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Solar Based Water Body Cleaning Robot

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Abstract: In recent years, the problem of water pollution has become increasingly critical, affecting ecosystems, wildlife, and human health. Rivers, as vital freshwater resources, often suffer from litter and waste that accumulate, leading to harmful consequences. Assessment of water quality over the years revealed that in the year 2015, 70% of rivers monitored (275 out of 390) were identified as polluted whereas, in the year 2022, only 46% of rivers monitored (279 out of 603) are identified as polluted. This solar-powered, Arduino-controlled cleaning robot represents a sustainable and scalable approach to addressing water pollution, with the potential for large-scale deployment in both urban and rural water bodies. The feasibility, performance, and potential impact of the robot are evaluated, with suggestions for future improvements to increase its efficiency and adaptability.

Index Terms - Solar power, Arduino, pH sensor, Ultrasonic sensor.

I. INTRODUCTION

In many Indian towns today, environmental issues stem from development activities, such as the construction of homes, offices, and commercial areas. These challenges arise due to various factors, including inadequate funding for environmental management and a lack of public interest in protecting the environment. One recurring and unresolved issue is the disposal of garbage and waste into rivers from multiple sources. This waste can block water flow, contaminate the water, create unpleasant odors, and sometimes lead to floods due to overflow. Traditional methods of collecting floating trash, such as using human labor, waste collection boats, and trash skimmers, are not only complicated but also costly. Additionally, handling chemical waste presents a significant health risk to workers, often leading to respiratory problems. While automation has been implemented in many industries, applying it to clean sewage and trash in rivers remains a considerable challenge. Municipal workers often have to enter sewage sludge, which puts their health at risk and can cause skin conditions. The "River tidy up machine" utilized in that places where there might be waste garbage in the water outline that will be removed. This machine comprises of L298N engine pushed arm components which gathers and dispose of the wastage, garbage and plastic wastages from water bodies. This also diminish the issues which we are confronting when accumulation of waste materials and unwanted materials happen. A device will convey the waste surface particles from the water bodies, this could be toward the end it will realize reduction of water contamination and eventually the oceanic creature's demise to these issues can be diminished. It incorporates electrical component which lifts the waste materials and unwanted particles from the Water and gathers the loss in a container outfitted in Robot.

II. LITERATURE SURVEY

[1] M. Mohamed Idhris, M. Elamparthi, C. Manoj Kumar Dr.N. Nithyavathy, Mr. K. Suganeswaran, Mr. S. Arun kumar, Design And Fabrication of Remote-Controlled Sewage Cleaning Machine [2021] The paper gives the idea about the working and positioning of various components in the machine. In the proposed system, the machine is operated using a remote control to take waste. Therefore, the system avoids the

harmful impacts from the sewage waste and gases. When the system is ON wiper motor that starts running. The two power window motors are connected to the wheel, and it is operated with the help of the remote-control setup. The system collects the sewage wastes by using the arm and put it into waste bin fixed in the machine. The set-up runs in the sewage area with water, so it collects the floating waste. The waste which affects the drainage is also taken and removed. This system has less human intervention in cleaning process and in turn reduces wide spreading of diseases.

[2] Basant Rai Pollution and Conservation of ganga river In modern India [2022] This study helps the successful analysis of pollution level in various rivers in India especially Ganga river and identification of various pollutants and debris presentin river. Considering the World Bank Sponsored Study regarding various pollution level in the rivers in India (State of Environment Report - U.P.) (In: Mallikarjun, 2003), pollution levels in the Ganga River is contributing about 10- 12% of total disease burden in Uttar Pradesh. The level of coliform bacteria present in the water is very high and are in excess of 2 lakh MPN while considering against the national water quality standard of 5000 (Mallikarjun, 2003). The report estimated total health damage caused by water pollution in up to is around 6.4 million dailies (Disability Adjusted Life Year).

[3] Osiany Nurlansa, Dewi Anisa Istiqomah, and Mahendra Astu Sanggha Pawitra AGATOR (Automatic Garbage Collector) as Automatic Garbage Collector Robot Model [2019] The research paper provides a detailed view about the automation process. The research is done to design and make AGATOR (Automatic Garbage Collector), which is a rotor robot model to make it as a automatic garbage collector to counter accumulation of waste in the river which has no flow efficiently. The method of implementation is construction and design. This method includes the identification of needs, analysis of the components required specifically, software engineering, hardware, developing, and testing.

III. RESEARCH METHODOLOGY

The solar-powered water body cleaning robot is designed to autonomously clean floating debris, such as plastic waste, leaves, and other pollutants, from water bodies like rivers, lakes, and ponds. The robot operates using solar energy, ensuring an eco-friendly solution to water pollution. The methodology includes the design, operation, and control strategies that enable the robot to clean water efficiently.

