IoT Based Solar Water Trash Cleaner

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Abstract: Water pollution due to excessive disposal of plastic, polystyrene and metal in water resources need to be repelled. This is not only hampering natural balance but also spreading vital diseases like cholera, diarrhea, intestinal sickness, typhoid and so on. In this meaning we have designed a project which is completely eco-friendly and a smart solar powered robot that has been developed to recapture our transparent water resources. This project has such features that makes the garbage gathering system viable and effective and also examine water quality from rivers, channels, lakes and manholes. It can also operate in tidy water resources like seaward zones. Coordination of excellent floating capacity and motor speed gratifies the operator. It is capable of collecting vast assortment of debris, approximately around 40kgs at a time. The integration of IoT has provided impressive facilities of monitoring and controlling this device from distance by a smartphone. This cleaning robot is specialized in cleaning contaminations from drainage territory where utilization of human for cleaning is very risky and extremely prohibited.

Index Items: Water pollution, Eco-friendly, Solar, IoT, smart monitoring system.

I. Introduction

This project introduces a whole new level of automation which is completely eco-friendly. We have developed such a water robot that will collect floating and partially submerged rubbish. This robot can identify dangerous molecular particles such as nitrogen, bleach, salts, pesticides, tiny metals, bacteria-produced toxins, and human or animal medications to determine the water quality. If any of these harmful particles are identified, this robot will immediately send text messages to our phones. This is a high-capacity water robot that can be controlled remotely. Although this project is mostly solar-powered, we have included a highly efficient lithium battery that can be refilled from any external source to eliminate the possibility of intermittent sustainable electricity. It is more efficient because it has an automated self-cooling mechanism. A monitoring camera allows the robot's operator to identify both floating and submerged rubbish. It has the ability to move quickly and alter its direction with ease. It can automatically collect rubbish that is slightly submerged by releasing a one-meter long, three-dimensional iron net box. This water cleaner robot will collect water debris on its own. We can explore and collect underwater debris using a remotely controlled robotic hand with a monitoring camera. To alleviate visibility issues caused by low light, an automated lighting system has been installed around it. This project has been designed such a way that it can get through barriers and take challenges to prevent water pollution.

For sustainability, solar power system with a highly efficient PV inverter has been installed. Submerged camera, microprocessor chips, heat sensors for safe operation, arduino (UNO), ultrasonic sensor (HC-SR04) for measuring the depth of water, NAND gate (IC-7400) and LDR for automatic visual lighting and powerful DC motors like 700rpm DC motors has been used to rotate the propellers and wheels. This project has the scope to get upgraded everyday with new ideas and the efficiency can be increased everyday which substantiates this technology highly innovative.

II. Exploration of Traditional Method

In the prospect of employment, traditional methods are not only appreciable but also highly recommended almost everywhere. The traditional approach to decontaminate water resources by usage of manpower or heavy machineries. we have to venture further to demolish this problem because these methods cannot be established for both health and environmental concern.

A. Manpower

Water trashes has always been collected by manpower in the conventional manner. Where someone must dive in the water which is poisonous and allergic. It is a time-consuming process including several danger factors.

Figure 1: Using man power for collecting waste [1]

B. Heavy Machineries

This method is effective but costly and also have space issues. For example a crane which is huge in size. It can certainly take and clean up a lot of trashes but it cannot be used in narrow

spaces and city areas. Besides these heavy equipment causes sound pollution and emits massive carbon dioxide.

Figure 2: Using machine for collecting waste [1]

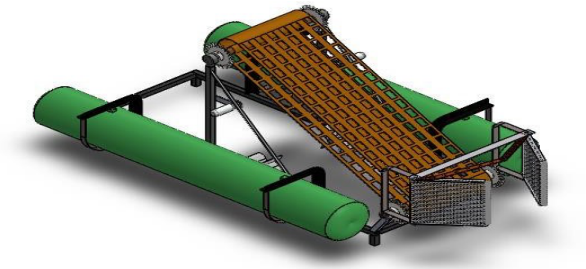


Figure 3: Assembled View of River Cleaning Machine [2]

III. Sustainability And Mechanism

The first solar powered trash collector on water to gather water debris from a pool using a solar-powered remote-controlled boat using a 5V solar panel that is connected to a battery, which is coupled to a 3.75V DC motor in that project [3]. Due to technical limitations that prototype was not efficient enough to operate in all conditions. Besides collecting trash from water does is not the ultimate solution, the water quality should be examined thus we can bring necessary arrangements to prevent hazardous elements from water.

