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AN IOT-BASED WATER MONITORING SYSTEM AND A FLOATING WASTE COLLECTION ROBOT

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Abstract

The development of a compact, affordable prototype for collecting floating debris in small bodies of water, such as water tanks, canals, lakes, and ponds, is discussed in this paper. The use of plastic is spreading quickly throughout the world, which has a significant influence on water bodies and causes pollution, serious health problems, ecological damage, and other problems. The main goal of creating this prototype was to clean up small water bodies and solve all of these problems. Propellers, DC motors, and a conveyor belt mechanism are used in its design, and a mobile app is created and connected through WiFi allowing it to be controlled and moved in all directions. Also, the Oleo sponge and squeezer added here efficiently absorbs the floating oil in the water bodies . The prototype is therefore multi-purpose, effective, economical, and small. It can work effectively and cleans the water bodies by removing all floating trash. This floating trash collector creates a channel for unpolluted water bodies with protected aquatic ecosystems.

Keywords—: *Floating waste, Propeller, DC motor, Squeezer.*

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I. INTRODUCTION

In all likelihood, trash dumped into water will end up in the ocean. Particularly detrimental to marine life is plastic debris, and there are many worries that 'micro plastics' could infiltrate the food chain in this way. Oil spills in water bodies are one of the main contributors to water pollution, much like floating trash. Sea otters and seagulls, which are found on the oceans surface or on shorelines, are most affected by oil spills. Seabirds suffer and are more frequently killed after oil spills than other types of animals.Some marine life swallow's plastic bags thinking they are jellyfish and chokes. A large portion of the waste will wash up on distant coastlines. Plastic pollution has already reached the once virgin Arctic. Not to mention the possibility of pollutants getting into the water. It is not necessary for anything to be 'toxic'. Any substance that significantly alters the PH, nutritional balance, etc. could have a negative impact on the environment in a given area.

The prototype's design is simple, water resistant, portable, and strong. Foam board and Polyvinyl Chloride (PVC) board were used to connect the robot's body together. The body is kept afloat by a floating tube, and the structure's streamlines make it easier to navigate through water currents. A trash collection conveyor belt composed of a leather-like substance and equipped with obstacles. A separate DC motor that is connected to a relay through which the conveyor belt is attached. The robot's whole body, including the conveyor belt, is built of materials that are water-resistant and light in weight.The PH level sensor continuously measures the water's purity, and the data are immediately relayed to the mobile application that's developed.

The trash collector is constructed of polyethylene terephthalate material. The trash container features etched grooves so that any extra water from the conveyor system can drain back into the water body and not add to the weight of the garbage inside. An ultrasonic sensor mounted above the trash gives instant measurements of how full the collector bin is. It is designed in a specific design with a wheel-like construction and four propellers that are made with efficiency to run in water. A small waste pan collector is placed in the end of the conveyor belt to collect trash on land. High-speed motors are employed so that the motor cannot be forced to rotate when the torque reduces by water currents.Oleo sponge, a breakthrough material that readily absorbs oil from water, is coupled to the same conveyor belt in order to collect the oil that is being floated on the water's surface. A manually operated squeezer fitted closely next to the conveyor belt squeezes the oil the sponge has collected. Beside the garbage collector is an oil collector tank where the squeezed oil is kept. Also, the squeezer stops operating when the collector stores the oil beyond a certain limit and receives notification from the user via the mobile application created. To determine whether the contaminated water is being cleaned, the PH reading of the water is taken once more and compared with the earlier results.

In order to maintain the purity of the water, the system can be operated to efficiently gather floating plastic garbage as well as floating oil.

II. METHODOLOGY

The research approach includes a description of how the floating garbage collector boat prototype is built and operated.

a) DESIGN

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A special type of squeezer is created using two lightweight wooden or plastic rollers or rollers that are powered by a 50 RPM DC motor. The rollers are situated very closely to one another with a small space between them for the sponge to roll in. The sponge is set up on the conveyor such that it rolls, passes through the squeezer, and then exits once again to separate the oil from the water in a circular motion.

In front of the garbage collector is a small oil-collecting tank constructed of the same polyethylene terephthalate material. A level sensor is positioned within the oil tank to inform users of the tank's level via a mobile application that has been developed.
The NodeMCU is equipped with a Ph level sensor that records the water's pH level on a continual basis to check on its purity.

