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Solar-Based Water Surface Cleaning Boat

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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 water cleanliness is a very important aspect of life to survive on earth. But, the by-products 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 project aims at the design and development of an ESP32 Cam-controlled surface water trash cleaning semi-autonomous boat with a robotic arm.*

Keywords: Solar Water Cleaning Boat

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 which means it can dissolve most substances including toxic materials from factories, sewage, chemicals, etc. Because of this, water is completely polluted by human activities. The major problem living organisms face is water pollution, which means introducing 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. Indian rivers like Ganga contribute over 40% of water for the Indian population across 11 states, serving an estimated population of 500 million people which is very high compared to any other river in India, but it was ranked second most polluted river in the world in 2017. The government had undertaken a project called the 'Namami Gange program' in 2014 with a budget of around 20,000 crores to clean the holy river, Ganga. Similarly, there are a lot of problems regarding water pollution under the Godavari River, which affects human life and the 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., in 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 fish 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 SURVEY

This section describes the previous work of water cleaning boats based on different technology designs 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 have 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, the movement of the shipwas not smooth, and no control over the collection of garbage. [6] introduced a new concept of flexibility in the

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crawling mechanism in designing an industrial underwater cleaning boat, which can work underwater, scan thedesired surface, and record biological reactions. The system design was limited to clean bio-fouled 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 are involved in the design, there is no automatic control over 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 in the tray provided. But the system was not automated to detect the trash. Soumya et al. [9] proposed a "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 the automatic detection of garbage and guiding 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.

III. COMPONENTS

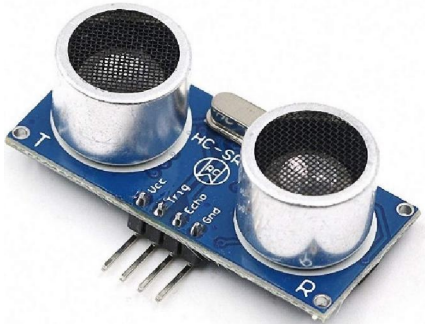
The hardware of the system is based on the Arduino Uno platform. Two Arduino Uno boards are employed: one for controlling the wheels of the boat & taking input from the sensors; another for controlling the robotic arm. The hardware requirements are discussed in the following section.

3.1 Microcontroller (ESP32 CAM)

The world has been revolving around IoTs i.e., the Internet of Things for quite a while now. From hobbyists to innovators, everyone is interested in Smart technology, designing different prototypes and products, and launching them in the market. ESP32 Series chips are one of the popular intelligent modules for IoTs. ESP32-CAM AI-Thinker is the advanced version of ESP8266-01 launched by Espressif with many features. The ultra-small, low-power module comes with two high-performance 32-bit LX6 CPUs with a 7-stage pipeline architecture.

3.2 Ultrasonic Sensor

An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound (i.e. the sound that humans can hear). Ultrasonic sensors have two main components: the transmitter, which emits the sound using piezoelectric crystals, and the receiver, which encounters the sound after it has traveled to and from the target. To calculate the distance between the sensor and the object, the sensor measures the time it takes between the emission of the sound by the transmitter to its contact with the receiver. The formula for this calculation is D = ½ T x C (where D is the distance, T is the time, and C is the speed of sound ~ 343 meters/second



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3.3 DC Motor

A DC motor or direct current motor is an electrical machine that transforms electrical energy into mechanical energy by creating a magnetic field that is powered by direct current. When a DC motor is powered, a magnetic field is created in its stator. The field attracts and repels magnets on the rotor; this causes the rotor to rotate. To keep the rotor continually rotating, the commutator that is attached to the brushes is connected to the power source supply current to the motors wire windings. One of the reasons DC motors are preferred over other types of motors is their ability to precision control their speed, which is a necessity for industrial machinery. DC motors can immediately start, stop, and reverse—an essential factor for controlling the operation of production equipment.

3.4 Solar Panel

A solar cell panel, solar electric panel, or solar panel, also known as a photo-voltaic module or PV panel, assembles photovoltaic solar cells mounted in a frame. When the sun shines onto a solar panel, energy from the sunlight is absorbed by the PV cells in the panel. This energy creates electrical charges that move in response to an internal electric field in the cell, causing electricity to flow.

3.5 Robotic Arm

It is equipped with DC motors. Depending on the given instructions, the arm adjusts in particular directions, picks up the trash, and dumps it into the dumping space.

