Design and Construction of a Radio Controlled Floating Waste Collector Robot

Md. Shahnauze Ahsan
Department of Electrical and Electronic Engineering
Premier University, Chittagong.
Chattogram-4203, Bangladesh
E-mail: ehsan.puc16@gmail.com

Hossen Mobarak
Department of Electrical and Electronic Engineering
Premier University, Chittagong.
Chattogram-4203, Bangladesh
E-mail: hmobarak032@gmail.com

Kainatun Nahar Chy
Department of Electrical and Electronic Engineering
Premier University, Chittagong.
Chattogram-4203, Bangladesh
E-mail: Kainatisha460@gmail.com

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Abstract—**This research paper proposes the design and fabrication of a cost-effective floating waste cleaning robot that will lift the waste surface garbage from the water surface. This robot is containing a propeller-driven conveyor mechanism, which collects & removes the wastage, garbage & plastic wastages from the water surface. The robot consists of a conveyor belt built-in with a fixed number of claws to pick up the waste material and a steel rod bound to a DC gear motor drives it. The claws transfer the collected waste into a deposit box and from there it will be displayed in the desired location utilizing a conveyor system. 2.4 GHz radio transmitter and receiver has been used to control this cleaning machine. The motor and belt-pulley drive mechanism gives a robust performance for grabbing the floating waste materials.**

***Keywords*— Floating Waste, Robot, Conveyor, Radio**

I. INTRODUCTION

Water is a fundamental necessity of humans and all living creatures. There is a bounty of water on earth that is not suitable for humans to utilize. Various kinds of impurities present in water can cause dangerous diseases. Water is accessible to utilize in the form of rivers, lakes, and rains, etc. These water bodies are habitually been contaminated due to human waste dumping. These wastes include plastic bottles, wrappers, polythene sacks, etc. These wastes materials float on the surface of the water. In the case of drainage, these waste materials deter the flow of water. This leads to the blockage of channels. These days, environmental problems emerge in many places in Bangladesh. These problems come along with developing activities such as the development of the house, workplaces, and other business zones. In Bangladesh, these environmental problems which come up from year to year and still cannot be unraveled are about waste and garbage materials from different places dispose of the rivers, ponds, lakes, etc. Those waste materials can clog water flow, make the water dirty, smelly, and sometimes overflow makes floods. Besides, these floating materials deter the outside Oxygen from mixing with the water. Therefore, the low oxygen level in the water will affect the aquatic ecosystem.

To overcome this issue and to save human as well as aquatic life this design of remote-controlled operated floating waste collector is proposed. The existing framework is designed to decrease the number of workers and to make clean Bangladesh. This robot can be placed in ponds, rivers, lakes, etc. to remove all the wastes like plastics, bottles, wrappers, polythene, etc. In this work, we utilized a simple conveyor mechanism and remote control to operate this robot. Therefore,the robot operator doesn't require much skill and it is user-friendly and economical.

II. LITERATURE REVIEW

A lot of works have been done in the region of collecting floating waste material from the drainage, ponds, lakes, etc. A machine has been introduced that can clean the drainage without workers and also prevent blockage in the drain [1]. Their research work is solely focused on solid waste material. The machine collects the waste automatically and dumps it into the collecting tank or dustbin. They worked to clean the garbage material only for drainage purposes whereas we focused to clean waste materials from rivers, lakes, ponds, drainage, etc. A framework has been proposed on bicycle mechanics in which the pedal mechanism is used to collect the waste material from the water surfaces[2]. They used a chain drive for transmitting the power to the propeller for the forward movement of the boat and also a conveyor for collecting the garbage into a box. Our mechanism is different from them. We have made our control circuit which is operated through a 2.4 GHz radio frequency remote control system.

A remote-controlled sewage cleaning machine has been introduced where they used two power window motors are connected to the wheel and it was driven with the help of the remote control set-up[3]. Their mechanism is similar to ours but they made their design only for the drainage system. A chain sprocket has been proposed where the researchers used chain and sprocket for the movement of the rim which was fitted fins to collect the wastes from the water surface [4]. Our proposed design is very user-friendly and economical than its systems. A river cleanup machine has been proposed where the water wheels of the machine are rotated by using hydropower and this converted the kinetic energy of the water into mechanical energy to drive the shaft to the conveyor system[5]. Their mechanism is completely different from ours. A plastic cleaning framework has been developed by utilizing a mobile application based Bluetooth control system to control the robot [6]. The scholars used a mechanical hand to push the waste material towards the conveyor belt. The robot could only clean the plastics from the water surfaces.

