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DESIGN AND DEVELOPMENT OF RIVER CLEANING ROBOT USING IOT TECHNOLOGY

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Abstract—The issue of water logging due to plastic, thermocole and metal is prompting bother development and it favors ailments like intestinal sickness, typhoid and so on. Cleaning the wastes by utilizing manual procedures would be insufficient as it regularly covers immense territory of works and endeavors with plausibility to getting influenced by different sicknesses from the irresistible microorganisms present in the sewage while cleaning manually. This study features a proposed plan of garbage gathering system viable and effective for tidying up waste from rivers, channels and lakes. The trash gathering system is explicitly coordinated to application for getting up a wide assortment of debris, including gliding litter, trash, logs, disposed tires and others. The integrated system incorporates the usage of IoT technology that has the ability to monitor and control the entire process. From the interest and need of cleaning contaminations in the conduits territory, the vessel has been created to suit the prerequisite of working at places other than seaward zone, giving more decisions for the utilization of cleaning garbage and waste from the water environment.

Keywords— river cleaning robot, design & simulation, IoT

1. INTRODUCTION

Inland conduits are earnest for human life and other living things. Water that is flowing there is utilized for the water system and drinking, and they keep up the humidity of the earth. Additionally, inland conduits have been participating to transportation where numerous urban areas on the planet are arranged in their region. As the population grows exponentially, numerous inland waterways become a sort of water channel system. As society getting bigger, the city then generates large wastes in which the greater parts of them are dumped into the inland conduits through sewers or straightforwardly from hands, compounding the contamination gradually. A recent report by WWF of Myanmar, Irrawaddy River Dolphins is in dangers due to habitat degradation and population fragmentation such as dam development that severely impacted the species along with pollution of pesticides from palm oil plantation and mining (Indonesia), mercury poisoning from gold mining hydraulic blasting and dredging (Myanmar) [1]. Another report from WWF-Malaysia showed that river pollution is one of the largest threats to the river and the reduction in water quality is a clear indicator of the decline in the environmental health of a river basin [2].

There are numerous sources of pollution such as domestic and industrial sewerage, effluents from livestock farms, manufacturing and agro-based industries, suspended solids form mining, housing, and road construction, logging and clearing of forest and heavy metals from factories. Moreover, in 2017, Deputy Energy, Green Technology and Water has categorized many rivers in West Malaysia as “dead” due to pollution, contributed to the reduction of dissolved oxygen for which the lack of dissolved oxygen in inland waterways leads to critical circumstances to the fishes and other bio-diversities in those rivers. Therefore, it is important to address a solution that would make it, at the very least, a better condition through a river cleaning robot [3-4].

Several studies in the literature have reported and addressed the issues related to the river cleaning machine. Sinha et al., (2014) have developed Ro-Boat, an autonomous river cleaning robot. It exploits a computer vision algorithm to combine with structural design and kinematic analysis with CATIA V5, SURF (Speeded Up Robust Feature) to overcome issues related to the sorting of pollutants in the rivers, differentiate with the desired pollutant with the real-time pollutant [3]. Rafique and Langde have developed a river cleaning machine,

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working by lifting up waste into designed places through a conveyor [4]. Ganesh U. L. and Vinod V.Rampur Revealed the utilization of mechanical water drainage cleaner to compensate the manual work. The Drainage pipes are always very dirty and often affect human life that nictitate the development of cleaning drainage system. Thus, a semi-automatic mechanical drainage cleaner was implemented to overcome this issue. This machine would overcome this problem and facilitate the water flow effectively inside the drainage pipe as a result of regular wastage infiltration [5]. M. Mohamed Idhris et al. proposed automatic swage cleaning system to minimise waste spreading that threatens human life. The system involves wiper motor for start running and window motors that are driven by remote control [6]. Abhijeet. M.Ballade et al have emphasised in his work on the design and fabrication of river waste cleaning machine. It consists of DC motor, propellers, PVC pipes, RF transmitter and rectifier, chain drive with attached conveyor to pick up the wastage from the river [7].

Several electrical components that are critical to the river cleaning robot has been delivered in [8] for which consists of the power generation devices such as transformer, bridges rectifier, a filter capacitor as for charging circuit, and a voltage regulator in receiving unit to the battery. Those studies have lightened up the possible solution of the 'dead' river. It is urgent to address issues as mentioned above with a hope to highlight the current situation and thus could lead to a better solution in cleaning the 'dead river'.