The robot's core system is powered by solar panels that convert sunlight into electrical energy. A 12V solar panel array is used to generate sufficient power for the robot’s operation. The generated energy is stored in a 12V rechargeable battery, typically a lithium-ion or lead-acid battery, which powers the robot when solar energy is insufficient (such as on cloudy days or at night). A charge controller is integrated to regulate the charging process, preventing overcharging and ensuring the battery's longevity.

For mobility and navigation, the robot is equipped with servo motors. Continuous rotation servo motors drive the propulsion system, which moves the robot across the water surface. Additionally, steering servo motors control the direction of movement, allowing the robot to navigate around obstacles and follow a defined path. The robot can either follow a pre-programmed cleaning route or respond to real-time data collected from its sensors.

To collect floating waste, the robot is equipped with a waste collection mechanism, typically a waterwheel , which is powered by servo motors. The waterwheel or skimmer collects floating debris as the robot moves across the water. In addition, a mechanical arm or scoop is used to lift larger debris from the water, transporting it to an onboard storage area for disposal. The mechanical arm is also controlled by servo motors, enabling precise movements for efficient waste collection.

Sensors play a critical role in the robot’s functionality. Ultrasonic sensors are used to detect obstacles in the robot's path, allowing it to avoid collisions with rocks, branches, or other objects.pH sensors monitor the levels of pollution in the water, enabling the robot to prioritize areas with higher contamination for more intensive cleaning.

The robot operates autonomously, using the solar panels to continuously charge the battery and power its systems. During operation, the servo motors control the movement of the robot, directing it across the water surface and allowing it to clean designated areas. The waste collection mechanism, consisting of the waterwheel or skimmer and mechanical arm, gathers floating debris while avoiding obstacles detected by the ultrasonic sensors. The water quality sensors provide real-time feedback on the cleanliness of the water, guiding the robot to areas that require more attention.

The control system of the robot is managed by a Arduino, which processes data from the sensors and controls the motors. The microcontroller manages the robot's movement, adjusts the cleaning mechanisms based on sensor inputs, and monitors the battery's charge level to optimize energy consumption. The charge controller ensures that the battery is charged appropriately, preventing overcharging and maximizing the robot’s operational time.

The robot's operation is divided into several phases. Initially, it is deployed into the water body, where the solar panels are positioned for optimal sunlight exposure. The robot begins cleaning by following a predefined route or by responding to its sensors. During the cleaning process, the robot collects waste, navigates around obstacles, and adapts its behavior based on water quality readings. As the robot operates, it uses energy from the solar panels and stored energy in the battery. If sunlight is insufficient, the battery takes over to ensure continuous operation. Once the task is completed or the battery runs low, the robot returns to a docking station for recharging and waste disposal.

Data collected during the cleaning process, such as water quality measurements and the amount of debris collected, is stored for performance evaluation. This data helps assess the efficiency of the robot's cleaning process and allows for adjustments in the robot’s behavior to improve future performance. The robot’s energy consumption is also monitored, ensuring that it operates within optimal power limits and minimizing energy waste.

The solar-powered water body cleaning robot offers a sustainable solution to the growing problem of water pollution. By utilizing renewable solar energy, it operates autonomously with minimal human intervention. The precise control of movement and waste collection using servo motors, coupled with real-time data from sensors, allows for efficient and effective cleaning of water bodies. The methodology outlined here demonstrates how the robot's design and operation can help reduce pollution in aquatic ecosystems, contributing to environmental sustainability.

IV. SYSTEM COMPONENTS

A. SOLAR PANEL

Fig.1: Solar Panel

A **solar panel** is designed to generate 12 volts of direct current (D C) electrical power when exposed to sunlight. It typically consists of multiple solar cells connected in series to achieve the desired voltage output. These panels are commonly used for small-scale solar energy systems, such as powering off-grid devices, lighting, or charging batteries. The current (in amperes) generated by the solar panel depends on its wattage and voltage. For instance, a 12V, 50W panel will produce approximately 4.17 amps (50W ÷ 12V = 4.17A).

B. ULTRASONIC SENSOR

Fig. 2: Ultrasonic sensor

Ultrasonic sensor is a non-contact distance measurement module, which is also compatible with electronic brick. It's designed for easy modular project usage with industrial performance. An ultrasonic sensor 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). The ultrasonic sensor works on the principle of SONAR and RADAR system which is used to determine the distance to an object.