A pedal mechanism has been proposed for cleaning the waste material from the water bodies [7]. An operator has to control the pedal which is connected with the turbine and conveyor arrangement. They made their project especially for the plastics bottle whereas our robot can clean up any kinds of waste materials from the water surface.Some scholars introduced a framework where the machine is placed across a drain so that only water could flow through the lower basement [8]. They used lifters that were connected to the

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chain and by the use of a motor, the lifters lifted the waste materials from the water surface. Our proposed design is completely different from theirs. We used advanced automation in our project.

Considering all the shortcomings, we proposed a remote operated floating waste collector Robot that is capable of cleaning all kinds of wastes material and can be used in canals, rivers, ponds even in oceans.

III. Methodology

This area comprises the overall description of the hardware of the remote control operated Automatic Floating Waste Collector Robot system and details of the control circuit used in this project. It also discusses the mathematical terms or any other calculations involved in this project.

We started our work by taking some initial measurements and experiments on river water. At first, we tested the floating ability of various particles like plastic, wood, cork sheet, cellulose board, etc. We got the better result from the cork sheet but this was not stable. That is why we used the cellulose board on the cork sheet for getting more stability and productive result. We also attached two PVC pipes on both sides for having a better balance. We made a mechanical 3D design of our robot in Solid works which are shown in Fig. 1 and Fig. 2. Then we proceeded with the hardware implementation of our system. Making wheels for our system was not an easy task. At first, we made a plastic waterwheel but after some practical experiments, we realized that such kind of wheel was not efficient and viable for our system. Then we made two custom wheels with stainless steel blades and installed both sides of the boat, which was installed with two gear motors. After completing the wheel task, we focused on the waste grabbing system. We made a waste grabber with a thin conveyor belt, which was controlled through a DC gear motor. After completing the hardware design, we designed our control circuit which was operated through a 2.4 GHz Radio Frequency remote control system. We attached the control circuit with the proper water protection system and made our test run in the river.

A. Mechanical Drawing

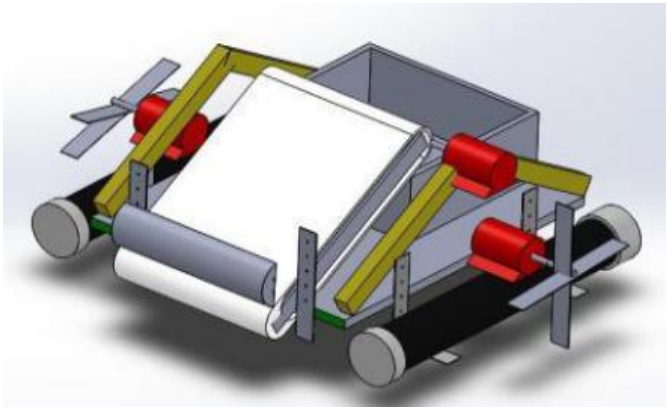

Fig. 1: 3D Design of the Robot front view (designed in SolidWorks)

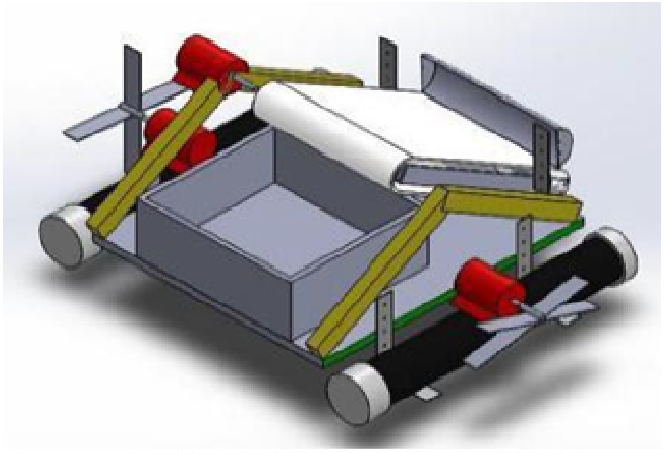

Fig. 2: 3D Design of the Robot back view(designed in SolidWorks)

B. Block Diagram

As depicted in Fig. 3, the signal from the remote will go to the receiver, the signal from the receiver will be passed to the Arduino and this Arduino will control the motor. Arduino and two motor drivers interface with power supply. Arduino will control all three motors through the motor driver. A motor driver will control two motors, which are the left and right wheel. The other motor driver will drive a motor that controls the conveyor belt arrangement.