To overcome those issues, this study aims to design and simulate a rubbish collecting system that is expected to further develop experimentally for the application in the real world. Hence, it will be able to getting a wide assortment of debris, including gliding litter, trash, logs, disposed tires and others. Thus, it is expected to enhance the demand and need for a design of a river cleaning machine that is able for tidying up waste from rivers, channels and lakes and overcome the current issues. The integrated system incorporates the usage of IoT technology that has the ability to monitor and control the entire process.

2. METHODOLOGY

The river cleaning robot was integrated into three segments as shown in Figure 1. The first segment of the system involves the input source of the mechanism that consists of the magnetic switch mobile phone application and solar panel. The processor development was the second segment of system development. In this segment, the microcontroller processor was integrated using the Arduino IDE software to perform coding of the source code. The software enables compilation of the necessary commands and source code into the NODEMCU V2 processor. Meanwhile, the third segment of the system focused on the output source for the mechanism. The output source consists of the integration of mechanical segments such as DC motors.

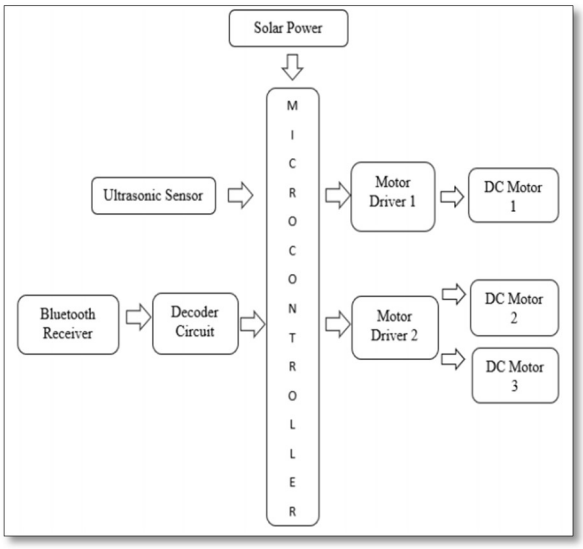

Figure 1: The proposed block diagram of river cleaning robot

The circuit diagram for this system has been designed using Proteus software, a software developed by England Labcenter Electronics Ltd for schematic capture, simulation, and printed circuit board layout design [9-10]. This circuit diagram consists of an Arduino, motor driver, switches and motors as shown in Figure 2.

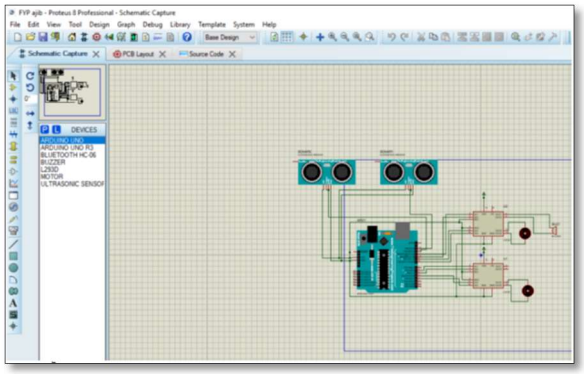

Figure 2: The proposed circuit diagram

The design phase is a vital aspect of the developed system because it's the objective and scope are justified through the conceptual design while the interface design enables better vision for the system development based on the logical and physical design. The design of this prototype was done using the Solidworks software version 2018, a solid modeling computer-aided design program that runs primarily on Microsoft Windows [11-12].

This software has a rich feature that can be used for engineering design ranging from machinery design and its mechanics, electrical system, and has a friendly development environment. Several components, including the body of the robot which has a shape similar to a boat, propeller to move the robot forward and backward through micro-controller, then a sort of conveyor is employed to bring the waste on the surface of the river to the designated area.

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Waste that will be ably collected by this robot is floating on the surface of waterways, such as bottles, plastic cans, covers, and etc. It is collected through a belt conveyor then placed in the designed place. This conveyer designed rotating continuously, especially when it is detecting rubbish and waste, therefore some sort of sensor will be placed in further study.