Apart from this, the new proposed design was created and produced so that it is applicable to be used anywhere and more importantly, it was designed to suit for the Bruneian context. However, the main important steps that need to be taken is to create awareness among the world population of the negative impacts of plastic pollution [4].

Recently, humans are becoming more aggressive about environment safety as well. So, this type of technology can be manufactured and brought into the market by different companies. Much bigger watercraft for serving same purposes can be used to keep water bodies clean. This technology can decrease human efforts and it is very effective to keep environmental balance. On the basis of this result, is an innovative method of minimizing manual stress and thus very much reliably stabilizing them in the lake [5].

According to Greek scientist Archimedes, every object set in a liquid encounters an upward pressure that permits the body to float if it displaces the amount of water with the weight equal to the weight of the body.

$$P = \rho g h$$

Using this principle, it has managed to increase the floating capacity of this vehicle and thus it has the ability to carry 40kg trash at a time.

A. Solar Power

This project is primarily solar-powered, with a high-efficiency lithium battery as a backup. There are two solar panel (15V-17V each) has been used in this device to recharge a 15V battery. This battery has the capability to provide backup for 8h at night. In a sunny day there will be no need of external sources to recharge the battery though the overall power consumption of this device is not more than 1kwh.

B. Mechanical Overview

This project goal is to focus on green energy and so, there is a solar system that can function all day without interruption and does not require any fuel. When the weather is bad, there is a battery that can run on alternate days as an option. The boat has four dc motors, to speed up the boat eventually. For collecting the trash there is a 3D hand and a conveyor belt system mechanism to collecting the trash smoothly. There are sensors like PH, TDS, weight to operate the atmosphere properly and an ultrasonic sensor that can detect metal underwater and send signal. This project includes a GSM module, as well as a PH indicator and water quality information that will be sent to mobile phones automatically.

IV. Methodology And Modeling

There are distinctive project management methodologies to benefit diverse projects. Throughout this project, a certain methodology has been maintained for its modeling and implementation which is utilized for the design, scheming, execution and accomplishment of the project goals.

A. 3D Model

This 3D modeling design has done using “Edrawmax”. All the scales and parameters were measured according to weight distribution theorem. This boat is designed such a way that it can easily operate in water surface without any disturbance. This model has been designed by keeping in mind about the buoyancy.