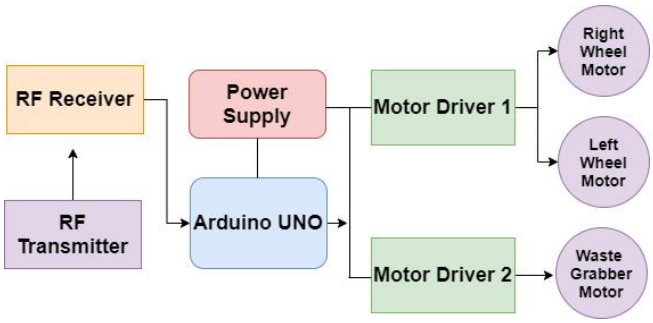

Fig. 3: Block diagram of the System

C. Schematic Diagram

The schematic shown in Fig. 4, where there is a RC receiver, three gear motor and two motor drivers. The central microcontroller Arduino which is powered with a lipo battery.

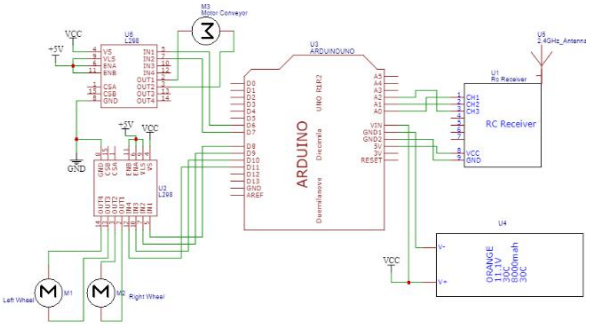

Fig. 4: Schematic Diagram of the system

D. *Flow Chart*

The Process will be started by initializing 2.4 GHz radio communication between transmitter and receiver. We connect the receiver to the power supply and binding between transmitter and receiver. we shorted the receiver signal pin and ground pin with each other and the transmitter switched hold on to connect with the receiver. Transmitter sends the signal to the receiver, if the signal is received it will go to the next step and if this signal is not received it will go to the previous process. If the signal is received transmitter sends analog data in Arduino. Arduino converts analog to digital data and generates Pulse Width Modulation (PWM). PWM is used for run motor drivers and these motor drivers control all motors. Transmitter signal again transferred signal in the receiver and continues this process smoothly which is shown in Fig. 5.

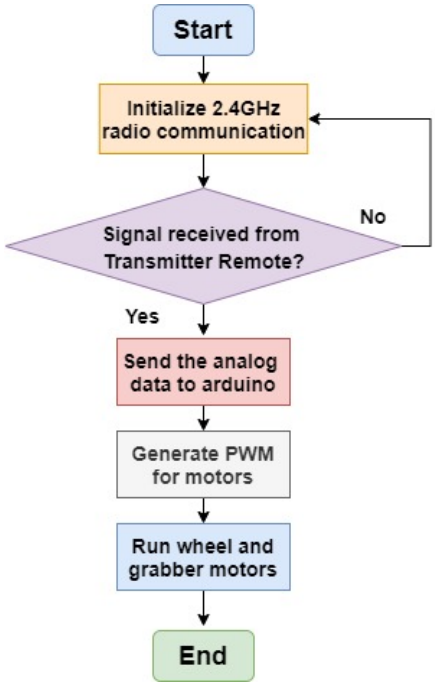

Fig. 5: Controlling Flow chart of the system

IV. System Implementation

In this proposed framework, our basic material was DC gear motor, remote, Motor driver, microcontroller, lipo battery etc. For the planning and control unit, we utilized the microcontroller Arduino UNO. The implemented mechanical set-up of our robot and working procedure is shown in Fig. 6 and Fig. 7.