For the sake of mechanical design and simulation are listed below (some of them are shown in Figure 1):

1. Axle shaft as the place for the propeller to rotate, thus the robot could move correctly.
2. Front slab is used for directing the waste on the water surface and introducing it to the conveyor so that the trash could be transferred to trashcans.
3. Trashcans are used for the place of waste after directed by front slab and conveyor.
4. Propellers will be connected to two DC motors; therefore, it could be controlled including turning move and upward & backward.
5. A tube-like boat body is used as the main body of the robot. This design is chosen to enable robot floating on the water.
6. A solar cell is used for making the battery used could stay on for a longer time.
7. Belt is used for connecting between the DC motor with the propeller.
8. Conveyor is used for the delivery system of the waste from the water to the designated trashcans.

Under the solar cell, it is designed for unit control of the robot. Battery, microcontroller, cables, including cables for wiring the DC motor will be centered in this place. These components will be assembled later for simulation to investigate the capability of the designed robot through the circumstances that it will face in the development in further study.

3. RESULT AND DISCUSSIONS

The circuit simulation imitated the performance of the real electronic device and circuit on the cell phone-aided software. The circuit operation was successfully demonstrated using Proteus software. The circuit design was constructed using the Proteus software in order to obtain a simulation before-hand of implementing the mechanism construction while Arduino Compiler let the appropriate required coding for river cleaning robot to be written on the NODEMCU V2 microcontroller. Firstly, the circuit diagram was drawn according to the circuit principle and structure shown in Figure 3. It was then followed by downloading of .HEX file to the MCU to obtain the simulation results as shown in Figure 3. The simulation consist of three stages and each stage is controlled by a switch. The process starts once the coding of simulation been verified. In the first stage, once the switch is closed then the motor will move in a forward direction. When the second switch is closed the motor will move in reverse direction. In the third stage when the switch is closed, the motor will stop to show that the system is ended as shown in Figure 3. The great simulation capabilities and broad resource libraries of the Proteus software has made the circuit of the designing process easy.

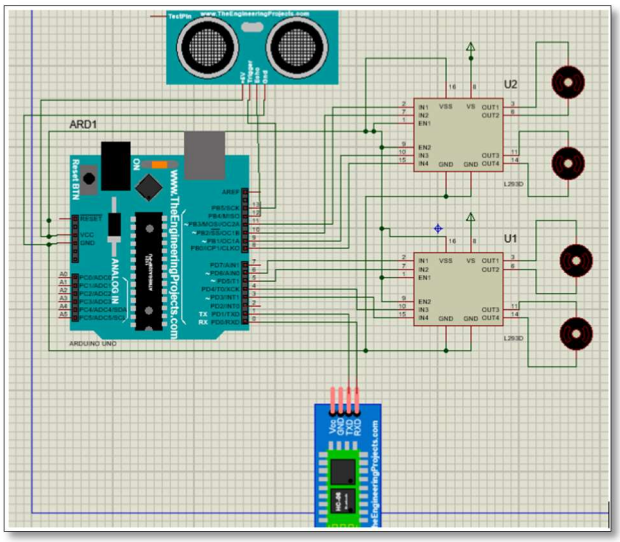

Figure 3: Proteus Circuit Simulation

Figure 4 shows the 3D sketch of final design in Top, Front and Isometric Views that is created using Solidworks software. This robot is expected to operate automatically and manually through a remote control which connected via wireless media. However, to meet the functional design necessary for some particular application, this model, perhaps, will be changed. In order to maintain the main function of this robot, here are several of the main function that should be accommodated by a river cleaning robot designed in this study as depicted in Figure 5. These features could be breakdown into more tangible components, they are:

1. The system will be fully controlled by microcontroller that is now very much used in IoT application.
2. GPS module will be connected to Arduino and thus introducing the possibility to locate the robot when it is working with a large area of water, minimizing the possibility of the robot miss-controlled or lost during the operation.
3. In order to employ an AI system for recognition of trash in inland waterways, this Arduino system could be connected through an IoT system, thus allowing the image recognition feature to be adopted and controlled in the system. However, a camera that could be used for this feature is at the very least has 2 MP resolution with good lighting, since most of the feature extraction that mostly employed in AI system is based on the contrast of the image after the image being converted into grayscale.
4. For solar cell, the harvested energy has made the battery at least ¼ times longer than only using battery. It is perhaps is a small value, but could be designed for larger capacity if only the space could be created in future study for the solar cell.
5. IoT system will be managed by some sort of cloud system that allow IoT features, such as Amazon Web Services (AWS).
6. The waterproof ultrasonic sensor will be applied in the system, since the robot will work with the watery environment. However, the ultrasonic sensor will still be protected physically by some sort of shield.
7. PH sensor will be located thus introducing a monitoring system of a pH level of surrounding water in the river through a robot. Therefore, this system is

not only could be used for cleaning river, but also monitoring the pH value, thus when a slight change is detected, a prevention before the river is 'dead' could be performed.

