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A MINI PROJECT REPORT
On

"SOLAR POWERED WATER TRASH COLLECTOR"

Submitted in partial fulfillment of the requirements for the award of the degree of

BACHELOR OF ENGINEERING IN

ELECTRONICS AND COMMUNICATION ENGINEERING

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CERTIFICATE

This is to certify that the mini project work entitled **" SOLAR POWERED WATER TRASH COLLECTOR"** carried out by bonafide of DBIT students **AMULYA S GUPTA (1DB22EC013)**, **MYTHRI C (1DBB22EC099)**, **RACHANA S M (1DB22EC121)** and **RAHUL MALVIYA D (1DB22EC126)** studying in Fifth semester, in partial fulfilment for the award of degree of Bachelor of Engineering in Electronics and Communication Engineering, Visvesvaraya Technological University, Belagavi for the academic year 2024-2025. It is certified that all corrections/suggestions indicated during mini project work have been incorporated in the report deposited in the department library. The mini project has been approved as it satisfies the academic requirement in respect of the project work described for the partial fulfilment of said degree.

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ABSTRACT

The poisoning of water sources and rivers by solid waste is a serious problem all over the world. Waste, such as plastics, chemicals, and other non-biodegradable items, can end up in rivers if they are not disposed of properly. The improper disposal of hazardous waste, such as batteries and electrical equipment, releases toxic compounds into the environment. Reduced water quality, destroyed aquatic ecosystems, and damage to aquatic animals are some of the undesirable effects that can result from solid waste contamination. In addition, it also has an effect on human health since polluted water can lead to the spread of waterborne diseases. Due to rapid economic growth, overpopulation, inadequate urban planning, and a catastrophe, the world is currently facing a major garbage crisis. This article's purpose is to introduce a solar-powered garbage collector to bodies of water. The world is currently facing a major garbage crisis. This article introduces a solar- powered garbage collector for bodies of water. Our battery-operated, autonomously floating, solar-powered system cleans the water surface. The primary goal is to collect the solid wastes from water bodies, minimize the amount of labor and time necessary to clear the river, and remove the solid objects that pollute the water.

KEYWORDS: Water body, Solar, Trash Collector

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

Water pollution is one of the most pressing environmental issues of our time, posing significant threats to aquatic ecosystems, human health, and biodiversity. Rivers, lakes, and other water bodies are often plagued by floating debris, plastic waste, and other pollutants, which accumulate over time and degrade the quality of the water. With increasing industrialization, urbanization, and population growth, the volume of waste entering water bodies has risen dramatically, making it critical to develop sustainable and effective solutions for cleaning them. Traditional river cleaning methods, which often involve manual labor or fuel-powered boats, are not only inefficient but also contribute to further environmental degradation through carbon emissions and resource consumption.

To address this challenge, we present a Solar-Powered River Cleaner—an innovative and eco-friendly solution designed to clean floating debris and waste from rivers and lakes using renewable energy. This project harnesses the power of the sun through solar panels to drive an automated waste collection system. The collected energy is stored in rechargeable batteries, which power various components, including DC motors and a conveyor belt mechanism. The system is designed to operate autonomously, reducing the need for manual intervention, and minimizing operational costs.

This project is inspired by global efforts to combat plastic waste and preserve aquatic ecosystems, such as India's National Mission for Clean Ganga (NMCG) and Swachh Bharat Abhiyan. These programs emphasize the importance of clean water bodies and advocate for the adoption of innovative technologies to achieve environmental sustainability. By leveraging solar energy, this project not only addresses the problem of water pollution but also aligns with the broader goals of reducing carbon emissions and promoting the use of renewable energy sources.

In addition to its environmental benefits, the Solar-Powered River Cleaner has the potential to raise public awareness about the importance of waste management and sustainable practices. It serves as a scalable solution that can be adapted for use in various water bodies, ranging from small lakes to large rivers. With further optimization and IoT integration, the system can be enhanced to include real-time monitoring and remote-control capabilities, making it an even more effective tool for environmental conservation.

1.1 Literature Survey

[1] Title: **"Amphibious Clean-up Robot"**

Author Name: Nan Pan, Lifeng Kan, Yajun Sun, Jinlun Dai

Published year:2017

In this paper authors have mentioned that at the both side of the robot they have installed the rotary agglomeration system consists of a left-handed agger and a right-handed agger. A right-hand rotating device and a left handed converts rotating the motor output shaft, turn the collector clockwise rotation, the right rotation of the collector rotation of the motor output shaft counterclockwise rotation to promote the right rotation of the collector clockwise rotation, while the robot in the water forward, the water hyacinth, garbage collection to the collection of the mouth to be collected to the collection system. The rotary collection system includes a rotary collector, a rotary collector motor, a rotary collector running trackwheel, a storage bin, a collecting motor when the water hyacinth garbage gathered to the collector in the collection of motor driven, the water hyacinth garbage rotation collected into the storage warehouse.

[2] Title: **"A Floating Waste Scooper Robot on Water Surface"**

Author name: Niramon, Jakkrit Sumroengrit, Monthian Leanglum

Published date:2017

The floating waste scooper is designed and developed for replacing labor cleaning waste on city canal, pond, or pool. The robot is a ship made of two pontoons fixing together leaving free space in the middle for the front scooper, waste container and paddle wheels in this project. They have used green plastic net in the place of rubber belt. Because itis lighter and generates smaller amplitude of surface wave. They have selected the double paddle wheels and rudder for driving speed and direction control mechanism. The paddle wheels are mounted next to each other on the same shaft between the pontoons, whereas the rudder is mounted behind the paddle wheels. The paddle wheels are driven by a 250W, 400RPM.DC brushless motor.Inthis system the driving speed of robot is adjustable in both forward and backward direction by rotating speed of the paddle wheels. When approaching waste near to the robot at that time they reduce the speed of paddle wheels in order to reduce generated wave that cause waste flowing away. For turning left and right in this robot they have used rudder. By adjusting the angle of rudder with respect to the robot body the direction change. The rudder is driven by stepping motor with gearbox. In these two types of mechanism are used for waste collection one is a flight conveyor and the other is a scooping arm with basket. The flight conveyor is often used in the literature whereas the scooping arm is one DOF robot arm. Both of them can overcome waste surface tension as material is net.

[3] Title: **"Design and Fabrication of River Cleaning Machine"**

Author name: Sheikh Md Shahid Md Rafique, Dr. Akash Langde

Published date:2017

Mohammad Irshad and his team have fabricated the mechanical based river cleaning machine which is a stationary system. This system consisting a bicycle wheel with eight numbers of aluminum buckets attached to its periphery is mounted on a shaft to make a turbine resembling a Pelton wheel. When flowing water falls on buckets, the wheel starts rotating. A spur gear called the driver also mounted on the turbine shaft begins to rotate. Due to the meshing of the driver with another spur gear mounted on a parallel shaft, power gets transmitted to the driven gear. The driven gear shaft also carries sprocket 1. Which drives sprockets, 2. Mounted on an intermediate shaft 3. Through a chain. Sprocket Amounted on shaft 3 carries the drive to sprocket B mounted on the main sprocket shaft 4 through a chain. On shaft 4 more sprockets C and D are mounted. Sprocket D drives another sprocket E through a chain. This chain carries meshed buckets meant for picking up the floating waste. This constitutes the inclined conveyor system. Sprockets C drives another sprockets E through a chain. The shaft of sprocket E also carries one bevel pinion. This enables the direction change through 90 degrees. A roller is mounted on the shaft of the second bevel pinon. This roller drives another roller through an endless conveyor belt. This constitutes the horizontal conveyor system. The waste falling from the inclined conveyor is carried away by the horizontal conveyor.

[4] Title: **"Design and Fabrication of River Waste Collector"**

Author Name: Mahto Ravindrabhai, Dehadray Vaibhav, Kaka Smit, Ankur Joshi

Published year:2018

The authors of this paper have fabricated the mechanical based river waste collector device. In project they have used different types of fins attached at both the side. Component which is running the project is chain and sprocket assembly and two rims, on the spokes of rims they have fixed curvature cross section due to which when rims are rotating on the surface of the river it pushes the water in opposite direction and boat moves in forward direction.. Servo motor is connected with 9-volt battery to pull the fins upward. The solid waste screening or skimming vessel is for collecting waste from flowing water ways by means of using different types of fins. The fins are connected with rod with the help of hook at outside of the boat. The flowing of water from fins collects the floating solid waste between fins all the wastes are transferred into last section by lifting the fins with the help of servo motor. Fins are hanging from one point and another point is connected with metal wire and metal wire is connected with servo motor and the servo motor is connected with 9-volt battery. This boat is run only by manually operator.

[5] Title: **"Detection and Removal of Floating Wastes on Water Bodies"**

Author name: Madhvi N. Wagh, Kashinath Munde

Published date:2018

In this paper authors explained how the wastage on water body is detected and removed. Their whole system works on two voltage levels, 5 and 12 Volt generated by voltage regulator. The Renesas microcontroller controls and co-ordinates the whole system. They have used ultrasonic sensor at certain distance from one another, these sensors detect the floating wastes by 180-degree range. They are placed on a pole and along the river. In their project they have used the infrared sensor for the prototype. If floating wastes are detected by the sensors, the signal will be sent to the authority via GSM. By using GPS, the location will be tracked by the authority. The floating barricades then come into action and remove the waste present. The barricades operate with the help of DC motor. They have also used the flow sensor to know the rate of flow of water.

1.2 Problem Statement

Water pollution, caused by the accumulation of plastic waste, floating debris, and other pollutants, poses a severe threat to aquatic ecosystems, human health, and biodiversity. Rivers and lakes, vital sources of freshwater and habitats for countless species, are increasingly becoming dumping grounds for solid waste due to unchecked industrialization, urbanization, and poor waste management practices. This not only deteriorates the quality of water but also disrupts the ecological balance and affects the livelihoods of communities dependent on these water bodies.

Traditional methods of cleaning rivers and lakes, such as manual waste removal or the use of fuel-powered boats, are labour-intensive, inefficient, and often costly. Additionally, these methods contribute to further environmental harm through carbon emissions and the use of non-renewable energy sources. The scale of water pollution demands a more sustainable, efficient, and technologically advanced solution that can address the issue without causing additional harm to the environment.

