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Swachh Hasth- A Water Cleaning Robot

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***Abstract*:- Water acts as a great essential life source. It is a well-known fact that life began with water and the water cleanliness is a very important aspect of life to survive on earth. But, the byproducts of science laid their monstrous footsteps as pollutants. Most of these pollutants are toxic and are affecting adversely the water resources (wells, lakes, rivers, and sea), living organisms in the water, and all dependent organisms. Also, due to the carelessness in the use & maintenance of water bodies, millions of tons of plastics and other floating wastes are dumped into the water daily. Most of the time, the water bodies are cleaned manually with human labor which requires a lot of time and cost. To address this, the proposed work in this article aims at the design and development of an Arduino-Uno controlled surface water trash cleaning semi-autonomous boat with a robotic arm. This work is simulated using the open-source simulation tool** TINKERCAD**. Simulation results have shown that the proposed work would be an alternative for surface water trash collection and maintenance of cleanliness of the water with low cost and minimum human effort.**

I. INTRODUCTION:

Water is an important resource to survive on the earth, it covers over 70% of the earth's surface, amongst only 3% of that is drinkable water. Water is called a universal solvent that means it can dissolve most of the substances including toxic materials from factories, sewage, chemicals, etc. Because of this, water is completely polluted by human activities. The major problem that living organisms facing is water pollution which means the introduction of foreign materials into water bodies. The major causes of water pollution are sewage disposal, garbage, and liquid wastes of households and chemical industries. Discharging these chemicals into water bodies is harming the lives of the aquatic ecosystem as well as the water is becoming non-drinkable [1].

Indian rivers like Ganga contribute over 40% of water for the Indian population across 11 states, serving around an estimated population of 500 million people which is very high compared to any other rivers in India, but it was ranked second most polluted river in the world in 2017 [2]. The government had undertaken a project called 'Namami Gange program' in 2014 with a budget of around 20,000 crores to clean the holy river Ganga [3]. Similarly, there are a lot of problems regarding water pollution under the Godavari river, which affects the human life and beauty of the Godavari river. Likewise, many of the projects have been undertaken by the government to control water pollution. The impact of water pollution is widespread. It causes many severe water-borne diseases such as diarrhea, trachoma, hepatitis, etc., to humans. According to WHO, 22% of all communicable diseases are water-borne diseases [4]. The maximum impact is on marine animals because their survival is completely dependent on water. Due to the abundant growth of algae, the oxygen content in the water becomes lesser, which may lead to the death of fishes and other marine organisms. To address the issues mentioned above, the project proposed in this article aims to develop a water boat with a robotic arm that can detect, pick, and place garbage from water-bodies and thereby clean the water-bodies.

II. LITERATURE REVIEW:

This Section describes the previous works on the water cleaning boats based on different technologies designed by other researchers around the world.

Chen Su, et al. [5] described "An Autonomous ship for cleaning the garbage floating on a lake". The structure and principle of an autonomous ship for cleaning the garbage floating on the lake has been proposed in the article. The ship was programmed to operate both manually and run automatically with a motion control strategy based on ultrasonic distance measurement. The major drawback observed was, movement of the ship was not smooth and no control over the collection of garbage. In [6] introduced a new concept of flexibility crawling mechanism in designing an industrial underwater cleaning boat, which is capable of working underwater, scanning the desired surface, and recording biological reactions. The system design was limited to clean bio-fouled in water surfaces. "Efficient Lake Garbage Collector by Using Pedal Operated Boat" was described by Aakash Sinha et al. [7]. The proposed work was based on human pedaling, the system was mechanical in nature. Since no electronics involved in the design, there is no automatic control over the garbage collection. In [8] a method was presented for cleaning the floating debris present in the water bodies. The function of the designed robot is to pick up the garbage particles from the water surface and dispose of them into the tray provided. But the system was not automated to detect the trash. Soumya et al. [9] proposed "Pond Cleaning Robot", the machine is operated using a smartphone to remove the debris from the lake. The machine is designed based on the AT89S51 controller. The system had no sensors for automatic detection of garbage and guide the robot [9]. 'Water Surface Cleaning Robot' was developed by Raghavi et al [10]. The main aim of the work proposed was to develop a surface vehicle. The robot was employed with water quality monitoring sensors. The major limitation observed with this method is -it is not cost-efficient and the process of manufacturing is complex.

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III. PROPOSED SYSTEM MODEL:

To address the issues discussed in the previous section, this paper describes the system "Swachh Hasth- A water cleaning robot". The proposed system design employs sensors to record parameters such as the detection of obstacles & their distance from the boat, and identification of living or non-living organisms. Based on the sensors' readings, the boat and robotic arm are controlled for picking up the floating trashes in the water. The block diagram of the proposed system is illustrated in Figure 1.
The system design concept is explained in two stages; the first stage involves the water boat with sensors assembly and the second stage is the robotic arm.