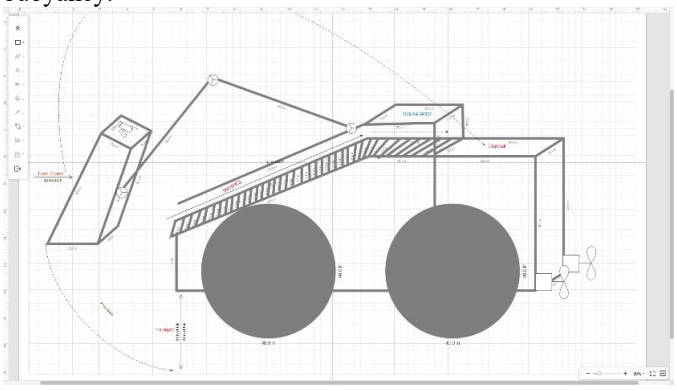


Figure 4: 3D Diagram

B. Block Diagram

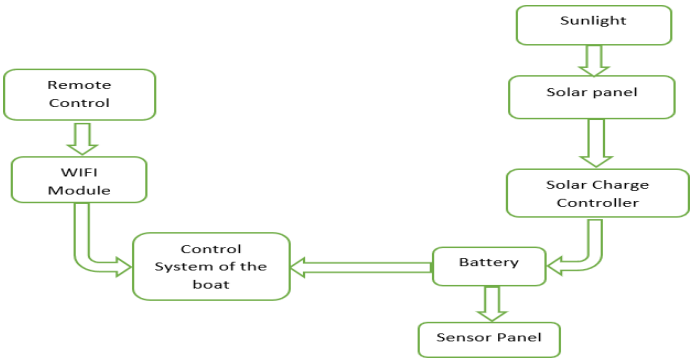


Figure 5: Block Diagram

In this embedded system, there is the software part where the codes are to be written and compiled to make a boot loader program which is to be burned on the microcontroller chip. Then there is the hardware part, which is regulated by the microcontroller. The mobility of the system is done by the motors which are controlled by the motor controller.
The Ubidots Event manager invoke a notification alert to garbage collector mobile phone via a SMS when the waste bin is nearly filled for immediate waste collection. Therefore, the waste collection became more effective and systematic [6].

C. System Flow Chart

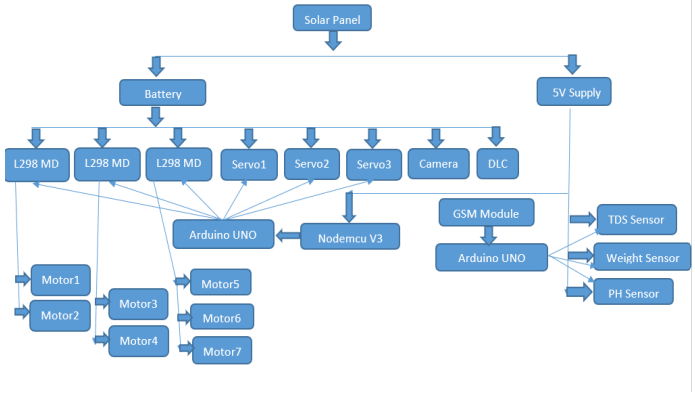


Figure 6: System Flow Chart

D. Simulation Diagram

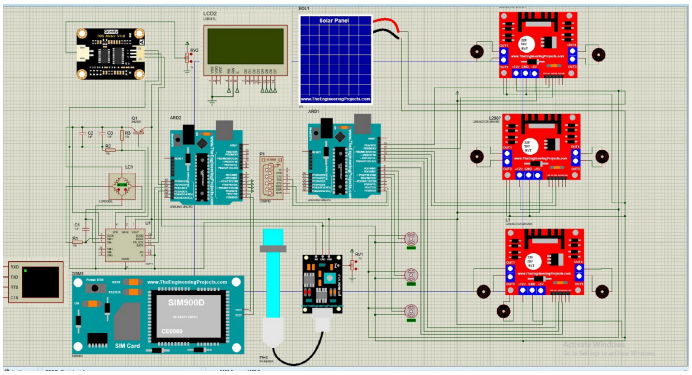


Figure 7: Simulation diagram of the project

The simulation part of the circuit diagram has been shown in this section. Before the hardware implementation, connecting the designed circuit diagram in simulation software is very important so that detection of prevalent errors or faulty connections can be solved. Besides, simulation of a circuit provides us with a result which can compare with the output of the hardware part. In this project, Proteus 8.12 professional has been used for simulation.

V. Hardware Implementation

We have two Arduino uno, one of which is coupled to the NodeMCU wifi module, as well as three motor drivers. And we've connected roughly seven motors to the three drivers, and the same arduino is also connected to three servo motors to operate our 3D hand.
The second Arduino uno is connected to a GSM module as well as a few sensors such as PH, TDS, and weight sensors. The motor driver and three servos are also powered by a 12v supply that comes directly from our solar system. The power has been provided as 5v to all sensors (TDS, Weight, and PH).

A. Simulated Result analysis

The real-time update from the sensor is uploaded through the developed mobile Apps via URL to the database. Waste collector or end user need to access the update via mobile Apps for further action. In this project, the ultrasonic sensor sensitivity is tested on 'flat' and 'non-flat' waste type. The result showed that type of waste ('flat' or 'non-flat') with specific angle of reflection has influenced the sensor sensitivity to identify the waste level status. The developed system could be potentially utilised to improvise the conventional system waste collection to more effective system [7].