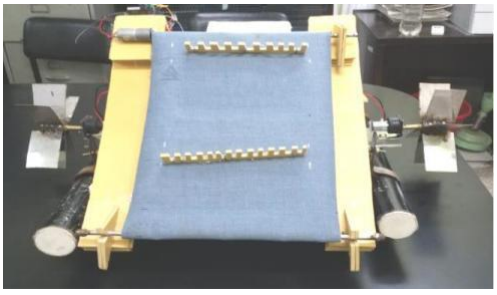

Fig. 6: Front view of Robot

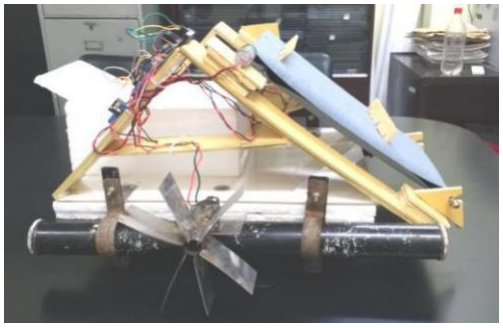

Fig. 7: Side view of Robot

We used a 2.4 GHz three channel RC remote to control the waste collector which is shown in Fig. 8.

Fig. 8: RC 3 channel remote for controlling the waste collector

E. *Waste collecting steps of our robot*

Fig. 9: Floating waste-collecting mechanism of the Robot

Step 1 (Sending Signal From Remote):

Operating signal will given from the RC remote which will be in hand of the operator of waste collector.

Step 2 (Movement of Robot):

After receiving the forward signal from remote right side gear motor will rotate counterclockwise and left side motor clockwise. For reverse right motor will rotate cw and left one ccw. To move right only left motor will rotate ccw and for moving left right motor rotates ccw.

Step 3 (Grabber Conveyor Motor Run):

When the receiver will receive waste grabbing signal from remote, the third gear motor rotater including the conveyor mechanism. The teeth of the conveyors collects the waste and drop in the bucket shown in Fig. 9.

F. *Component Specification*

As we have limited funds, we tried to make this project as light as possible. In Table I, our designed specifications has been shown.

TABLE I. DESIGNED SPECIFICATIONS

PVC Pipe	2.5cm X 5cm X 2ft.
Plywood	5mm X 1ft.6.5inch X 3inch.
Cellulose board	1ft.8inch X 1ft. 6.5 inch X 3inch.
Conveyor belt	32 inch round
Hub	3cm
Blade	.5mm X 4inch X 2inch
Battery Life	4.5 hours
Control System	Manual
Bodyweight (Unloaded)	3.2kg
Weight collected (Robot)	5.2kg
Maximum body weight (Loaded)	8.5kg

Our proposed system weight is 3.2kg which can withstand a total load of 8.5kg. The conveyor belt itself can pick up 550grm of floating waste materials from the water in every cycle of rotation. The Robot can work for 4.5 hours at a stretch without the necessity of charging.

G. *Cost Estimation:*

We have tried to do this project at a very low cost shown in Table II, because we want this project to make our day-to-day work easier and everyone can buy it at a reasonable cost.

TABLE II. MATERIALS AND INSTRUMENT COSTING

Name of Matt.	No.	Unit Price (USD)	Subtotal Price (USD)
Arduino Uno	1	6	6
Motor Driver	2	2	4
DC Gear Motor	3	8	24
Remote(2.4GHz)	1	35	35
Li-po Battery	1	12	12
Propeller	2	3	6
Conveyor Belt	1	6	6
Wiring, circuitry, and insulation		5	5
Hardware Components (screws, bearings, etc)		15	15
Miscellaneous		5	5
Total			118 $

Thus the estimated amount of 118 USD which is 10,000 BDT approximately can be utilized for cleaning 100 square meters of waste materials filled region. In this case, a single robot would be able to clean around 2 square kilometers area of the water body at each run. Another unique advantage of utilizing the robot is savings on human-hours. Only one to two operators are sufficient enough per robot and thus it reduces the need for the bounty of human resources employment in water-body cleaning projects.

V. CONCLUSION AND FUTURE SCOPE

Modern services are becoming polarized. With the rise of increasingly automatic terminal services, modern services are also gradually becoming automated. Therefore, in this research work, we adopted a modern strategy an automatic identification process of removing floating waste from the water surfaces. In such a case, our result is exceptionally viable when the proposed methods are utilized. As the human direct intervention into the sewage, It will help to decrease the spread of diseases. This system is time-saving, portable, affordable, consumes less power, and can be made easily available so that this system can be used whenever and wherever.

Some future scopes of this venture are:

- We can use an advanced conveyor system and conveyor materials for increasing the productivity of the collection of waste.
- We can use a solar panel for providing the power to the boat instead of a battery.

ACKNOWLEDGMENT

In the beginning, we announce that we are very thankful for the all-mighty and I would like to thank all the responded people who supported us to enable us to complete this work.

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