Hardware Requirements:

The hardware of the system is based on the Arduino Uno platform. Two Arduino Uno boards are employed one used for controlling wheels of the boat & taking input from the sensors; another one for controlling the robotic arm. The hardware requirements are discussed in the following section.

1. MICROCONTROLLER (Arduino UNO R3 CH340G): The controller used is ATmega328 on Arduino UNO platform. The controller takes input from the smartphone & sensors and operates the boat and robotic arm as per the requirement.

2. ULTRASONIC SENSOR: This distance measuring sensor is used to detect the obstacle and its distance from the water boat.

3. PIR SENSOR: The purpose of the passive infrared sensor (PIR) is to identify whether the obstacle detected is living organism or nonliving garbage.

4. BLUETOOTH MODULE hc05: HC-05 module here acts as a bridge to control the robotic arm movement and wheels of the boat.

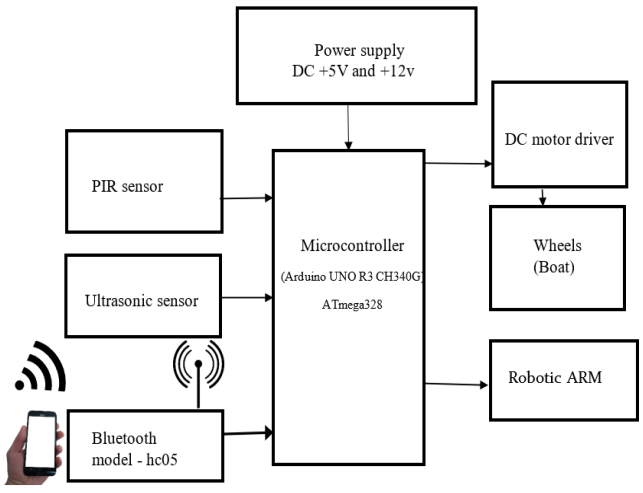

Figure 1: Block diagram of Swachh Hasth Robot

5. DC MOTORS: 4 DC motors with wheels are used to propel the water boat as per the commands given.

6. ROBOTIC ARM: It is equipped with servo motors. Depending on the given instructions, the arm adjusts in particular directions, picks up the trash, and dumps it to the dumping space.

7. SMARTPHONE: Android Smartphone is used to control the motion of the boat and servo motors.

Software Requirements:

The system is designed around the Arduino IDE and Blynk app. These tools are discussed in the following paragraphs.

1. Arduino IDE: It is an open-source integrated development environment (IDE); allows users to program the compatible boards. In the proposed work Arduino boards are programmed using Arduino IDE to read the sensor inputs & control the wheels and robotic arm. It is also compatible with the Blynk app for controlling mechanism.
2. Blynk App: It is a digital dashboard allows user to build a graphical user interface (GUI) by dragging and dropping of widgets. It is used for real-time control of robot wheels and the robotic arm.

IV. PROCESS FLOW:

This section describes the operation of the proposed water boat with robotic arm. An algorithm has been developed to task the microcontroller to read the inputs from the PIR and ultrasonic sensors and based on the sensed information take appropriate action. Figure 2 depicts the flowchart of water boat and sensor assembly operation and Figure 3 illustrates the flowchart of robotic arm operation.