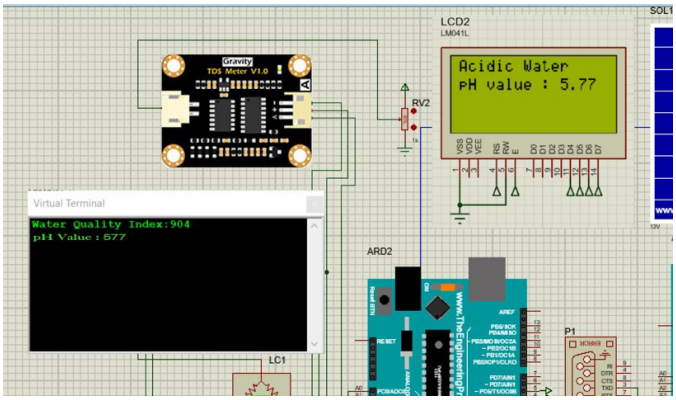


Figure 8: pH Readings from the sensors

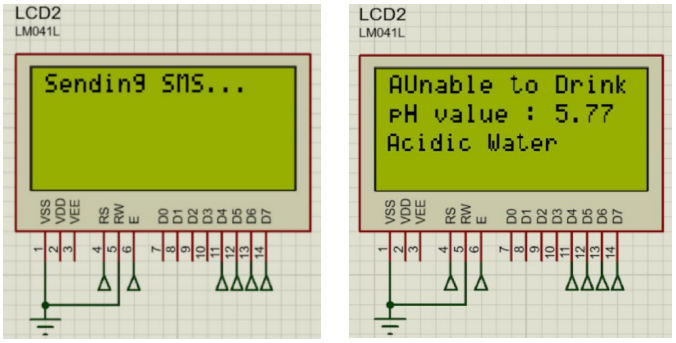


Figure 9: Drinkability Warning

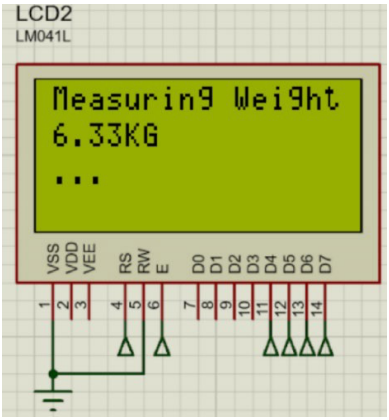


Figure 10: weight measurement

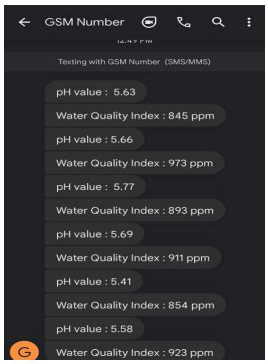


Figure 11: GSM readings via SMS

B. Hardware result and cost analysis

List of all required components and tools has been shown in the table below. Overall cost analysis has been done with proper accuracy and according to the market value of 2023, total cost will not exceed 20,000 taka including maintenance cost.

Required Tools And Components	
Microprocessor	Arduino UNO
Sensors And Modules	NODEMCU V3, GSM Module, weight sensor, pH sensor, TDS sensor, BTS7960 motor driver
Components	100 watt-solar panel, battery (Sealed Lead Acid Rechargeable Battery 12V 12Ah) and Charger, 20 Watt-Solar Panel, 300 RPM 370 Generated DC Motor, under-water camera, LED and NAND Gate.
Hardware Parts	SS Sheet, MS rod, bearings, piniums, robotic hands, Jumper wires, trash collecting belt and propeller.

Table 1: List of all components

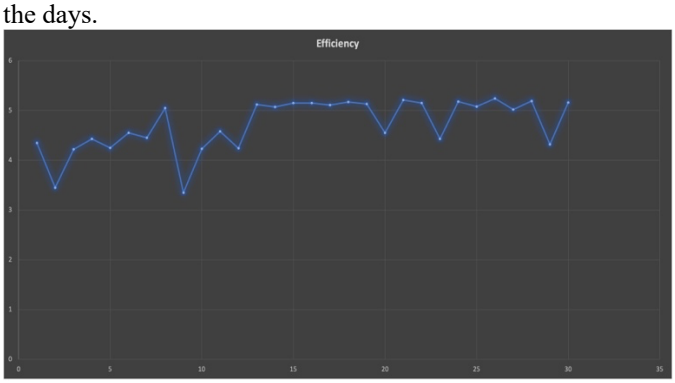
The calculated power supply needed to run this project expected backup power has also been tasted. It has a very good buoyancy. Then the sensors have been tasted in our household water after that it has been tested is real water resource. But many more developments can be done. For example, by increase supply more powerful motors can be used. Thus, it will be more used friendly.