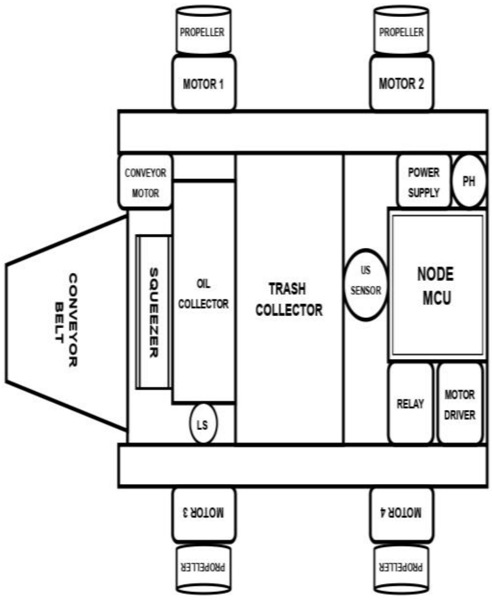


Figure 1. Mechanical Model of the Floating Waste Collecting Robot

b) WORKING

Through the use of buoyancy, the robot's hull design keeps it afloat. DC geared motors with propellers connected, controlled by the powerful and very efficient Motor Driver L293D. This will help the boat achieve its objectives. The robot can move left, right, backward, forward, left backward, and right forward by turning on and off the DC motors and switching their polarity. The table shown below contains the basic control operations and conditions for the garbage collector system.

Condition	Operation
To move Forward	motor1,ON motor3,ON
To move Backward	motor2,ON motor4,ON
To move Leftward	motor2,ON motor3,ON
To move Rightward	motor1,ON

	motor4,ON
To Stop	motor1,OFF motor2,OFF motor3,OFF motor4,OFF

Table 1. Basic movement operations for the garbage collector system

The Below table lists the basic operating condition for the conveyor belt mechanism attached to the Prototype for the collection of Debris.

Condition for Conveyor Motor	Operation
To turn ON	Button ==1 Conveyor Relay,ON
To turn OFF	Button ==0 Conveyor Relay,OFF

Table 2. Basic operating condition for Conveyor

The microcontroller NodeMCU receives input signals through a specially designed mobile application. The NodeMCU is utilized as the main control unit and includes an integrated WiFi module that accepts input signals from the mobile application and performs the required operational tasks. The controller is built in such a way that it can receive WiFi commands for propeller and conveyor belt movements. The controller also manages the flow of power to the various system components. In the event of internal issues or overload, it also signals back to the mobile application to which it is attached. When the conveyor belt becomes overloaded, the Ultrasonic sensor's readings cause it to automatically shut down, stopping further trash collecting.The oil is simultaneously collected from the water by the Oleo sponge and squeezed by the rollers in the squeezer once it reaches the oil collecting tank, which is located before the garbage collector. The level sensor, which is coupled to the built mobile application, signals FULL TANK after the required amount of oil has been accumulated in the tank. The squeezer and conveyor both come to an immediate stop when the oil tank is fully filled.

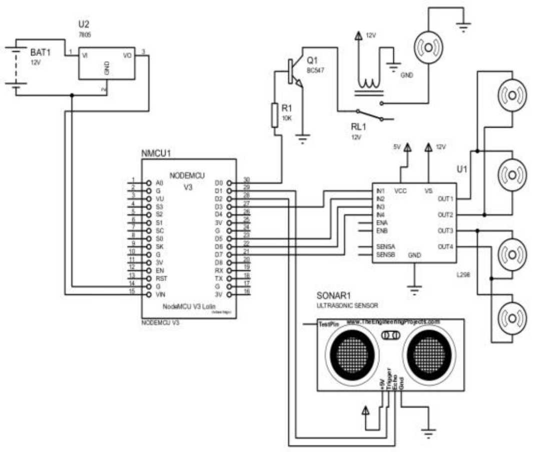


Figure 2.. PIN diagram of Control Unit

The h-bridge that controls the motor is powered directly by a 3-cell lithium polymer battery. A fully charged prototype can run continuously for four hours. It is fixed with a battery charging unit and rechargeable..

One of the main challenges in the robot's development is designing the system for collecting the floating trash. Due to their size and deformability, the majority of the floating trash is difficult for robot manipulators to grab. Also, a lot of rubbish needs to be gathered all at once. To gather the floating waste for this purpose, a conveyor belt mechanism is being used.The driving force for directing the robot's speed and direction is generated by four propellers. Each propeller is coupled to a 12 V, 1000 RPM, geared DC motor that has a high speed and low torque for maximum efficiency when moving through the water stream.

The conveyor belt is operated by a separate DC motor. For effective operation, a separate relay controls the conveyor motor. The belt moves the rubbish upward after the Conveyor has collected it.

The belt moves the rubbish upward after the Conveyor has collected it. The placement of the on-board garbage collector ensures that the waste will fall into the collector. When the garbage collection box is full, the rubbish is removed through a hinged door. Little slots are provided in the garbage collector's floor that allow extra water from the conveyor belt or water found in the waste itself to flow away, reducing the strain on the robot.

As the garbage collector puts the gathered trash in the bin, the microcontroller receives an immediate reading of the bin level, which leads to the development of the mobile application. The mobile application will inform that the bin has been filled once it reaches a specified level and will stop the conveyor belt from operating.