C. DC MOTOR

Fig.3: DC Motor

The DC Motor used here is a gear DC Motor. A gear DC Motor is a combination of a motor and gearbox. The important parameter of the gear DC Motor are speed in rpm, in this model the DC motor has 30 rpm speed, torque and efficiency.

D. L298N MOTOR DRIVER

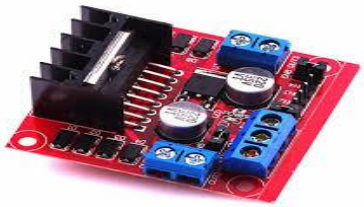


Fig.4: L298N motor driver

Motor driver is used to split the power that is given to the motors for their successive rotation. A huge amount of supply is given to the Driver IC which is further separated into small amount of supply and given to motors. When the motors are directly given a supply from the power source there is high chance of the circuit being malfunctioned or the end system will become short circuited. As the total system will be left troubled. To find a result for these type of power issues, Driver IC can run both in forward and backward direction which enables the motor to be run in every possible direction that are in need. Here the input voltage is given evenly to two motors. Driver IC has several configurations. Driver IC has Enable which acts as a switch making in On and OFF. The input and output terminals that are used as basic input and output terminals.

E. SERVO MOTOR

Fig.5: Servo Motor

A **servo motor** is a type of motor that is commonly used in applications that require precise control of angular position, velocity, and acceleration. It is an essential component in many mechanical systems, particularly in robotics, automation, and control systems.servo motors are controlled by Pulse Width Modulation (PWM). The length of the pulse sent to the motor determines the position it should move to. For example, a longer pulse might make the motor move to one extreme (e.g., 180 degrees), while a shorter pulse moves it to the other extreme.

F. LCD Display

Fig.6: LCD Board

+The full form of LCD is **Liquid Crystal Display.** it is a passive device, which means that it does not deliver any

light to display characters, animations, videos, etc. LCD uses fluorescent tubes to lighten the picture, but can't

provide a clearer picture as LED delivers.

G. pH sensor:

A pH sensor is an electronic device used to measure the acidity or alkalinity of a solution. It works by detecting

the concentration of hydrogen ions (H^+) in the solution, which determines the pH level. The pH scale typically ranges

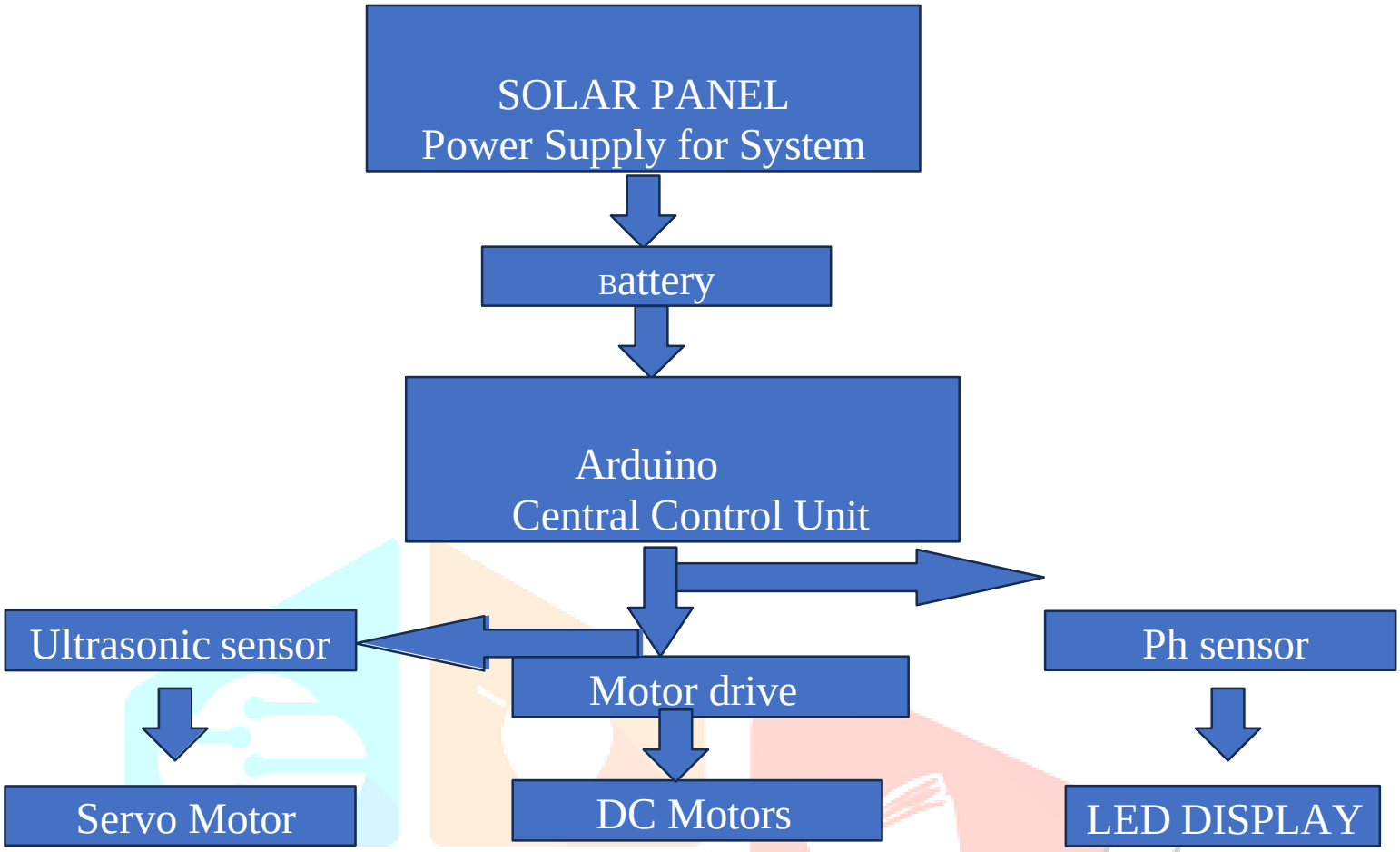
from 0 to 14:

pH 7: Neutral (e.g., pure water)

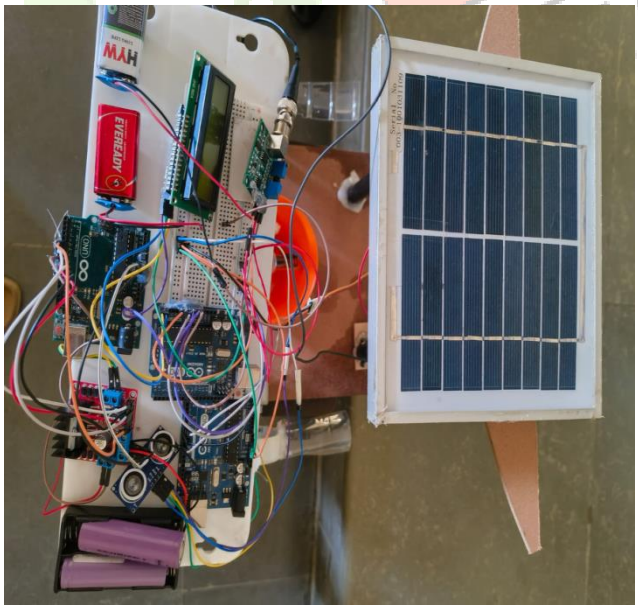
pH < 7: Acidic (higher concentration of hydrogen ions)

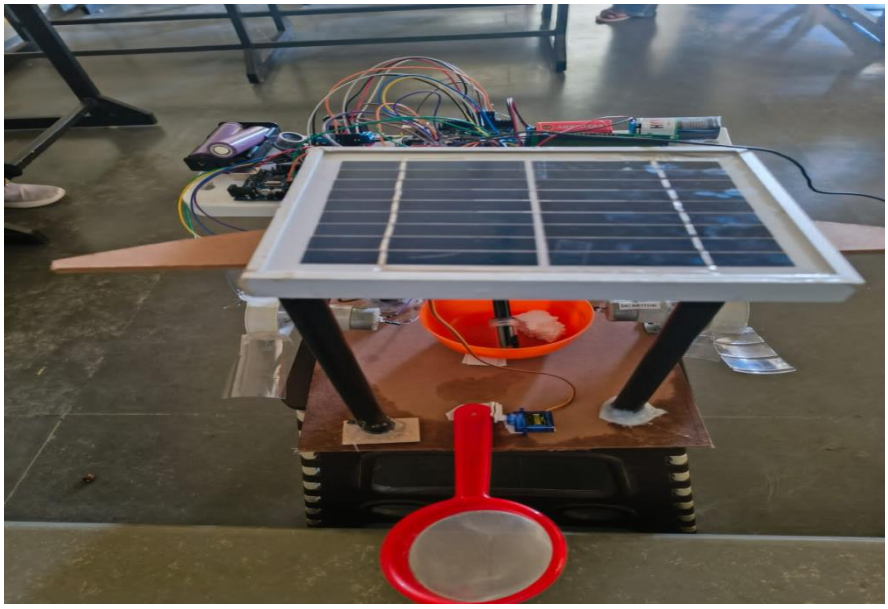
pH > 7: Alkaline (lower concentration of hydrogen ions).

V. BLOCK DIADRAM



VI. RESULT





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