Despite significant global and national efforts, such as India's National Mission for Clean Ganga (NMCG) and the Swachh Bharat Abhiyan, the problem of floating waste remains inadequately addressed due to the lack of innovative and scalable technologies. Most existing solutions focus on large-scale water bodies or ocean clean-ups, leaving smaller rivers, lakes, and localized systems under-served. There is an urgent need for a cost-effective, automated system that can operate autonomously to clean floating debris in these smaller water bodies while utilizing renewable energy sources to minimize environmental impact.

The challenge lies in developing a system that is eco-friendly, efficient, and capable of operating in various water conditions. The solution must integrate automation to reduce dependency on manual intervention and should be scalable to adapt to different sizes and types of water bodies. Moreover, the system should be affordable and sustainable, leveraging renewable energy like solar power to align with global goals for reducing carbon footprints and promoting clean energy adoption.

In summary, the problem is twofold:

1. Environmental Impact: The growing volume of floating debris in water bodies continues to harm aquatic ecosystems and water quality.

2. Inefficiency of Existing Methods: Traditional cleaning methods are not only insufficient for addressing the scale of the problem but also contribute to environmental harm through energy consumption and emissions. Thus, there is a pressing need for a solar-powered, automated river cleaner that provides a sustainable and scalable solution to combat water pollution and preserve aquatic ecosystems effectively.

1.3 Motivation

Water is a vital resource for life, yet it is increasingly threatened by pollution caused by human activities. Rivers and lakes, which serve as essential freshwater sources, are being polluted by floating waste, plastic debris, and industrial discharge. The alarming rate at which this pollution is increasing has raised significant concerns about the health of aquatic ecosystems, water quality, and the impact on human communities dependent on these water bodies. The need for an innovative, efficient, and sustainable solution to combat this growing issue is more urgent than ever.

Traditional cleaning methods, such as manual removal of waste or fuel-powered boats, have proven to be inefficient, labour-intensive, and environmentally harmful. These methods not only fail to address the problem on a large scale but also contribute to further pollution through the use of non-renewable energy sources. Recognizing this gap, there is a strong motivation to design an automated system that not only solves the problem of water pollution but also operates sustainably, aligning with modern environmental goals.

Renewable energy, particularly solar power, offers a promising solution to this challenge. Solar energy is abundant, clean, and renewable, making it an ideal power source for systems aimed at environmental conservation. The integration of solar energy with automation technologies, such as Arduino-based control systems, provides an opportunity to create a self-sustaining, cost-effective, and efficient river cleaner. Global efforts, such as the United Nations' Sustainable Development Goals (SDGs) and national initiatives like India's National Mission for Clean Ganga (NMCG) and Swachh Bharat Abhiyan, emphasize the importance of protecting water resources and reducing environmental pollution. These programs have inspired the development of innovative technologies to tackle water pollution while promoting public awareness about the importance of sustainable practices.

The motivation for this project stems from the desire to contribute to these global and national initiatives by providing a scalable, automated, and eco-friendly solution to water pollution. A solar-powered river cleaner not only addresses the pressing issue of floating debris but also serves as a practical demonstration of how renewable energy and technology can work together to solve environmental problems. Furthermore, it provides an opportunity to raise public awareness about the critical importance of water conservation and the potential of sustainable technologies to drive positive change. By combining renewable energy, automation, and innovative engineering, this project aims to make a meaningful impact in preserving aquatic ecosystems and addressing the broader issue of environmental sustainability.

The motivation for creating a solar-powered water trash collector is rooted in the need for sustainable solutions to address the growing issue of water pollution. Water bodies around the world, such as rivers, lakes, and oceans, are becoming increasingly polluted with plastics, chemicals, and other debris, which not only harm aquatic life but also disrupt entire ecosystems and affect human populations relying on these water sources for drinking, fishing, and recreation.This reliance on solar power also ensures that the collectors can operate in remote or off-grid locations, where traditional energy sources may be inaccessible, offering an autonomous, cost-effective solution. Moreover, solar-powered water trash collectors are low-maintenance once installed, with minimal operational costs, making them economically viable in the long run. Their potential for scalability means that they can be adapted to clean both small ponds and expansive oceans, offering versatility across various ecosystems. By deploying such technology, communities and governments can actively contribute to restoring and preserving aquatic ecosystems, while also raising public awareness about the importance of keeping water bodies clean.

1.4 Objective

The primary objective of the Solar-Powered River Cleaner project is to address the pressing issue of water pollution in rivers and lakes by providing an innovative, sustainable, and automated solution. This project aims to utilize renewable energy and advanced technologies to create a system that is not only efficient but also eco-friendly and scalable for broader applications.

- **Develop a Solar-Powered Cleaning System:** Design and implement a river cleaner powered by solar energy to eliminate dependence on non-renewable resources, ensuring the system operates sustainably while reducing operational costs and carbon emissions.
- **Automate Waste Collection:** Create a system that automates the collection of floating debris and waste using an Arduino-controlled mechanism, reducing the need for manual intervention and improving operational efficiency.
- **Improve Water Quality:** Enhance the cleanliness and quality of rivers and lakes by removing plastic waste, floating debris, and other pollutants, contributing to healthier aquatic ecosystems.
- **Promote Renewable Energy Utilization:** Highlight the practical application of renewable energy sources, particularly solar power, to address environmental challenges and encourage the adoption of clean energy technologies.
- **Increase Efficiency and Scalability:** Develop a system optimized for energy efficiency and designed to handle varying sizes of water bodies, from small lakes to large rivers. Ensure scalability to expand its application to harbors, coastal areas, and urban waterways.
- **Support Environmental Initiatives:** Align the project with national and global efforts like India’s Swachh Bharat Abhiyan, National Mission for Clean Ganga (NMCG), and the United Nations’ Sustainable Development Goals (SDGs) to address pollution and promote sustainable development.
- **Raise Public Awareness:** Use the system as a tool to educate and inspire communities about the importance of water conservation, waste management, and the role of renewable energy in environmental protection. Encourage collective action to reduce pollution at its source.

- **Incorporate Advanced Technologies:** Lay the groundwork for integrating advanced features such as IoT-based sensors for real-time data collection, monitoring of waste levels, and remote operation, enhancing the system's functionality and user interaction.
- **Ensure Cost-Effectiveness:** Design the system to be affordable and easy to maintain, making it accessible for widespread adoption in both urban and rural areas.
- **Foster Environmental Conservation:** Contribute to the preservation of aquatic biodiversity by reducing pollution and creating a cleaner environment for aquatic life, thereby restoring the ecological balance of water bodies.
- **Explore Future Development Possibilities:** Encourage continuous improvements and innovations in the design and operation of the cleaner, such as more efficient waste separation, increased storage capacity, and integration with artificial intelligence for predictive maintenance.

This project seeks to provide a practical and impactful solution to the growing problem of water pollution, combining technology, renewable energy, and environmental conservation to create a cleaner and greener future. By addressing both the immediate need for waste removal and the broader goal of sustainability, the Solar-Powered River Cleaner aims to leave a lasting positive impact on water ecosystems and society.

1.5 Scope of Project

The Solar-Powered River Cleaner project addresses the urgent need for sustainable and efficient solutions to combat water pollution in rivers and lakes. By utilizing renewable energy and automation, this project has significant potential for application in various environmental and conservation efforts. The scope of the project is as follows:

1. Environmental Impact: Removal of floating debris and pollutants from rivers, lakes, and other water bodies, contributing to improved water quality. Preservation of aquatic ecosystems by reducing the accumulation of plastic waste and other harmful materials.

2. Technological Integration: Incorporation of solar panels for renewable energy generation, ensuring eco-friendly operation. Use of Arduino-based automation to minimize manual intervention and increase efficiency.

3. Scalability and Adaptability: Application to a wide range of water bodies, from small ponds to large rivers, with design modifications to suit specific conditions. Scalability for larger systems to address industrial or municipal waste in harbors, coastal areas, and urban waterways.

4. Cost-Effective and Sustainable Solution: Affordable design using readily available components such as solar panels, motor drivers, and Arduino controllers. Reduction in operational costs due to the use of renewable energy and automated waste collection.

5. Alignment with National and Global Goals: Support for India’s Swachh Bharat Abhiyan and National Mission for Clean Ganga (NMCG) initiatives to combat pollution and promote sustainable practices. Contribution to global efforts under the United Nations’ Sustainable Development Goals (SDGs), particularly Goal 6 (Clean Water and Sanitation) and Goal 7 (Affordable and Clean Energy).

6. Educational and Awareness Initiatives: Demonstration of innovative, sustainable technologies to inspire future research and projects in environmental conservation. Creation of awareness about water pollution and the importance of renewable energy solutions among communities and stakeholders.

7. Future Enhancements: Expansion of functionality to include waste segregation, increased storage capacity, and adaptability to varying water conditions. Development of autonomous navigation systems to enable efficient operation in complex environments.

The Solar – Powered River Cleaner project has far-reaching implications in addressing environmental challenges while promoting sustainability and technological advancement. It lays the foundation for cleaner water bodies and supports long-term ecological preservation efforts

CHAPTER 2

EXISTING METHODOLOGY

Solar-powered water trash collectors are innovative systems designed to remove debris and waste from water bodies such as rivers, lakes, and oceans while harnessing the power of the sun for energy. These systems integrate renewable energy solutions with waste management, contributing to cleaner water environments without relying on traditional fossil fuels. The existing methodologies for these systems typically involve a combination of solar-powered propulsion, waste collection mechanisms, and automated monitoring to efficiently remove and transport waste from the water surface.

Solar-Powered Propulsion Systems: The core principle of a solar-powered water trash collector lies in using solar energy to drive the movement of the system. These collectors often feature solar panels mounted on the top or integrated into the body of the device, which capture sunlight and convert it into electrical energy. The energy generated by the solar panels powers electric motors that drive the movement of the collector. In many cases, these systems use energy-efficient brushless DC motors that can operate continuously throughout the day, depending on the intensity of sunlight. The propulsion system can either be designed for autonomous movement, using GPS and sensors to navigate along predetermined paths, or it can be manually operated, though autonomous systems are more common in modern designs.