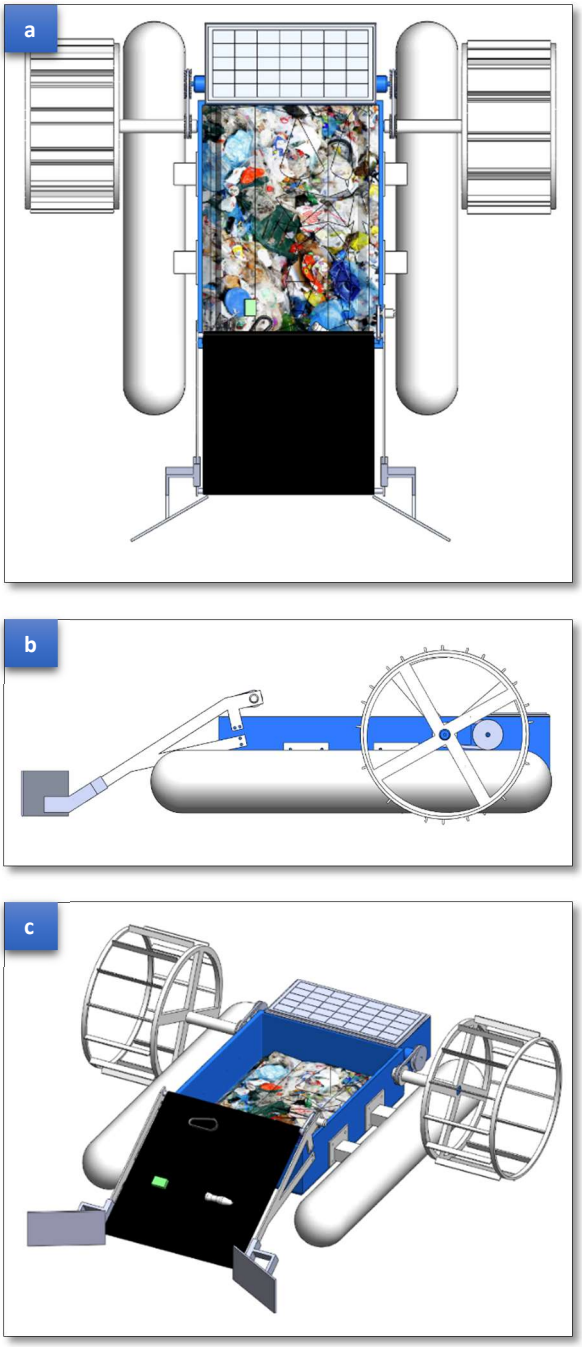

Figure 4: Final design (a)Top View, (b)Front View and (c)Isometric View

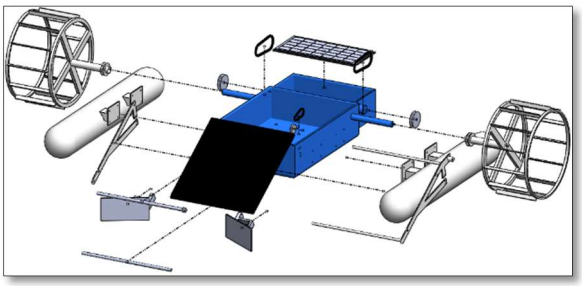

Figure 5: Components of the final design

4. CONCLUSION

A new generation of river cleaning robot has been presented in this research. The enhancements accomplished by the new design and features that make the river cleaning robot with IoT technology more competitive. Moreover, the proposed design is going to be an effective and user-friendly which can boost the rubbish collecting process which directs to pick up a wide variety of flotsam and jetsam with high quality by reducing time taken since it has the potential to replace manual labor steps. Besides, it can also prevent humans from direct contact and risk of injuries with infectious microbes during manual process. The integrated system incorporates the usage of IoT technology that has the ability to monitor and control the entire process. This preliminary study and proposed design have a high potential to overcome environment problem for inland waterways.

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