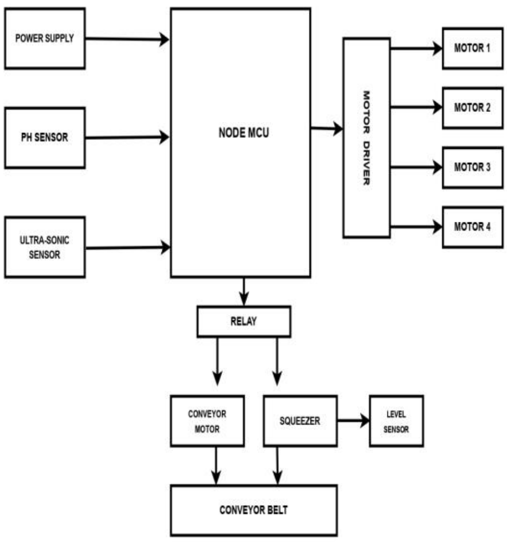


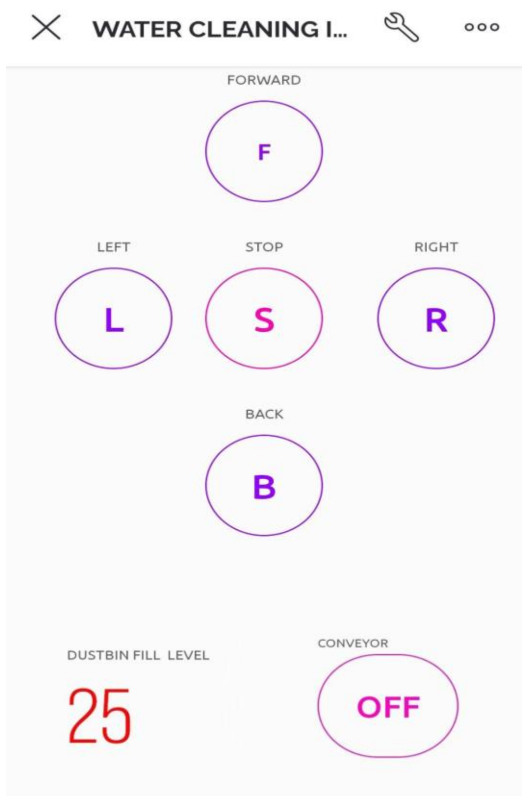
Figure 3.Functional Flow Diagram of Floating Waste Collecting Robot

DESIGN DESCRIPTION

Prototype Dimension	70cm X 36cm X 14cm
Waste Collector Dimension	35cm X 25cm X 9cm
Weight of collector (unloaded)	176gms
Weight of Oil collector (unloaded)	110 gms
Battery Life	70 minutes (approx)

Table 3. Design Description of Waste collector Robot

A mobile application interacts with the robot's control system which is to control the conveyor belt's speed and direction as well as the direction and speed of the propellers. Also, it causes the conveyor belt to quickly halt and indicates the level of the waste collecting bin.



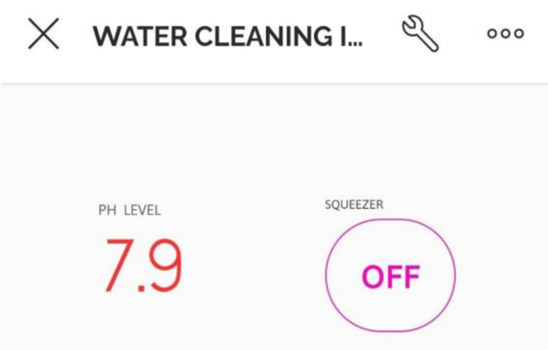


Figure 4. Mobile Application Interface for the waste collector prototype

III. PROTOTYPE DEVELOPMENT

The prototype is created using all of the previously specified details and specifications, and it is then put through additional testing.

Figure 5. Prototype of Floating Waste Collecting Robot

IV. RESULTS AND ANALYSIS

In this paper, from the detailed analysis of previously published papers and proposed articles, the different methods to solve our problem statement are identified. The system has undergone testing to evaluate its performance. Experiments were conducted at many sites to collect the data for this study. In a pool-like tank at home, one significant trace was taken. Many observations have been made and readings of numerous parameters have been recorded from the trials conducted in the home tank. It is clear from this demonstration that the prototype operates more effectively and produces superior results.The results data were clearly identified and placed in a table for inspection.