Collection Mechanism: The trash collection mechanism is typically designed to skim the surface of the water, gathering debris such as plastics, bottles, and other waste items. Many systems employ rotating drums, conveyor belts, or net-based systems that trap waste as the collector moves through the water. For example, some models feature a rotating drum or belt that extends slightly into the water, capturing floating debris. The waste is then transferred into a storage bin or container, which can be periodically emptied. The key challenge for these collection mechanisms is to effectively capture different types of waste, from large items like floating plastic containers to smaller debris like cigarette butts or microplastics. In certain systems, sensors are used to detect the type and volume of waste being collected, optimizing the collection process. These sensors might adjust the speed of the collector or activate certain waste sorting processes if needed.

Energy Efficiency and Sustainability: Energy efficiency is central to solar-powered trash collectors, as they must be able to operate continuously with a limited energy source. To ensure that the system operates effectively over long periods, energy storage solutions such as batteries are incorporated into the design. These batteries store excess energy generated during the day, which can then be used to power the system at night or during cloudy periods. In some advanced models, energy storage systems are integrated with automated energy management software, which controls how and when power is drawn from the battery to maintain efficiency. Many solar-powered trash collectors are designed to be lightweight and require minimal maintenance, which is important for long-term sustainability. The use of solar panels as the primary energy source eliminates the need for fossil fuels, reducing the environmental impact of the system and aligning with global goals for sustainable waste management and renewable energy use.

Autonomous Operation and Navigation: Some of the most advanced solar-powered water trash collectors use autonomous navigation technology to operate without human intervention. These systems use GPS, artificial intelligence (AI), and machine learning to plan and optimize the trash collection routes. AI algorithms analyse environmental factors such as water flow, wind, and obstacles to ensure the trash collector can efficiently move around the water body, adjusting its trajectory in real time. The system's sensors and cameras provide visual feedback, enabling the collector to identify and navigate around obstacles or areas with heavy waste concentrations. Autonomous systems can be programmed to follow pre-determined routes, ensuring that a given area is consistently cleaned. These systems often include monitoring tools to track performance and provide real-time data on the effectiveness of waste collection, which can be used to adjust the operation or inform future design improvements.

Deployment in Varied Water Environments: Solar-powered water trash collectors are deployed in a variety of aquatic environments, including rivers, lakes, ponds, and coastal areas. Each environment presents unique challenges, such as varying waste types, water conditions, and weather patterns. As such, many collectors are designed to be modular, with adjustable features that allow them to be adapted for different water bodies. In large bodies of water, such as oceans or extensive lakes, these systems are often deployed as part of a fleet, with multiple units working together to cover a broad area. In smaller or more confined water bodies, single units may be sufficient. Additionally, solar-powered trash collectors are often used in conjunction with other waste management systems, such as floating barriers or water filtering systems, to provide a more comprehensive solution to water pollution.

Monitoring and Data Collection: Modern solar-powered water trash collectors are equipped with advanced monitoring systems that collect data on the waste being collected, the environmental conditions, and the operational status of the device. Sensors that measure waste quantity, water quality, and GPS data are commonly integrated into the system. This data can be transmitted to cloud-based platforms or control centres, providing real-time information on the collector's performance and the environmental conditions of the water body. Some systems use this data to improve the efficiency of waste collection by adjusting the movement patterns or the collection mechanism based on the real-time assessment of waste density or water conditions. Moreover, environmental data collected by the collectors can also be used for research purposes, helping scientists and environmental agencies better understand pollution patterns and water health.

Challenges and Limitations: Despite the promising potential of solar-powered water trash collectors, there are still several challenges and limitations. One significant challenge is the varying availability of sunlight, which can affect the efficiency of solar panels, particularly in regions with frequent cloud cover or during night time operations. Energy storage solutions such as batteries can help mitigate this issue, but the need for continuous maintenance and charging remains. Another challenge is the effectiveness of waste collection in areas with large debris or rough water conditions. In environments with strong currents, waves, or heavy waste concentrations, trash collectors may need to be designed with more robust propulsion and collection mechanisms to handle the conditions. Additionally, the cost of manufacturing and deploying solar-powered water trash collectors can be high, especially for large-scale operations or in areas where infrastructure is lacking. However, ongoing advancements in solar energy efficiency and material costs are expected to reduce these costs over time.

CHAPTER 3

PROPOSED METHODOLOGY

The solar-powered water trash collector offers an innovative, sustainable solution to the growing problem of water pollution. By combining solar power, Arduino-based control, wireless Bluetooth communication, and efficient trash collection mechanisms, the system can operate autonomously or under manual control, providing flexibility and ease of use. This system is not only environmentally friendly but also scalable, allowing for implementation in various water bodies, from small ponds to larger lakes. Its use of renewable energy ensures that it can operate with minimal environmental impact, contributing to cleaner and healthier aquatic ecosystems.