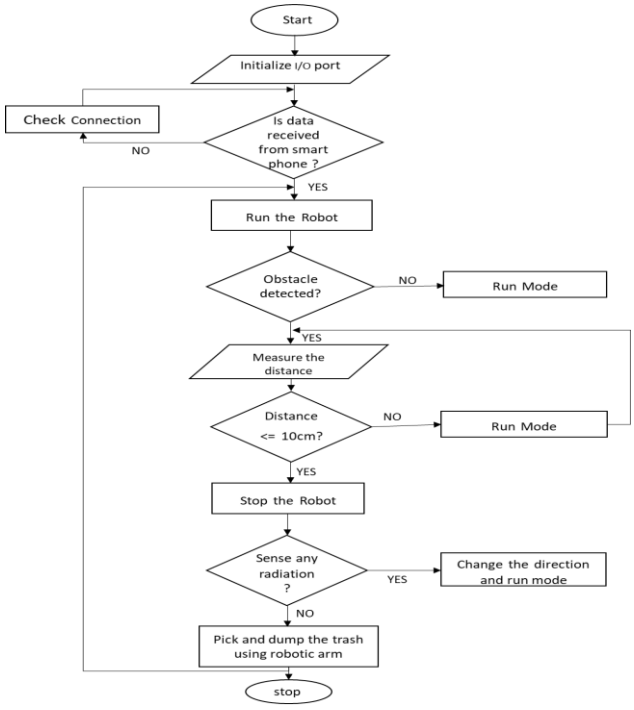

Figure 2: Flowchart of water boat

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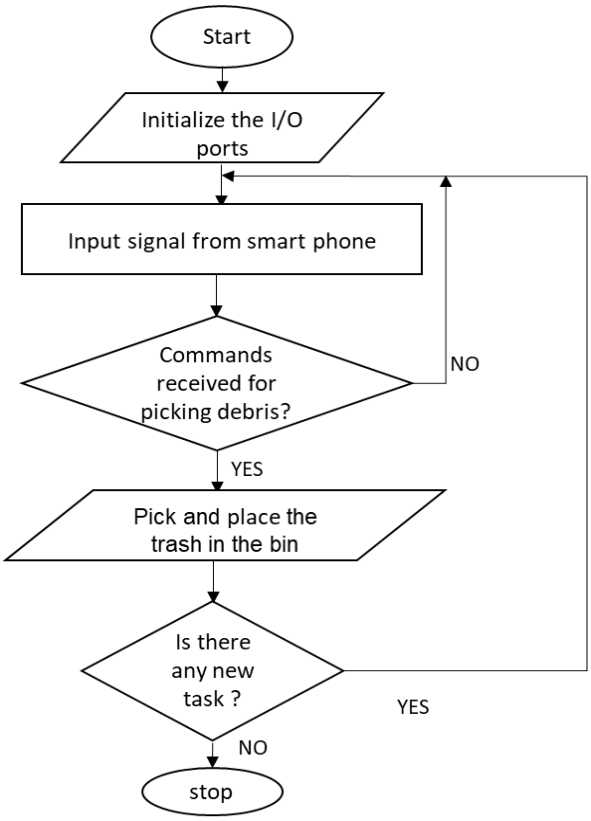


Figure 3: Flowchart of robotic arm and sensor assembly operation

V. IMPLEMENTATION:

The proposed concept is still in the development stage to include advanced features; therefore, the work has been implemented virtually. As an alternative to the physical implementation, the functionalities of the proposed system were simulated using an open source simulation tool TINKERCAD.

The simulation is carried out in two phases, the first phase is the IR controlled DC motors assembly with sensors to visualize the water boat working (Figure 4), and the second phase is the Arduino controlled servo motors using push button switches illustrating the functionality of the robotic arm (Figure 5).

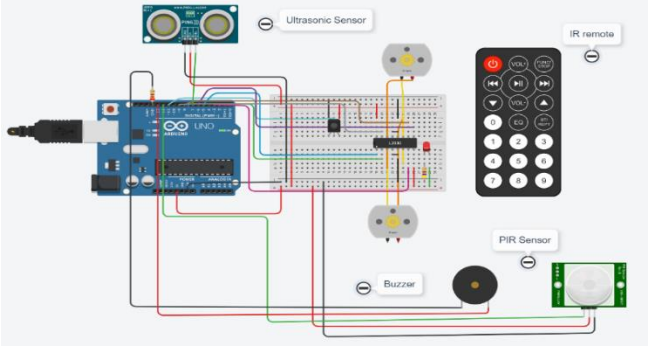


Figure 4: Water boat assembly

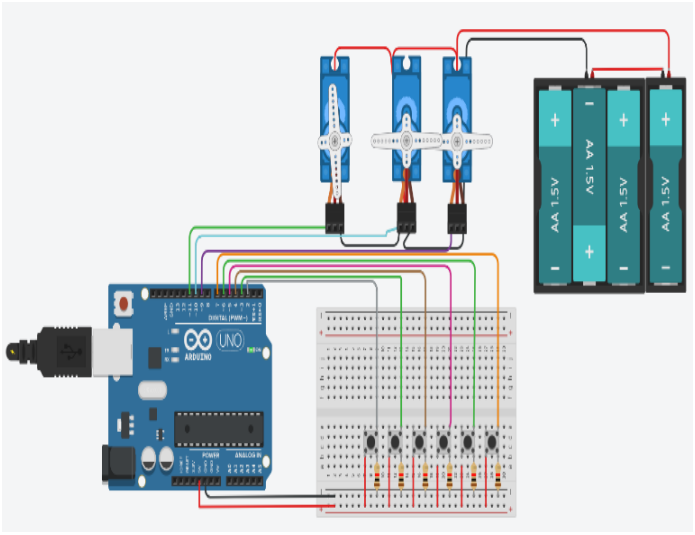
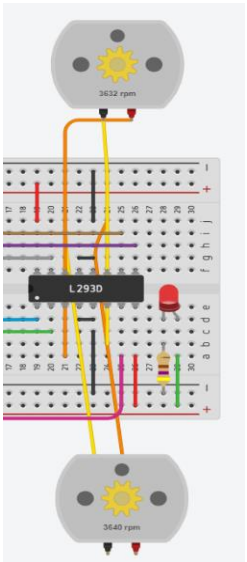
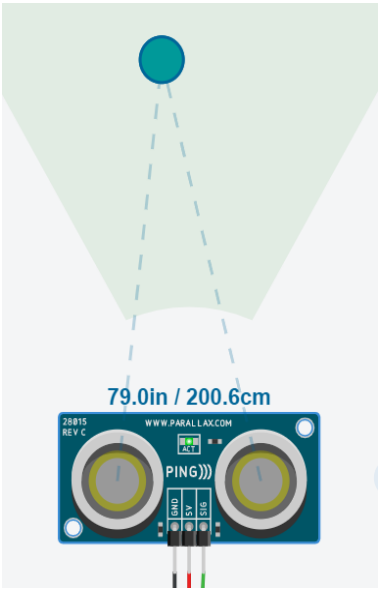