3.6 Arduino IDE Compiler

It is an open-source integrated development environment (IDE); that allows users to program compatible boards. In the proposed work Arduino boards are programmed using Arduino IDE to read the sensor inputs & control the wheels and robotic arm

IV. WORKING

4.1 Design and build the boat:

The first step is to design and build the boat itself. This should include a hull, a solar panel array to power the boat, a propulsion system consisting of propellers, an arm to carry waste, and an obstacle detection sensor. The size of the boat will depend on the scale of the project, but it should be large enough to carry the necessary equipment and waste.

4.2 Install the ESP32-CAM module

Once the boat is constructed, install the ESP32-CAM module. This module can be used to control the boat's motor driver IC and the obstacle detection sensor. The module can be connected to the boat's battery and the motor driver IC.

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4.3 Install the motor driver IC:

The motor driver IC can be connected to the boat's propellers. The ESP32-CAM module can be programmed to control the speed and direction of the boat's propellers using the motor driver IC.

4.4 Install the arm

The arm on the boat should be designed to carry waste and deposit it into a storage area on the boat. It can be controlled by a separate motor and controller, or it can be manually operated. Ensure that the arm is securely attached to the boat and that it can reach all areas of the water that need to be cleaned.

4.5 Install the solar panel array

The solar panel array should be installed on top of the boat, facing toward the sun. It should be connected to the boat's battery to provide power to the ESP32-CAM module and the arm. Depending on the size of the solar panels and the battery, the boat may be able to operate for several hours without needing to be recharged.

4.6 Install the obstacle detection sensor

The obstacle detection sensor can be connected to the ESP32-CAM module. The module can be programmed to detect obstacles and stop the boat when necessary using the sensor.

4.7 Test the boat

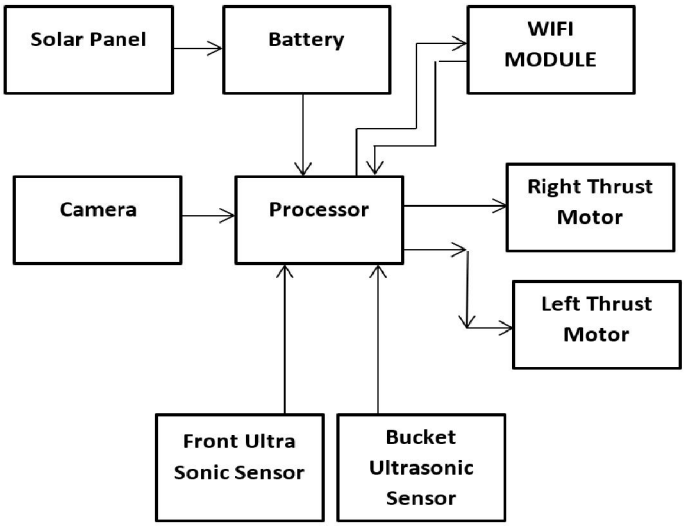
Before deploying the boat to clean the water, test it in a controlled environment. Make sure that the propellers, arm, and obstacle detection sensor are working correctly and that the boat can maneuver in the water. Test the boat's speed and power consumption to ensure that it can operate efficiently.

4.8 Deploy the boat

Once the boat has been tested and is working correctly, deploy it to clean the water. The arm can be used to collect waste, and the propellers can be used to maneuver the boat to different areas. The ESP32-CAM module can be used to control the boat's movements and monitor its performance. Make sure to follow all safety guidelines when operating the boat, and dispose of waste properly once it has been collected.

Overall, a solar water cleaning boat with an AL293D IC and an arm to carry waste is an innovative solution to help keep our waterways clean. With proper design and construction, this type of boat can be a sustainable and effective tool for removing waste from our oceans, lakes, and rivers.