3.1 Block Diagram

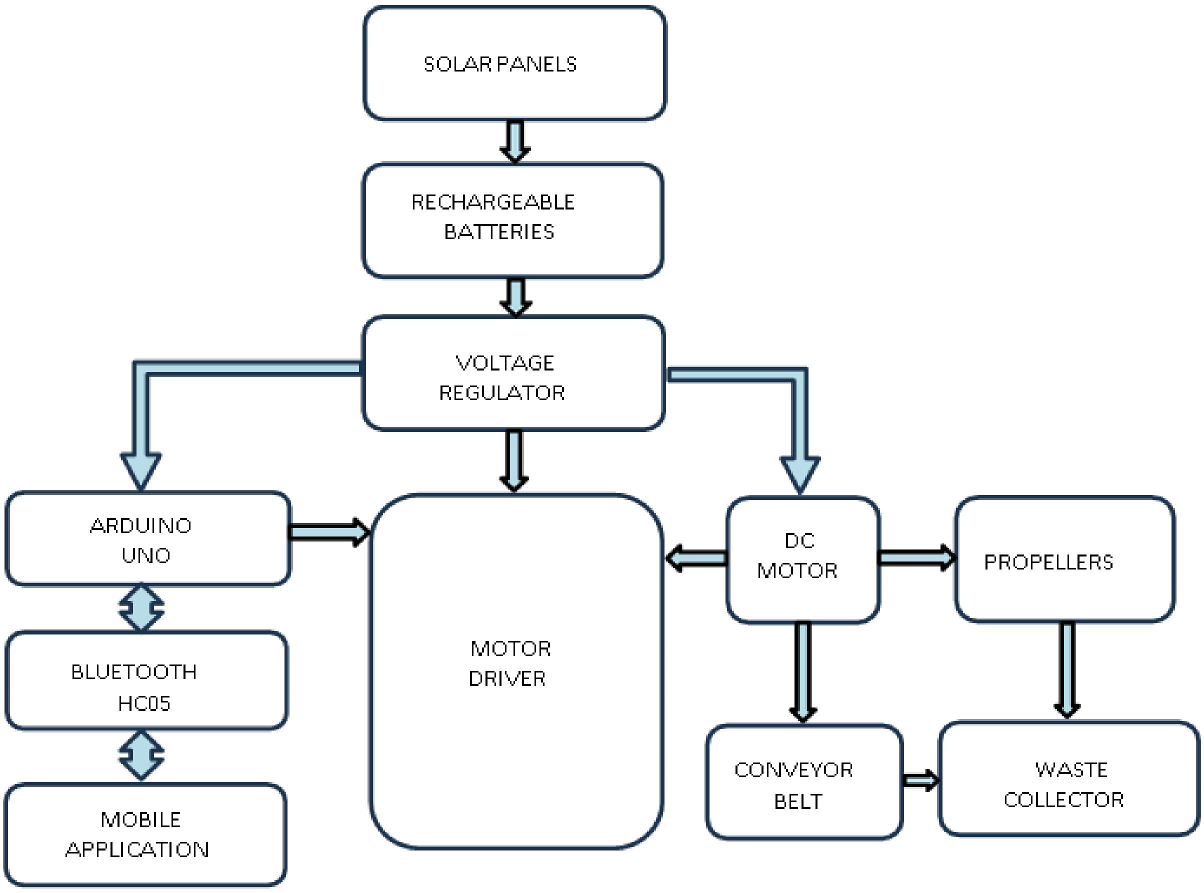

Figure 1: BLOCK DIAGRAM OF SOLAR POWERED WATER TRASH COLLECTOR

3.2 FLOW CHART

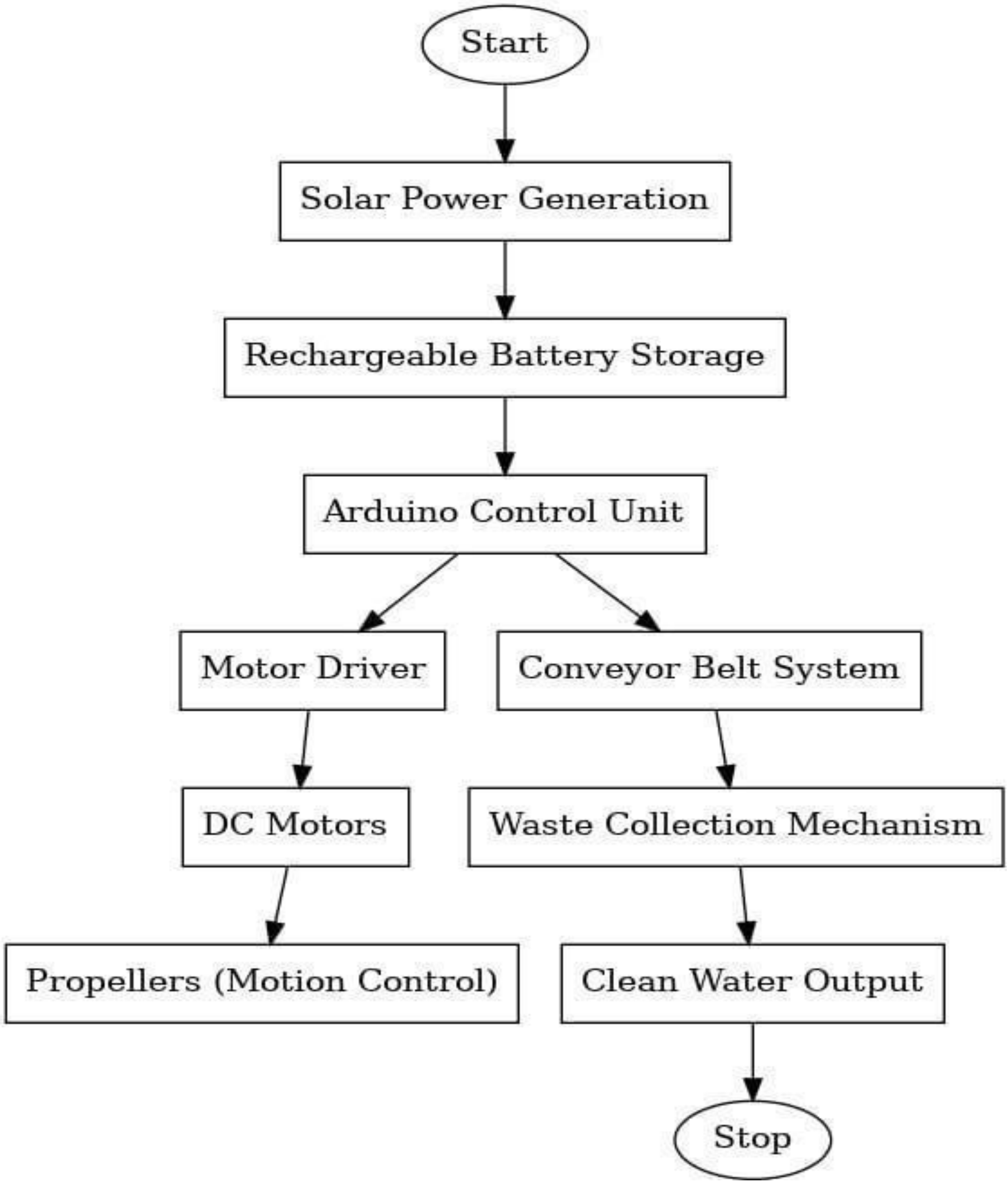

Figure2: FLOW CHART OF SOLAR POWERED WATER TRASH COLLECTOR

1. Start: The system begins operation upon activation.

2. Solar Power Generation: Solar panels collect sunlight and convert it into electrical energy, which serves as the primary power source.

3. Rechargeable Battery Storage: The energy generated is stored in rechargeable batteries, ensuring continuous operation even during low sunlight.

4. Arduino Control Unit: The Arduino microcontroller acts as the brain of the system, managing inputs and outputs to control the cleaner's functions.

5. Motor Driver: The motor driver receives signals from the Arduino to control the DC motors' speed and direction.

6. DC Motors: These motors power the propellers, enabling the cleaner's movement across the water body.

7. Propellers (Motion Control): Propellers are used for motion and maneuverability, allowing the cleaner to navigate through the water.

8. Conveyor Belt System: This mechanism is controlled by the Arduino to collect floating debris from the water surface.

9. Waste Collection Mechanism: The conveyor belt transfers the debris into a storage container, effectively separating waste from the water.

10. Clean Water Output: The system ensures cleaner water by removing visible floating debris.

11. Stop: The operation concludes when the system is either manually stopped or programmed to halt after completing its task.

This process highlights the integration of renewable energy with automation to achieve efficient and eco-friendly water body cleaning.

3.3 SYSTEM REQUIREMENTS

➢ HARDWARE COMPONENTS

- **Solar Panels**: Solar panels are the core energy source of the system, converting sunlight into electricity. These panels power the rechargeable battery and, in turn, supply energy to the motors and other electronic components of the water trash collector. As the robot operates in an outdoor environment, typically in sunlight, the solar panels ensure continuous operation, especially in remote locations, without the need for external charging. The solar panels are the cornerstone of the power system in a solar-powered water trash collector. These panels consist of photovoltaic cells that convert sunlight into electricity through the photovoltaic effect. As sunlight hits the cells, the energy is absorbed and converted into DC (direct current) electrical power. This energy is then used to charge the robot's rechargeable battery and directly power its motors, sensors, and the Arduino microcontroller. One of the most significant advantages of solar power in this context is its ability to provide continuous energy to the robot, even in remote locations far from power sources. By utilizing the natural energy from the sun, the robot can operate independently without requiring external charging, ensuring its functionality in outdoor, off-grid locations where access to power might be limited or unavailable.

Solar panels are particularly beneficial in this application because they make the system sustainable, reducing dependence on manual charging or external energy sources, which is crucial for long-term, autonomous operation in water environments.

Figure 3: REAL IMAGE OF SOLAR PANEL

- **Rechargeable Battery**: The rechargeable battery stores the electrical energy generated by the solar panels. It powers the Arduino, motors, and other sensors when the robot is in operation. The battery is essential for providing power during cloudy periods or night time when the solar panels are not generating enough energy. Common battery types for such systems include Li-ion or LiPo, which offer a good balance between energy capacity and weight, ensuring the robot remains functional for extended periods without needing constant recharging. The rechargeable battery plays a critical role in storing the energy generated by the solar panels. This battery serves as the power reservoir for the entire system, ensuring the robot can continue functioning when there is no sunlight or when the solar panels are not producing sufficient power, such as during cloudy weather or at night. Batteries used in these systems are typically Li-ion (Lithium-ion) or LiPo (Lithium-Polymer) due to their high energy density, long cycle life, and relatively lightweight nature. These battery types are ideal because they offer a good balance between capacity (how long the robot can operate on a full charge) and weight (to ensure the robot remains buoyant). The battery stores energy from the solar panels during the day and releases it to power the Arduino**,** motors**,** sensors, and other components when the robot is in operation. Without a reliable rechargeable battery, the robot would be dependent solely on solar energy and would not function during times when sunlight is not available, so this storage element ensures round-the-clock operation and autonomy.

Figure 4: REAL IMAGE OF RECHARGEABLE BATTERY

- **Arduino (e.g., Arduino Uno)**: The Arduino Uno serves as the brain of the system. It controls the entire operation, processing sensor data and executing commands to drive the motors and other components. It also handles communication with the Bluetooth HC05 module for remote control via a mobile device. The Arduino can be programmed to control the movement of the robot, initiate trash collection processes, and monitor system health, ensuring the robot performs the intended tasks autonomously or with minimal human intervention. The Arduino Uno acts as the brain of the solar-powered water trash collector. This microcontroller board is programmed to manage all aspects of the robot's operation, from controlling movement to initiating trash collection and processing sensor data. The Arduino works by receiving inputs from various sensors and user commands (via the Bluetooth HC05 module), then processing this information and sending output signals to the motor driver and other components to perform specific actions. For example, the Arduino might command the motors to adjust the robot’s movement or activate the conveyor belt to collect debris. It also monitors the battery’s charge and system status to ensure that everything functions as expected. The Arduino can be programmed to work autonomously, navigating the water, detecting trash, and activating the collection system without human intervention. The system can also be programmed to communicate via Bluetooth, allowing for remote control through a smartphone or tablet, which increases its versatility and ease of use.

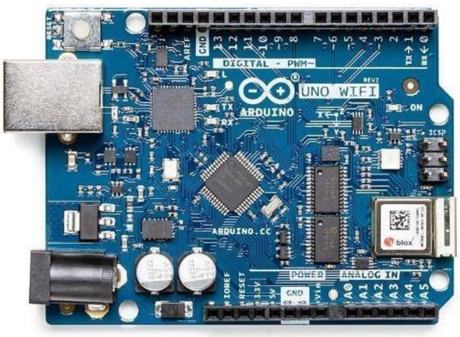

Figure 5: REAL IMAGE OF ARDUINO UNO

- **Motor Driver (e.g., L298N)**: The motor driver, such as the L298N, allows the Arduino to control the DC motors that drive the propellers or wheels of the robot. Since the Arduino cannot supply enough current to drive the motors directly, the motor driver acts as an intermediary. It receives signals from the Arduino, adjusting the speed and direction of the motors, allowing the robot to move, change directions, or navigate through obstacles. The motor driver is an essential component that allows the Arduino to control the DC motors in the robot. Since the Arduino alone cannot supply enough current to drive the motors directly, the motor driver acts as a bridge, amplifying the control signals from the Arduino and enabling it to handle the higher current required by the motors. The L298N is one of the most commonly used motor drivers in small robots and electronic systems. It can control two DC motors simultaneously and allows for precise control of both the direction and speed of the motors. The motor driver receives control signals from the Arduino and adjusts the voltage and current going to the motors accordingly. In the case of a water trash collector, these motors may control propellers (for movement in water) or wheels (for precise navigation). The motor driver ensures smooth and responsive movement, which is crucial for maneuvering around obstacles and effectively performing tasks such as trash collection.

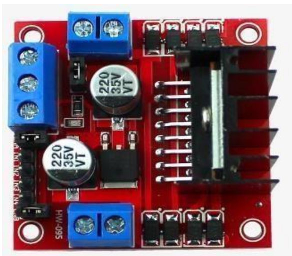

Figure 6: REAL IMAGE OF MOTOR DRIVER

- **Charging Module (TP4056)**: The TP4056 charging module is used to safely charge the rechargeable battery from the solar panel. It ensures that the battery is charged efficiently and prevents overcharging, which could damage the battery. It regulates the charging process, providing the proper voltage and current to the battery, ensuring that the robot always has enough power to operate without requiring manual intervention. The TP4056 charging module is crucial for managing the charging of the rechargeable battery. This module ensures the battery is charged safely and efficiently when energy is available from the solar panels. The TP4056 is a lithium battery charger module that regulates the voltage and current to avoid overcharging, which could damage the battery and reduce its lifespan. It provides a consistent and controlled charging process, ensuring the battery is charged at the optimal rate and protecting it from overcharging or overheating. This module is vital for maintaining the health of the battery over time, as it helps prevent issues like battery swelling or reduced performance. By ensuring that the battery is always adequately charged, the TP4056 module helps the robot operate continuously, even during periods of low sunlight or when the robot is idle.

Figure 7: REAL IMAGE OF CHARGING MODULE (TP4056)

- **DC Motors**: DC motors provide the mechanical movement of the robot, enabling it to move across the water surface. These motors are connected to either propellers or wheels and are controlled by the motor driver. The robot uses these motors to navigate the water, either pushing itself along the surface with propellers or using wheels for more precise control in areas where it might not be on open water. DC motors are the driving force behind the robot's movement. These motors convert electrical energy from the battery into mechanical motion, allowing the robot to navigate across the water. In a water trash collector, propellers or wheels are typically driven by these motors, depending on the design of the robot. DC motors are a popular choice for this type of application because they are efficient, easy to control, and capable of delivering sufficient power to move the robot across the water surface. The motors are connected to the motor driver, which allows the Arduino to control the speed and direction of the motors. For water-based robots, propellers are usually preferred because they provide continuous propulsion with minimal resistance in water, making them an ideal solution for ensuring smooth navigation. By providing the necessary thrust or movement, the DC motors enable the robot to travel to specific areas where trash has accumulated and then maneuver to collect the waste.