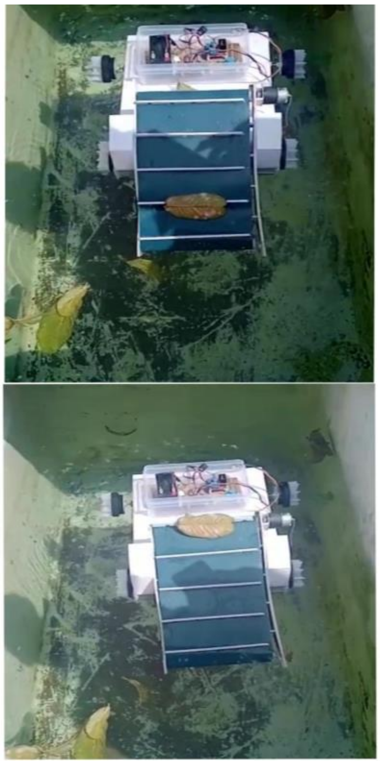


Figure 6. Prototype Demo carried out in Home Tank

The floating trash was successfully gathered and placed in the waste collection container. Four DC motors operating at 1000 RPM are employed in the prototype, which allows it to effortlessly move through the water. The prototype moved without any disruption because of its rapid speed and low torque. During a set amount of time, this procedure is fully implemented to gauge its effectiveness. The mobile application was created for the mobility of the prototype and was also used to control the entire prototype. The mobile application will alert users when the collector tank has been sufficiently topped out by the Ultrasonic sensor after the trash has been dumped into the bin to an appropriate level. When the bin is empty, the garbage collection stops and the conveyor belt turns off automatically.

A different test has been carried out to comprehend the accumulation of floating oil on the water's surface. It is abundantly clear from the demo test that the prototype can gather the floating oil extremely well. Using the mobile application's navigation buttons, the prototype is maneuvered towards the oil spilt region, where the Oleo sponge collects the floating oil. The squeezer works on the sponge for roughly 10 minutes, extracting close to 85 ml of oil. The mobile application alerts the user when the oil tank begins to fill and at what level.

The below table lists data acquired from the demo test conducted for the floating oil collection.

Trail	1
Oil collected	85ml
Battery Voltage prior to use (V)	12.19
Battery Voltage after the test (V)	12.11
Duration of the operation (s)	60

Table 4. Readings on oil collection

Figure 8. Oil collected from Sponge

The actual data monitoring of the propeller speed, the functioning of the garbage collector's movement, and rubbish collecting in the tank were the three main components of the experimental results. The propeller speed was recorded using a tachometer and is displayed in the table below every 10 seconds. To monitor propeller speed (no load) situations, the tachometer's laser was directed towards the propeller. Three times were used for each procedure to detect the propeller speed. Together with the drop in voltage supply, the maximum propeller speed was measured to be lower.

Duration of operation[s]	10 Seconds		
Trial	1	2	3
Battery voltage prior to use [V]	12.23	12.19	12.10
voltage after the Trial [V]	12.21	12.18	12.7

Speed of Propeller in air (unloaded) [rpm]	1011 max	1005.3 max	1002.4 max

Table 5. Measurements of the propeller speed

For each trial's operations, the duration of each operation and the battery voltage were noted. The robot was controlled to go forward, backward, left, and right, with each motion being performed for a trial. A propeller was deemed successful when it could run in all modes and stop when the "Stop" button was pressed.

Operation	To Move Forward	To Move Backward	To Move Right ward	To Move Leftward
Trial	1	1	1	1
Battery voltage prior to use [V]	12.2	12	12.1	12
voltage after the Trial [V]	12.2	12	12	19
Duration of operation [s]	7.3	8.7	2.4	2.3

Table 6. Movement Measurement

Following these two tests, the garbage collector was used to check its efficiency in gathering trash. The time needed to finish the waste collection in a home tank is displayed in the table below. The water garbage collector took an average of 6.54 seconds to collect trash around the pool, with leaves, plastic covers, and pieces of thermocol waste making up the majority of the debris. The battery had enough power, and it was clear that it could last for about 70 minutes.

	Operation in Tank		
Trial	1	2	3
Weight of garbage collected [g]	233	197	209
Battery voltage prior to use [V]	12.06	11.96	11.95
voltage after the Trial [V]	12.0	11.92	11.88
Duration of the garbage collection [s]	5.63	5.11	7.41

Table 7. Measurement of Garbage collected

V. CONCLUSION

Based on the results discussed, the drawbacks and failures in early proposed prototypes are found and the design of a compact-cost efficient Tentative model is done. Waterbody plastic contamination is a very serious problem on a local and international scale. The proposed prototype provides a very affordable, secure, and efficient method of removing floating debris from water bodies. It also has low maintenance costs and an easy-to-use management and monitoring system. Although there are numerous prototypes available, this one is suggested due to its affordability, portability, and versatility. It has been established through several experimental setups that a smartphone application can successfully manage the forward, reverse, left, and right turning of a water waste collector. By adopting strong and water-resistant materials for the collector body, which also aid in collecting huge amounts of trash from water bodies, the prototype can be further enhanced to serve the objective of removing the risk of floods.

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