If the pin11 is pressed then the 1st motor will move in clockwise direction while the other will move in reverse direction. When the pin10 is pressed the opposite of above condition will take place i.e. 1st motor will move in anticlockwise direction while the other will move in clockwise manner. So this circuit helps us in the movement of bot and collector.

B. Simulation in Unity

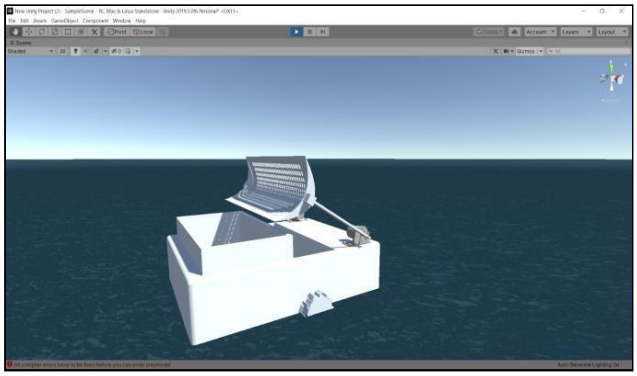

Fig10: Robot Floating in Unity

Fig11: Front View of the robot

We have simulated the working of our bot virtually using a game development software called unity.The simulation takes into account all relevant characteristics like gravity, mass and buoyant force. After taking our calculated submerged height into account, the simulation can test whether the bot will float or not based on its weight and other factors which can be given as input by the user. Since our bot is controlled remotely, the motion of our simulation can also be controlled using keyboard and mouse, the keys W,A,S and D are used for the bots movement, mouse click will makes the net perform its motion to collect garbage, the propellers will start their motion once the bot in the simulation moves.

5. LIMITATIONS

The robot can only take up the garbage up to a weight of 7 kg. Since the robot is submerged in water up to a depth of 130 mm, the bed of the water body should be lower than that for the robot to be free to move in the water body. Another limitation is that the robot can only remove solid waste from the water but is not capable of removing liquid waste like oils etc. Also, the robot is run on battery, so once the battery is dead there is no way for the bot to perform its functions. These are some of the limitations of the robot.

6. FUTURE SCOPE

Since the robot is battery operated, we can make it more environment friendly and add a solar panel on top of the bot. We have used a Bluetooth module to remotely control the robot, but we can also use the Wi-Fi module or even use Iot to increase its range of control. The robot can also be completely automated by using proximity and ultrasonic sensors to check if the tub is fully filled and to locate the garbage respectively. Even though a single robot can only collect 7 kg of waste at a time, many of these robots can be deployed to collect a large quantity ofwaste. The robot is mostly made of economical materials so the robot can also be mass produced in large quantities quite easily.

7. CONCLUSION

Water is an essential element when we talk about sustainability. This project extensively focuses on reducing the elemental waste in water bodies. What makes this project unique from other projects is that it reduces manual intervention, defines an innovative way to cover a large area for cleaning waste in the rivers, lakes, etc. Waste management and water treatment are two major factors which affect the overall indexes defined to declare whether a city is smart or not. This project will surely help in fulfilling all such criteria and is a perfect example of collaboration of fluid mechanics, machine design and electronics, etc. This is what the future of modern industries defines and the field of robotics and automation demands. Thus, this can act as a true help not only in the field of science and technology but also when it comes to conservation and preservation of the environment.

ACKNOWLEDGEMENT

We would like to thank Vishwakarma Institute of Technology (VIT) for providing us with a platform for producing such a wonderful project. We would like to acknowledge our honorable Director Prof. Dr. Rajesh M. Jalnekar for his overwhelming guidance and kind support. Also the Head of Department of Mechanical Engineering, Prof. Dr. Mangesh Chaudhari for his valuable support, help and time. Even our Engineering Design and Development Guide faculty Prof. Dr. UmeshChavan gave us his valuable time, support and inspiration for creating this project.

REFERENCES

[1] Nurlansa, Osiany, DewiAnisaIstiqomah, and MahendraAstuSangghaPawitra, “AGATOR (automatic garbage collector) as automatic garbage collector robot model,” in International Journal of Future Computer and Communication , Vol 3(5), pp.367, 2014.

[2] Idris, M. Mohamed, M. Elamparthi, C. Manoj Kumar, N. Nithyavathi, Kuganeswaran, and S. Arunkumar, “Design and fabrication of remote controlled sewage cleaning Machine”, in in International Journal of Engineering Trends and Technology (IJETT) ,Vol 45(2), March 2017.

[3] Agrawal, Pranay, and Bishakh Bhattacharya, “Aquatic Multi-Robot System For Lake Cleaning,” in Nature-Inspired Mobile Robotics, pp. 171-178. 2013.

[4] Jogi, N. G., AkashDambhare, KundanGolekar, AkshayGiri, and Shub- ham Take, “Efficient Lake Garbage Collector By Using Pedal Operated Boat,” in International Journal of Modern trends in Engineering and Research , Vol 2(4), pp.no 2455-2457, 2016.