Figure 8: REAL IMAGE OF DC MOTOR

- **Battery Holder**: The battery holder keeps the rechargeable battery securely in place within the robot's hull. It is designed to ensure that the battery is safely connected and positioned, minimizing the risk of damage due to movement or exposure to water. The battery holder is an important part of maintaining the integrity of the power system and ensuring the battery remains functional throughout the robot’s operation. The battery holder is designed to securely house the rechargeable battery within the robot's structure. It ensures that the battery stays in place during operation and prevents any movement or shifting that could damage the electrical connections or disrupt the robot’s functionality. A well-designed battery holder is critical for maintaining the overall stability and integrity of the robot. In addition to securing the battery, the holder must be waterproof or protected against water damage to avoid short-circuiting or other electrical failures. The battery holder also needs to be lightweight to prevent the robot from becoming top- heavy or unstable. It is typically designed to accommodate the battery's size and shape while allowing for easy removal or replacement if needed.

Figure 9: REAL IMAGE OF BATTERY HOLDER

- **Bluetooth HC05**: The Bluetooth HC05 module enables wireless communication between the robot and a mobile device (smartphone or tablet). This module allows users to control the robot remotely, adjusting movement, speed, or triggering trash collection operations. Bluetooth provides a simple and energy-efficient way to interact with the robot in real-time, especially useful for deploying or retrieving the robot from a specific location or controlling it from a distance. The Bluetooth HC05 module enables wireless communication between the robot and a mobile device, such as a smartphone or tablet. By connecting to the Arduino board, the Bluetooth module allows the user to send control commands to the robot remotely, using a Bluetooth-enabled app. This interaction can include tasks like controlling the robot's movement, adjusting its speed, or triggering trash collection mechanisms. The Bluetooth HC05 is chosen for its ease of use, low energy consumption, and simplicity in integrating with the Arduino platform. The wireless communication capability allows for greater flexibility in deploying and controlling the robot, especially in larger bodies of water where direct access to the robot may be difficult. The ability to control the robot from a distance also adds convenience for the user, eliminating the need for manual intervention or physical contact.

Figure 10: REAL IMAGE OF BLUETOOTH HC05

- **Propellers**: Propellers are essential for providing propulsion in water, allowing the robot to move across the surface. They are driven by DC motors and controlled via the motor driver. The propellers allow the robot to travel to specific areas where trash has been detected and then maneuver to collect the waste. Propellers are particularly efficient for movement in water due to their low drag and ability to provide continuous thrust. The propellers are the primary means of propulsion for the robot when it is operating on water. These are connected to the DC motors, and as the motors rotate the propellers, the robot is propelled forward or backward through the water. Propellers are well-suited for this application because they generate continuous thrust with low resistance, which is essential for navigating large or open bodies of water. Propellers work efficiently in aquatic environments, ensuring that the robot can travel over significant distances to collect trash and navigate around obstacles. The robot can be equipped with multiple propellers (typically two or four) to ensure good maneuverability and stability in the water.

Figure 11: REAL IMAGE OF PROPELLERS

- **Platform or Hull (Sunboard Sheets)**: The platform or hull, made from Sunboard sheets or similar lightweight, waterproof materials, serves as the structural frame for the robot. This component holds all the other elements, such as the solar panel, battery, Arduino,motors, and waste container, while ensuring that the robot remains afloat. The hull must be lightweight to ensure easy navigation while being robust enough to handle the system's weight and operate in varying water conditions.

  The hull or platform of the robot is the structural framework that holds all the components together. It must be made from lightweight, durable, and waterproof materials to ensure the robot stays afloat and operates smoothly in water. Materials like Sunboard sheets or other similar lightweight, water-resistant materials are commonly used for the hull. The hull must not only support the solar panels, motors, sensors, and battery but also keep the robot stable as it moves across the water. The design of the hull is also crucial for minimizing drag and ensuring that the robot can travel efficiently. It must be large enough to house all the essential components while maintaining the buoyancy required for safe operation in water

- **Conveyor Belt System**: The conveyor belt system is responsible for collecting trash from the water and moving it into the robot's waste container. This system could use a small DC motor or actuator to drive the belt, which may have a scoop or mesh net attached to it to gather waste. Once the trash is picked up, the conveyor belt transports it to the storage area, where it is stored for later disposal. This system is particularly useful for systematically gathering debris from larger areas in the water. The conveyor belt system is a crucial part of the trash collection mechanism. It is responsible for gathering debris from the water and transporting it into the robot’s waste container. The belt is often made from durable materials such as rubber or plastic, and it is powered by a small DC motor. The conveyor belt can have a mesh net or scoop attached to it, which helps capture floating debris like plastic bottles, wrappers, and other small trash items. The system works in conjunction with the robot's sensors and autonomous movement capabilities, allowing the robot to patrol a designated area, gather trash, and move it to the waste container for later disposal. The conveyor belt makes the trash collection process more efficient and systematic, helping the robot to cover larger areas without requiring constant human intervention.

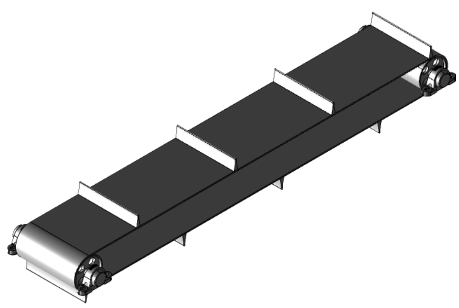

Figure 12: REAL IMAGE OF CONVEYOR BELT

- **Waste Container**: The waste container holds the debris collected by the robot. It needs to be large enough to store a significant amount of trash but lightweight enough not to interfere with the robot’s buoyancy and movement. The waste container should also be designed for easy removal or emptying once it is full, either by human intervention or through a docking station where the robot can unload its contents.

The waste container is designed to hold the trash that the robot collects from the water. It must be large enough to store significant amounts of debris but also lightweight enough not to affect the robot's buoyancy or stability. The container is typically made from plastic or other lightweight materials that are resistant to water and corrosion. It is placed strategically within the robot's hull and is easily accessible for maintenance or emptying. Once the waste container is full, the robot may either return to a docking station to unload the trash, or it may be emptied manually. The design of the waste container is important for ensuring the robot can store a large amount of debris without compromising its ability to float or navigate the water.

Figure 13: REAL IMAGE OF WASTE CONTAINER

- **Power Switch**: The power switch is an important safety and control feature, enabling the user to turn off the system when it's not in use, preserving battery life and preventing unnecessary energy consumption. It also helps to reset the system in case of a malfunction or to perform maintenance. The power switch is a simple but crucial component of the robot, allowing the user to control the on/off state of the system. This switch is used to turn the robot on when it's ready to operate and to turn it off when it's not in use, helping to conserve battery life and prevent unnecessary energy consumption. Additionally, the power switch allows the robot to be reset or powered down for maintenance, repairs, or in case of malfunction. In a water-based robot, the power switch is typically designed to be waterproof or sealed to prevent damage from water exposure.

Figure 14: REAL IMAGE OF POWER SWITCH

- **Connecting Wires and Jumper Cables**: These wires and cables are used to connect all the components of the robot. They link the Arduino to the motor driver, the motors, the sensors, the Bluetooth module, and the battery. Proper wiring ensures that electrical signals flow correctly between components, allowing the robot to function as intended. Additionally, waterproofing the wiring or using waterproof connectors is crucial in water-based applications to prevent damage from exposure to water. Connecting wires and jumper cables are essential for linking all the electronic components of the robot. These wires ensure that electrical signals flow between the Arduino**,** motor driver**,** battery**,** sensors**,** Bluetooth module, and other parts. Proper wiring is crucial to ensure that all components work as intended. In water-based applications, it is particularly important to use waterproof connectors or sealed wiring to protect the electronics from water damage. If the wiring is not adequately insulated or protected, water can cause short circuits, component failures, or even permanent damage to the robot's electrical systems.

➢ **SOFTWARE USED**

- The **Arduino Bluetooth controller** application controls and monitors all the dashboards in the Arduino cloud.
- **Arduino IDE** is a free open-source software used to write, compile and upload code to Arduino board.

Arduino IDE

The Arduino IDE is the software platform used to write, compile, and upload code to the Arduino board. It is a user-friendly, open-source platform that allows for easy programming of microcontrollers. The Arduino IDE supports multiple programming languages, most commonly C/C++, and provides a variety of libraries to make interfacing with hardware components simple. Through the Arduino IDE, users can write custom code to control the robot's behaviour, such as movement, trash collection, and sensor readings. It also supports debugging and uploading code to the Arduino board, allowing users to modify and improve the robot's functionality over time.

Figure 15: ARDUINO IDE APPLICATION

Arduino Bluetooth Controller Application

The Arduino Bluetooth Controller app is a mobile application used to control the robot via Bluetooth. It allows users to interact with the robot remotely, making it easier to control the robot from a distance, adjust its speed and movement, and activate trash collection systems. This wireless communication feature increases the robot's versatility and ease of use, particularly in large or hard-to-reach water bodies. The Bluetooth controller app interfaces directly with the Arduino's Bluetooth module (HC05), sending commands and receiving feedback to ensure the robot operates efficiently.

Figure 16: ARDUINO BLUETOOTH CONTROLLER APPLICATION

CHAPTER 4

RESULTS AND DISCUSSIONS

RESULT

The Solar-Powered River Cleaner demonstrates the feasibility of integrating renewable energy and automation for effective water body cleaning. The system was able to:

- Successfully collect floating debris using the conveyor belt mechanism.
- Operate autonomously, powered entirely by solar energy stored in rechargeable batteries.
- Achieve consistent motion and navigation through the use of DC motors and propellers controlled by the Arduino.
- Reduce environmental impact by eliminating the need for fossil fuels and manual intervention.

The prototype showed promising results in terms of debris collection efficiency and energy consumption, making it suitable for small-scale water cleaning tasks such as ponds, lakes, or slow-moving river sections.