V. BLOCK DIAGRAM



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VI. PROCESS FLOW

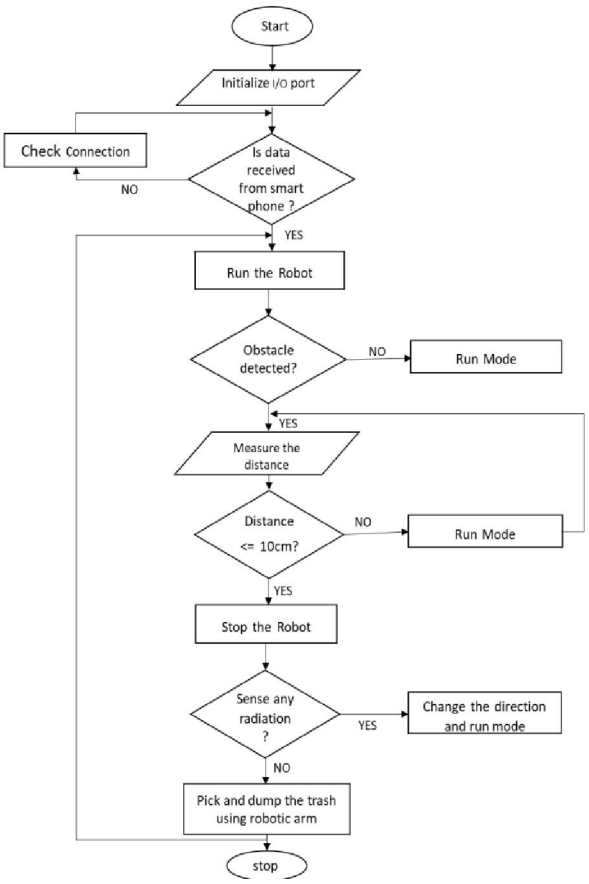

Figure 1: Flowchart of Water Boat

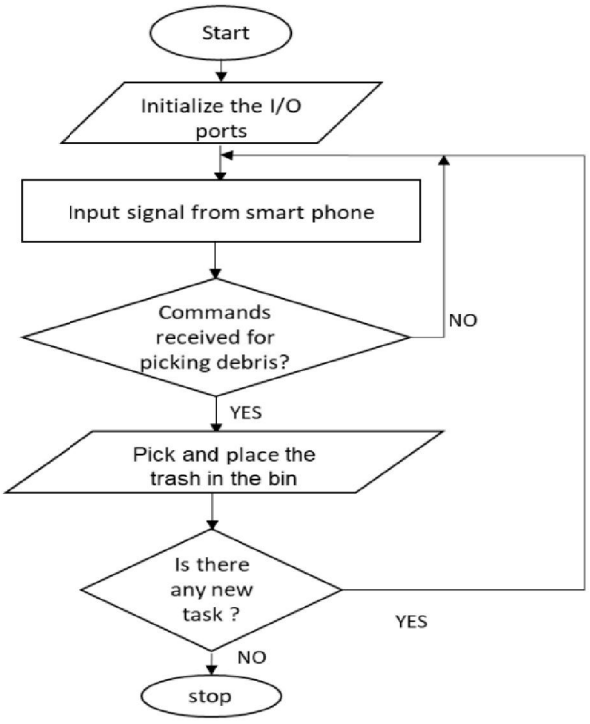

Figure 2: Flowchart of the Robotic Arm

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VII. APPLICATION

- To reduce water pollution in rivers, ponds, and other water bodies
- Industrial waste management.
- Eco-friendly.
- Cost-effective.
- Real-time monitoring.
- Aquaculture.

VIII. ADVANTAGE

- Environmentally friendly system.
- Reduces threat to human life.
- It is compact, portable, and highly efficient.
- It is a non-conventional river clean-up system.
- Working principle quite easy

IX. FUTURE SCOPE

In the future, we can expect to see an increase in the use of solar water-cleaning boats for water management and pollution control. With advancements in technology, these boats will become more efficient and effective at removing pollutants from water sources.

Furthermore, solar water cleaning boats can be used for a variety of purposes, such as cleaning up oil spills, removing debris from waterways, and monitoring water quality. As such, they will become an essential tool for environmental agencies, municipalities, and private companies that want to keep our waterways clean and healthy

Finally, the market for solar water cleaning boats is likely to grow significantly in the coming years, as more and more organizations become aware of their benefits. As a result, we can expect to see more investment in the research and development of these boats, leading to further improvements in their design and functionality.

X. RESULT

The three motors will be used to control the boat, i.e. the navigation of the boat through mobile. The Boat will be connected through a WIFI module. The boat will be a web server. The IP address of the boat has to be given to the web browser. The Control will be displayed on the web browser. With control on the web page, the boat will be controlled. The garbage on surface water can be cleaned with the help of a mobile.

XI. CONCLUSION

The design and development of a real-time robotic system based on ESP32 Cam for surface trash collection in water bodies are presented in this project. The proposed work utilizes a sensor mechanism to detect and collect garbage. Project results indicate that the proposed low-cost Swachh robot will be a potential alternative for surface water trash collection to preserve the quality of water & aquatic life with minimum human efforts. The future work of the authors is focused on employing machine learning and the Internet of Things (IoT) so that the system will be completely autonomous and operated remotely

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