Figure 11: Testing the prototype in lake water.

Simulated values hardly matches the obtained simulated data in the project. Result analysis helps to upgrade the components and design. Hopefully, this prototype will help significantly to the users, especially to people with disabilities.

C. Efficiency

This water robot has been operated in a lake for 1 month. Operating time has been noted for the corresponding day. The time counted for non-stop maximum runtime per day. The x axis shows the value of operating hours and the y axis shows the days.



Graph 1: Day vs Time (Hours)

The values varied due to the availability of solar power of that day. The average runtime of the month is almost 5h per day. Which is satisfying for this initial model. Run time can be increased by adding more efficient solar cell and storage.

VI. Challenges And Findings

A. Limitations

This project cannot operate in less or equal 2 feet drain. This project can clean the floating waste materials and shallow waste materials (up to 1 meter). Robotic hands cannot pull up heavier materials than 10kg. Most of the components of this project are

expensive and some of them are not available. TDS sensor and Weight measurement sensor still unavailable in the market. To work in manhole customized wheels has been used because of unavailability of the required size.

B. Social Impacts

The final project design will solve the water logging problem and will reduce sufferings of common people from mega cities during the monsoon. People can get the information of any water resources if pH value increases or any kind of hazardous molecule detected. Safe water lands can be determined for children and residents.

Bangladesh has many people who are drinking river or pond water even they have to complete their household works by using this water. But nowadays it has been seen that there are lots of plastic and industrial wastes in the water. This type of waste does not dissolve and that's why they are causing water logging and spreading diseases. There are many types of harmful chemical are dissolved in the water. Many peoples are affected by drinking this water like Arsenic, Diarrhea etc. By thinking all of this situation it has been designed. In this country there are lots of lakes to clean them up but there is only way is the manpower which is costly and time consuming.

C. Economical change

In this project the main focus was to serve the society. The project is economical than manpower, it takes less time to clean water resources which saves both our time and money significantly. As this project is eco-friendly, it doesn't cause any harm to ecology and no external power means no more waste of valuable energy for the service.

D. Code of ethics

In every code of ethics safety, health and welfare of the public has been the first priority. Our project has also the same priorities to devote this work for mankind. No one can harm people or society by misusing this device. Only authorized use can be assured and special security system will also be developed before shifting hands.

E. Novelty of the work

Novelty of this project is its own uniqueness, as the purpose of this project is to clean water via collecting trash from water surface area. In this project, there has been strongly discussed all other project that has been done past few decades and due to that, the project had made some eventual changes. In this project some sensors have been added like PH, TDS, weight sensor, Basically, focused on the design and power consumption and also the main fact about the shafts that has use powerful four DC motor for going forward and backward.

VII. Conclusion

This proposed system has been developed such a way that it can contribute in the welfare of the society. Its shape is suitable to operate in any water resources. Also, the weight distribution theorem had followed to keep balance on water surface. As the main power source of this robot is solar, so it is ecofriendly. It has auto colling system that increases its working capability. This can be operated from any distance and anywhere it any one want. It requires a very little maintenance cost. It can be operated all weather and it doesn't need any human afford to unload the collected trashes.

In rainy season water logging is the biggest problem in our country. Dhaka city is a most populated city in our country. About 1 million people live in this city. In every rainy season most of the road are being flooded. To solve this problem there is no easy solution. Dhaka metropolitan need lots of man power to solve this and it is also time consuming. Some of the problems have noticed and due to that it has to be solved. First of all, the main cause of water logging is plastic, bottles and wrappers which are not fully dissolve materials. This waste materials lock the water drainage system also the rivers and canals water is being polluted. Water livelihood in in alarming situation. Due to the pollution haven't get enough protein source from the river, people could not use the water. They were suffering various water diseases and the number of affected increasing day by day. Considering all of these problems and designing our project so that it can use in manhole, river, canal, swimming pool any kind of water resources.

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