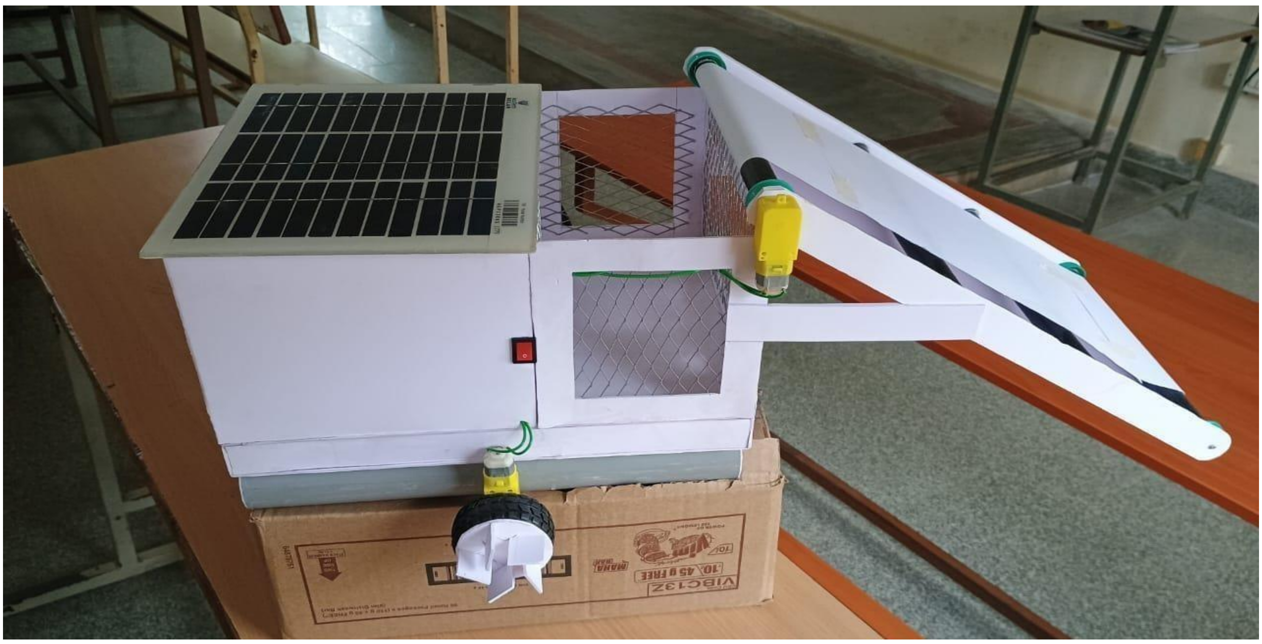

Figure 17: REAL IMAGE OF OUR SOLAR POWERED WATER TRASH COLLECTOR MODEL

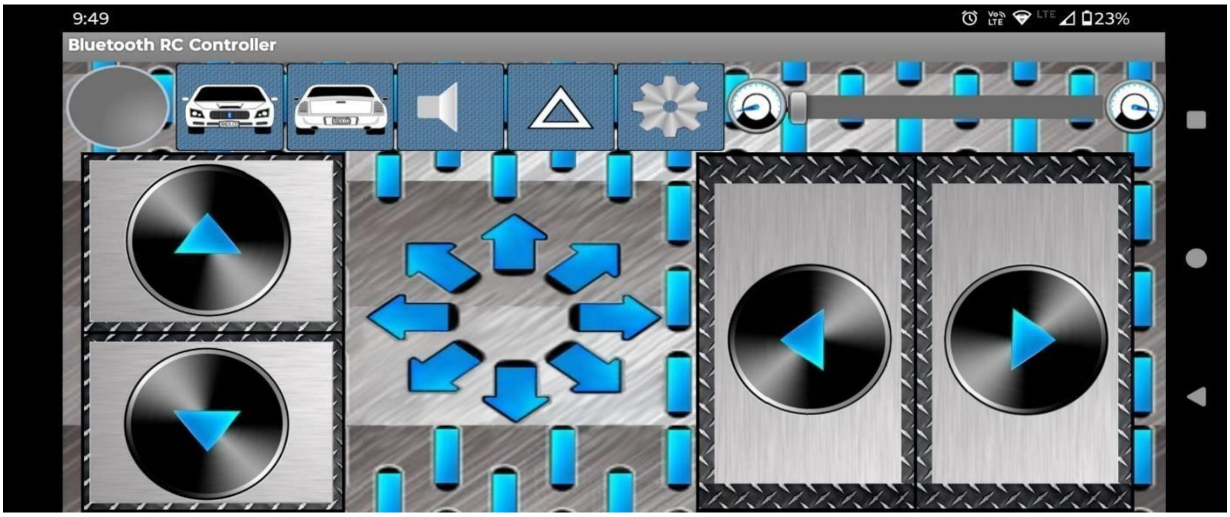

Figure 18: CONTROLLING THROUGH ARDUINO BLUETOOTH RC CONTROLLER APPLICATION

DISCUSSION

Performance Analysis:

- The conveyor belt system efficiently collected debris such as plastic bottles and leaves, ensuring minimal residue left in the water.
- The solar panels provided a steady power supply in sunny conditions, though performance dropped during cloudy weather, highlighting the need for improved energy storage.

System Efficiency:

- The Arduino-controlled system proved to be reliable and responsive to commands, managing motor operations seamlessly.
- The motor driver effectively regulated the power supply to DC motors, ensuring smooth and precise movement of the cleaner.

Limitations:

- The cleaner is limited to floating debris and cannot address submerged or heavy waste.
- The performance of the system depends on sunlight availability, which may restrict operations during prolonged cloudy or rainy conditions.
- The current design is effective for small-scale applications but requires scaling and optimization for larger or fast-flowing water bodies.

Environmental Impact:

- The project demonstrated an eco-friendly approach to water pollution, contributing to sustainable practices.
- Using renewable energy significantly reduces carbon emissions compared to fuel-powered cleaning methods.

Future Improvements:

- Integrating IoT sensors can allow real-time monitoring of the cleaner's performance and remote operation.
- Developing a more robust energy storage system can enhance performance during low sunlight conditions.
- Scaling the system to larger water bodies or designing modular units can increase its application scope.

In conclusion, the Solar-Powered River Cleaner represents a step forward in sustainable and automated solutions for addressing water pollution. While effective as a prototype, further enhancements can improve its functionality, scalability, and adaptability for diverse environmental conditions.

4.1 APPLICATION

The Solar-Powered River Cleaner has diverse applications, addressing various aspects of water pollution management and contributing to environmental sustainability. Below are detailed applications that highlight its potential:

1. **Cleaning of Rivers and Lakes:** The primary application of this project is the cleaning of floating waste in rivers and lakes. It can efficiently collect plastic, leaves, and other debris, ensuring the cleanliness of water bodies and helping to restore their ecological balance. This is particularly useful for water bodies in urban and semi-urban areas where waste dumping is prevalent.
2. **Harbor and Coastal Region Cleanup:** The cleaner can be deployed in harbors, small bays, and coastal regions to tackle waste accumulation due to tides and human activities. This application is essential for preventing marine pollution and maintaining the cleanliness of entry points into the ocean.
3. **Industrial Waste Management:** Water bodies near industrial zones often face pollution from floating debris and chemical runoff. The river cleaner can remove surface-level

waste, contributing to better management of industrial effluents and promoting cleaner water resources.

4. **Support for Tourist Destinations:** Water bodies in tourist destinations often face increased pollution due to visitor activities. Deploying the solar-powered cleaner in these locations helps maintain aesthetics, improve water quality, and ensure a positive experience for tourists. Clean water bodies also enhance the reputation of the location.
5. **Flood Mitigation:** Blockages in water channels due to floating debris are a common cause of urban flooding. The cleaner can regularly remove such waste, ensuring smooth water flow and reducing the risk of floods, especially during monsoons or heavy rain seasons.
6. **Contribution to Smart City Initiatives:** As part of government initiatives like Smart Cities Mission and Swachh Bharat Abhiyan, this cleaner offers a sustainable and automated solution for urban waste management in water bodies. Its renewable energy design aligns with the goals of smart and eco-friendly cities.
7. **Environmental Conservation:** By removing floating debris, the river cleaner reduces the chances of pollutants harming aquatic flora and fauna. This application directly supports biodiversity conservation and helps maintain the balance of aquatic ecosystems. It also prevents waste like plastics from breaking down into microplastics, which can harm organisms in the food chain.
8. **Post-Disaster Cleanup:** In the aftermath of natural disasters like floods or cyclones, water bodies often accumulate large amounts of debris. The solar-powered cleaner can assist in post-disaster recovery by quickly clearing waste and helping restore water flow.
9. **Public Awareness and Education:** The cleaner can be used in environmental awareness campaigns to demonstrate the importance of renewable energy and automated technologies in solving real-world problems. It serves as an excellent model to inspire communities to adopt sustainable practices.
10. **Aquaculture and Fisheries:** In aquaculture farms and fisheries, maintaining clean water is crucial for the health of aquatic organisms. The river cleaner can help by removing surface-level debris, ensuring optimal conditions for fish farming and related activities.
11. **Cost-Effective Municipal Waste Management:** Municipal corporations can utilize this system to reduce the costs and manpower associated with manual cleaning. The solar-powered design further minimizes operational costs, making it a feasible option for long-term waste management.

12. **Waste Reduction in Water Transport Routes:** For areas where water transport is common, such as ferry routes, the cleaner can ensure clear paths by removing floating waste, improving navigation safety and water quality.

By combining automation, sustainability, and efficiency, the Solar-Powered River Cleaner offers a wide range of applications, making it a valuable innovation for addressing global water pollution challenges. Its integration with renewable energy sources also sets a benchmark for environmentally conscious technological solutions.

4.2 ADVANTAGES

1. **Eco-Friendly:** Operates using solar energy, reducing dependency on fossil fuels and lowering carbon emissions. Promotes the use of renewable energy, contributing to environmental sustainability.
2. **Automated and Efficient:** Automated system reduces the need for manual labor, making operations more efficient. Can operate continuously during sunlight hours with minimal supervision.
3. **Cost-Effective:** Low operational costs as it runs on free solar energy. Reduces long- term expenses compared to fuel-powered alternatives.
4. **Adaptable Design:** Can be deployed in various water bodies such as rivers, lakes, ponds, and harbors. Modular design allows scalability for different sizes and capacities.
5. **Reduces Pollution:** Collects floating debris and plastic waste, improving water quality and protecting aquatic ecosystems. Prevents waste from breaking down into harmful microplastics.
6. **Promotes Awareness:** Demonstrates the potential of renewable energy and automated systems to address environmental challenges. Serves as an educational tool for sustainability initiatives.
7. **Alignment with Government Initiatives:** Supports programs like Swachh Bharat Abhiyan and Smart Cities Mission by promoting clean and sustainable environments.
8. **Low Maintenance:** Requires minimal maintenance due to its simple and robust design.