Figure 5: Robotic arm assembly

VI. RESULTS

The simulation results of the proposed work are discussed in this section. DC motors for forward/reverse movement of buoy including the left and right direction movement is been programmed and simulated using TINKERCAD. Passive IR sensor and ultrasonic sensor are simulated for trash detection and measurement of distance of the trash from the water boat. The virtual Robotic Arm has been tested. This is carried out by programming and operating the 3 servo motors as elbow, wrist, and finger of the robotic arm for collecting the trash floating on the water surface.





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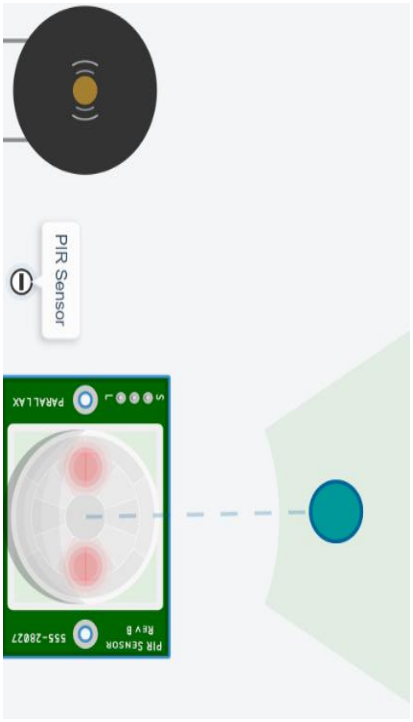

Figure 6: (i) DC motors movement, (ii) Ultrasonic sensor operation, and (iii) PIR sensor with buzzer operation

Figure 6 shows (i) the DC motors operation showing positive rpm (forward motion) of the water boat. (ii) ultrasonic sensor indicting the distance of the green dot (trash) from the sensor in inches & centimeters, and (iii) PIR sensor with buzzer indicates whether the detected obstacle is living organism or garbage. The buzzer will turn on indicating living organism; if it's off indicates that the detected obstacle is garbage.

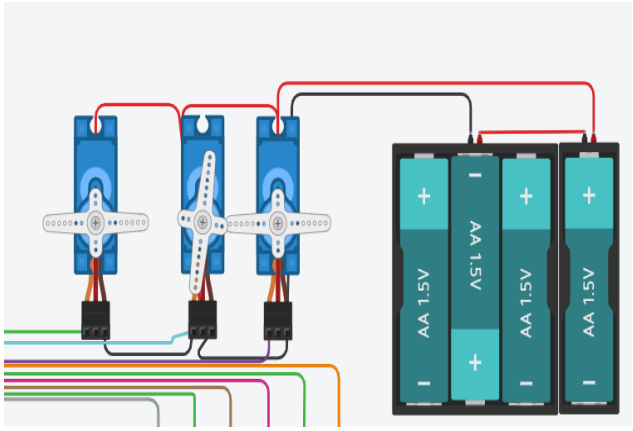

Figure 7: Servo motors movement indicating the robotic arm operation

VII. CONCLUSION

The design and development of a real-time robotic system based on Arduino uno for surface trash collection in the waterbodies is presented in this paper. The proposed work utilizes two sensor mechanism to detect and collect the garbage. The proposed concept is simulated using open-source tool tinkercad. The simulation results indicate that the proposed low cost Swachh hasth robot will be a potential alternative for surface water trash collection to preserve the quality of water & aquatic life with minimum human efforts. Future work of the authors is focused on to employing machine learning and internet of things (IOT), so that the system will be completely autonomous and operated remotely.

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