4.3 DISADVANTAGES

1. **Weather Dependency:** Efficiency is reduced on cloudy or rainy days due to reliance on solar energy. Limited performance during nighttime without adequate battery storage.

2. **Limited Capacity:** May not handle large-scale debris or heavy pollutants efficiently. Requires periodic emptying of the waste container.
3. **Initial Cost:** High initial cost for components like solar panels, batteries, and motor systems. Investment in design and testing adds to upfront expenses.
4. **Navigation Challenges:** May struggle in strong currents or rapidly flowing water bodies. Propellers and motors need to be carefully designed to ensure stability.
5. **Battery Lifespan:** Rechargeable batteries have a limited lifespan and need replacement after a certain period.
6. **Debris Limitations:** Cannot collect submerged waste or very small particles effectively. May face difficulty with entangled or oversized debris.
7. **Environmental Risks:** Risk of damage to aquatic life if not carefully designed to avoid accidental harm. Malfunctioning could lead to water contamination if components like batteries leak.
8. **Complexity in Maintenance:** Though infrequent, repairs to specialized components like solar panels or Arduino systems require technical expertise.

By weighing these advantages and disadvantages, the Solar-Powered River Cleaner emerges as a promising yet evolving solution for water pollution management.

CHAPTER 5

CONCLUSIONS AND FUTURE SCOPE

CONCLUSION

Water pollution is one of the most significant environmental challenges of our time, and its adverse impacts on aquatic ecosystems, biodiversity, and human health are undeniable. The Solar-Powered River Cleaner offers a promising solution to this growing issue by harnessing renewable solar energy and leveraging automation technology to efficiently remove floating debris from water bodies. Designed to operate sustainably, the system integrates critical components such as solar panels, Arduino-based controls, DC motors, and a conveyor mechanism to deliver an eco-friendly and cost-effective alternative to traditional river-cleaning methods.

The cleaner's automated functionality eliminates the need for manual labor, reducing operational costs and increasing efficiency. Its reliance on solar power aligns with global efforts to combat climate change and reduce dependence on fossil fuels, while its waste-collection capability helps to restore the ecological balance of polluted rivers, lakes, and harbors. The project also supports national initiatives such as Swachh Bharat Abhiyan and Smart Cities Mission, reinforcing India's commitment to creating cleaner and more sustainable urban environments.

While the current prototype demonstrates the feasibility of using solar energy for continuous cleaning operations, it also lays the foundation for further innovation and development. By addressing issues like floating plastic, organic waste, and other pollutants, the Solar-Powered River Cleaner contributes to reducing microplastic formation, safeguarding aquatic biodiversity, and improving the aesthetic and functional value of water bodies. This project not only addresses an environmental need but also promotes awareness about renewable energy applications and sustainable practices.

The Solar-Powered Water Trash Collector project provides an innovative and sustainable solution to the growing problem of water pollution. By integrating solar energy with waste management technology, this system addresses two critical global concerns: environmental degradation caused by floating debris in water bodies and the need for cleaner, renewable energy sources. The project demonstrated that solar power can be effectively harnessed to operate an autonomous trash collection system, offering a practical and eco-friendly alternative to traditional methods that often rely on fossil fuels. This system not only reduces operational costs but also contributes significantly to lowering the carbon footprint associated with waterway clean-up activities. One of the most notable outcomes of the project is its positive environmental impact. By collecting floating trash from rivers, lakes, and other bodies of water, the system helps prevent the accumulation of pollutants that threaten marine life, degrade water quality, and disrupt ecosystems. Removing this waste also reduces the risk of hazardous chemicals leaching into water sources, which can pose serious health risks to both wildlife and humans.

Furthermore, the use of solar energy to power the trash collector ensures that the operation is clean and sustainable, avoiding the emissions and pollution associated with gas-powered or electric-powered systems.

In terms of operational efficiency, the solar-powered system was designed to function autonomously, which reduces the need for constant human oversight. This ability to run continuously, even in off-grid or remote areas where electricity may not be readily available, makes it highly adaptable and scalable for various water bodies. Whether deployed in urban areas to clean up lakes and canals or in rural or coastal areas to address pollution in rivers and beaches, the system can be tailored to meet specific environmental needs. Its energy independence also means that it can operate in areas where traditional waste collection infrastructure might be too costly or impractical to maintain. The cost-effectiveness of the system, while requiring an initial investment for setup, becomes apparent in the long term. The elimination of fuel costs and the reduction in labour and maintenance requirements make the solar-powered water trash collector a financially viable solution in the long run. Moreover, the longevity and low-maintenance nature of the system contribute to ongoing savings. Over time, the system's ability to function without frequent human intervention or additional energy input will lead to a reduction in operational costs, making it an attractive solution for municipalities, environmental organizations, and other stakeholders interested in sustainable waste management.

In conclusion, the Solar-Powered River Cleaner is a step forward in the fight against water pollution, showcasing how technology and renewable energy can be combined to address pressing environmental issues. Its modular design, sustainability, and automation make it a scalable solution that can be adapted for varied applications, ranging from local lakes to large rivers. The project signifies a move toward a cleaner, greener future, emphasizing the need for innovation and collective responsibility in environmental conservation.

The Solar-Powered Water Trash Collector project serves as a model for how renewable energy and innovative design can work together to address environmental challenges. By providing an efficient, cost- effective, and sustainable way to clean our waterways, this project contributes to the larger effort to protect our natural resources, improve water quality, and safeguard biodiversity. Its scalability ensures that it can be adapted for use in various contexts, offering a promising tool for future waterway clean-up efforts around the world.

FUTURE SCOPE

The future scope of the Solar-Powered Water Trash Collector holds tremendous potential for addressing the escalating issue of water pollution and advancing the goals of sustainability, particularly in aquatic ecosystems. As the world increasingly turns to renewable energy solutions to combat environmental degradation, the application of solar-powered technology for waste collection on water bodies offers an innovative and scalable model for sustainable clean-up efforts. One of the most promising directions for the future of this project lies in its ability to be deployed globally in diverse environments. The system can be adapted for use in urban lakes, rivers, canals, and even vast oceanic regions. With the growing need for effective waste management solutions, particularly in areas that lack access to traditional infrastructure or energy sources, solar-powered trash collectors provide an autonomous, cost-effective alternative that can function without relying on local power grids. These systems can be installed in both densely populated urban areas to tackle pollution in local water bodies and in remote or coastal regions where traditional waste management is more challenging.

In addition to geographic expansion, the future of solar-powered trash collectors includes integrating them with advanced waste sorting and recycling technologies. Currently, the focus of these systems is on collecting floating debris, but future models could incorporate artificial intelligence (AI) and machine learning to sort and categorize the collected waste in real-time. For example, the system could differentiate between plastic, metal, and organic materials, enabling more efficient recycling at the point of collection. This would not only enhance the efficiency of waste removal but also contribute to reducing the amount of recyclable materials that end up in landfills. Furthermore, integrating advanced energy storage solutions, such as high-capacity batteries or even next-generation supercapacitors, could allow the system to store excess solar energy collected during the day and operate during cloudy conditions or at night, improving its reliability and extending its operational hours.

The future scope also includes the potential to incorporate the solar-powered water trash collectors into the growing trend of "smart city" infrastructure. By embedding these systems with IoT (Internet of Things) sensors and connectivity, they can be monitored and managed remotely, providing real-time data on waste collection, system performance, and environmental conditions. Municipalities could integrate these trash collectors into larger environmental monitoring networks, allowing for a more holistic approach to urban water management. In this context, the collectors could also be used to monitor water quality, detect pollutants, or even assess the health of aquatic ecosystems, providing valuable data for urban planners, environmental scientists, and government agencies. This would also enable data-driven decision-making, ensuring that trash collectors are deployed and maintained in the most effective locations based on real-time conditions and needs.

Another exciting future opportunity lies in the integration of solar-powered trash collectors with autonomous technologies. As drone and robotic technologies continue to evolve, the next generation of trash collectors could work in coordinated fleets to cover larger areas more efficiently. Autonomous boats or even floating drones could be deployed in strategic locations to collect debris without human intervention. These systems could communicate with each other to optimize their operations, ensuring that no areas are overlooked and minimizing energy consumption by adapting to local conditions, such as water current patterns or the density of trash in specific regions. The ability to scale this technology into a fleet system would significantly increase the efficiency of waterway clean-ups, particularly in large and difficult-to-access bodies of water, such as remote rivers, lakes, or parts of the ocean.

The potential for marine and ocean clean-ups is another critical area for the future of the Solar-Powered Water Trash Collector project. The issue of plastic pollution in the oceans has reached alarming levels, with millions of tons of plastic waste entering the seas every year. Deploying these solar-powered systems in key areas of the ocean, such as the Great Pacific Garbage Patch or coastal zones, could be instrumental in removing plastic and other debris from marine environments. This could be a game-changer for large-scale ocean clean-up efforts, where traditional methods have struggled to keep pace with the volume of waste. Solar-powered systems, due to their autonomy and ability to operate in areas far from the shore, could play a key role in addressing this growing environmental crisis.

Collaboration with environmental organizations, governmental bodies, and international organizations could also accelerate the adoption and development of solar-powered water trash collectors. These stakeholders often seek innovative, low-cost solutions to manage waste, particularly in regions affected by climate change or natural disasters. In areas with limited access to electricity or where infrastructure is damaged, solar-powered systems could provide a lifeline for waste management efforts. By working with such partners, the project could be tailored for specific environmental conditions, such as flood zones, post-disaster clean-up, or coastal areas that are prone to pollution from industrial and urban runoff. Furthermore, with the backing of governments and international organizations, funding for research and development could lead to the creation of even more advanced and efficient models of solar-powered trash collectors.

Finally, public awareness and community engagement are essential components of the future of this project. As the global population becomes more conscious of the impacts of water pollution and the need for conservation, there is significant potential to involve local communities in waterway cleanup initiatives. By placing solar-powered water trash collectors in highly visible locations, such as urban lakes, beaches, and parks, these systems can serve as both functional tools for environmental cleanup and educational platforms for raising awareness. Involving communities in monitoring, operating, or even participating in the maintenance of these systems could foster a sense of collective responsibility toward protecting water resources. Moreover, public outreach programs could help emphasize the importance of reducing waste and the role that renewable energy plays in combating pollution.

The future scope of the Solar-Powered Water Trash Collector project is extensive and highly promising. As technology continues to advance, these systems could become integral components of global efforts to combat water pollution, particularly in regions where waste management infrastructure is lacking. From enhancing operational efficiency with advanced sorting and AI technology to expanding their use in marine clean-up and smart city applications, solar-powered water trash collectors offer a sustainable, cost-effective, and scalable solution for improving the health of our waterways. Their potential to revolutionize environmental management, reduce waste, and protect ecosystems ensures that this project will continue to play a crucial role in the fight against pollution in the years to come.

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APPENDIX

DATA SHEET:

1. ARDUINO UNO

Figure 19: REAL IMAGE OF ARDUINO UNO

PIN DESCRIPTION

Table 1: Pin description Arduino Uno board

Pin Category	Pin Name	Details
Power	Vin, 3.3V, 5V, GND	Vin: Input voltage to Arduino when using an external power source. 5V: Regulated power supply used to power microcontroller and other components on the board. 3.3V: 3.3V supply generated by on-board voltage regulator. Maximum current draw is 50mA. GND: ground pins.
Reset	Reset	Resets the microcontroller.
Analog Pins	A0 – A5	Used to provide analog input in the range of 0-5V
Input/output Pins	Digital Pins 0 - 13	Can be used as input or output pins.

Serial	0(Rx), 1(Tx)	Used to receive and transmit TTL serial data.
External Interrupts	2, 3	To trigger an interrupt.
PWM	3, 5, 6, 9, 11	Provides 8-bit PWM output.
SPI	10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK)	Used for SPI communication.
SPI	10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK)	Used for SPI communication.
Inbuilt LED	13	To turn on the inbuilt LED.
TWI	A4 (SDA), A5 (SCA)	Used for TWI communication.
AREF	AREF	To provide reference voltage for input voltage.

ARDUINO UNO TECHNICAL SPECIFICATION

Table 2: Explains the Arduino Uno technical specification.

Microcontroller	ATmega328P – 8-bit AVR family microcontroller
Operating Voltage	5V
Recommended Input Voltage	7-12V
Input Voltage Limits	6-20V
Analog Input Pins	6 (A0 – A5)
Digital I/O Pins	14 (Out of which 6 provide PWM output)
DC Current on I/O Pins	40 mA
DC Current on 3.3V Pin	50 mA

Flash Memory	32 KB (0.5 KB is used for Bootloader)
SRAM	2KB
EEPROM	1 KB
Frequency (Clock Speed)	16 MHz

SOFTWARE

Arduino IDE (Integrated Development Environment) is required to program the Arduino Uno board.

CODE INTERFACED TO ARDUINO UNO

```
const int IN1 = 13;
const int IN2 = 12;
const int IN3 = 11;
const int IN4 = 10;


char val;



void setup() {
  pinMode(IN1, OUTPUT);
  pinMode(IN2, OUTPUT);
  pinMode(IN3, OUTPUT);
  pinMode(IN4, OUTPUT);
  Serial.begin(9600);
}
```

```
void loop()

 {

  if (Serial.available() > 0)

{

    val = Serial.read();
    Serial.println(val);



    if (val == 'F')

{

      digitalWrite(IN1,  HIGH);
      digitalWrite(IN2,   LOW);
      digitalWrite(IN3,  HIGH);
      digitalWrite(IN4, LOW);
    }

else if (val == 'B')

{

      digitalWrite(IN1,   LOW);
      digitalWrite(IN2,  HIGH);
      digitalWrite(IN3,   LOW);
      digitalWrite(IN4, HIGH);
    }

else if (val == 'L')

 {
```

```
      digitalWrite(IN1,   LOW);
      digitalWrite(IN2,   LOW);
      digitalWrite(IN3,  HIGH);
      digitalWrite(IN4, LOW);
    }

 else if (val == 'R')

{

      digitalWrite(IN1,  HIGH);
      digitalWrite(IN2,   LOW);
      digitalWrite(IN3,   LOW);
      digitalWrite(IN4, LOW);
    }

else if (val == 'S')

{

      digitalWrite(IN1,  LOW);
      digitalWrite(IN2,  LOW);
      digitalWrite(IN3,  LOW);
      digitalWrite(IN4, LOW);
    }

  }

  delay (50);

}
```

2.MOTOR DRIVER(L298N)

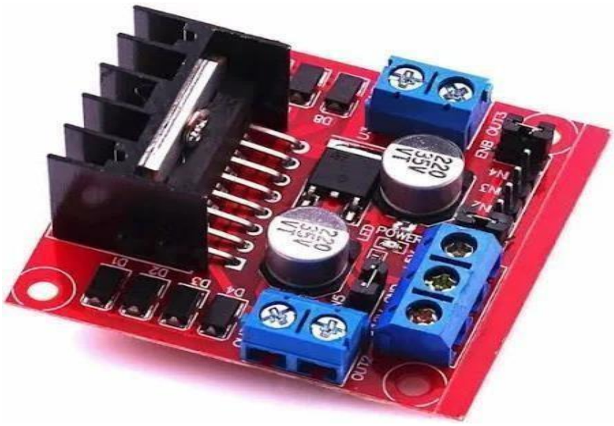


Figure 20: REAL IMAGE OF MOTOR DRIVER

Table 3: Specifications of Motor driver(L298N)

Parameter	Specification
Operating Voltage	4.5V to 46V (DC motor supply voltage)
Logic Voltage	5V (Typically from an external 5V supply)
Continuous Output Current	2A (per channel)
Peak Output Current	3A (per channel, for a brief duration)
Power Dissipation	25W (with heatsink, under full load)
Max Output Power	25W (depends on voltage and current)
Control Inputs	4 (IN1, IN2, IN3, IN4) for controlling the motor direction
Output Pins	4 (OUT1, OUT2, OUT3, OUT4) for motor connections

Enable Pins	2 (EN1, EN2) for controlling motor speed (PWM)
PWM Frequency	Up to 25kHz (depending on the application)
Operating Temperature Range	-25°C to +130°C (with adequate heat sinking)
Package Type	15-pin Multiwatt-15 or Dual In-Line Package (DIP-15)
Heat Sink	Required for high-power applications

3. CHARGING MODULE(TP4056)

Figure 21: REAL IMAGE OF CHARGING MODULE TP4056

Table 4: Specifications of charging module (TP4056)

Parameter	Specification
Charging Voltage	4.2V ± 1% (Nominal voltage for Li-ion/LiPo battery)
Charging Current	1A (Maximum, set by external resistor)
Input Voltage	4.5V to 5.5V (Typically 5V via micro-USB)
Charging Method	CC/CV (Constant Current / Constant Voltage)

Charge Termination	- Delta-V method (when the battery voltage reaches 4.2V) - Timer-based cutoff (if charge duration exceeds set time)
End of Charge Voltage	4.2V ± 1%
Battery Type	Single-cell Li-ion / LiPo (3.7V nominal)
Current Sense Resistor	1.2Ω (typically, sets the charge current)
Temperature Range	-40°C to +85°C
Efficiency	~90% (depends on input voltage and charge current)
PCB Size	25mm x 17mm (Typical module size)
Protection Features	- Overcharge protection (4.2V) - Over-discharge protection (2.5V to 3.0V) - Short-circuit protection
LED Indicators	- Red LED (Charging) - Green LED (Fully Charged)
Standby Current	< 50 µA (when no battery is connected and not charging)

4. BLUETOOTH MODULE(HC05)

Figure 22: REAL IMAGE OF BLUETOOTH MODULE HC05

Table 5: Specifications of Bluetooth module HC05

Specification	Details
Module Name	HC-05 Bluetooth Module
Bluetooth Version	Bluetooth 2.0 + EDR (Enhanced Data Rate)
Operating Voltage	3.3V to 6V (typically powered with 5V)
Current Consumption (Active)	30-40 mA
Current Consumption (Standby)	1-2 mA
Data Rate	2.1 Mbps (max)
Transmission Range	10 meters (class 2)
Frequency Range	2.4 GHz ISM Band
Interface	Serial (UART) - RX/TX (TTL level)
Baud Rate	9600 bps (default)
Parity	None
Stop Bits	1
Flow Control	None
Modulation Scheme	GFSK (Gaussian Frequency Shift Keying)
Security	128-bit encryption (optional, depending on configuration)
Chipset	SR BlueCore 04 (or similar Bluetooth chip)
Mode of Operation	Master/Slave
Pinout	6-pin Header (VCC, GND, TXD, RXD, EN, STATE)
Dimensions	3.5 cm x 1.5 cm (approx.)
LED Indicator 2 LEDs:	One for power (often red) and one for status (often blue)
Operating Temperature	-20°C to 75°C

5. SOLAR PANEL

A solar panel is a set of solar photovoltaic modules electrically connected and mounted on a supporting structure. A photovoltaic module is a packaged, connected assembly of solar cells. The solar panel can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential applications. Each module is rated by its DC output power under standard test conditions (STC), and typically ranges from 100 to 320 watts. The efficiency of a module determines the area of a module given the same rated output - an 8% efficient 230-watt module will have twice the area of a 16% efficient 230 watt module. A single solar module can produce only a limited amount of power; most installations contain multiple modules. A photovoltaic system typically includes a panel or an array of solar modules, an inverter, and sometimes a battery and/or solar tracker and interconnection wiring.

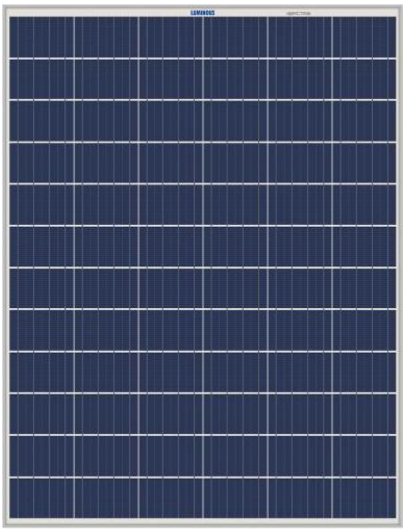


Figure 23: REAL IMAGE OF SOLAR PANEL

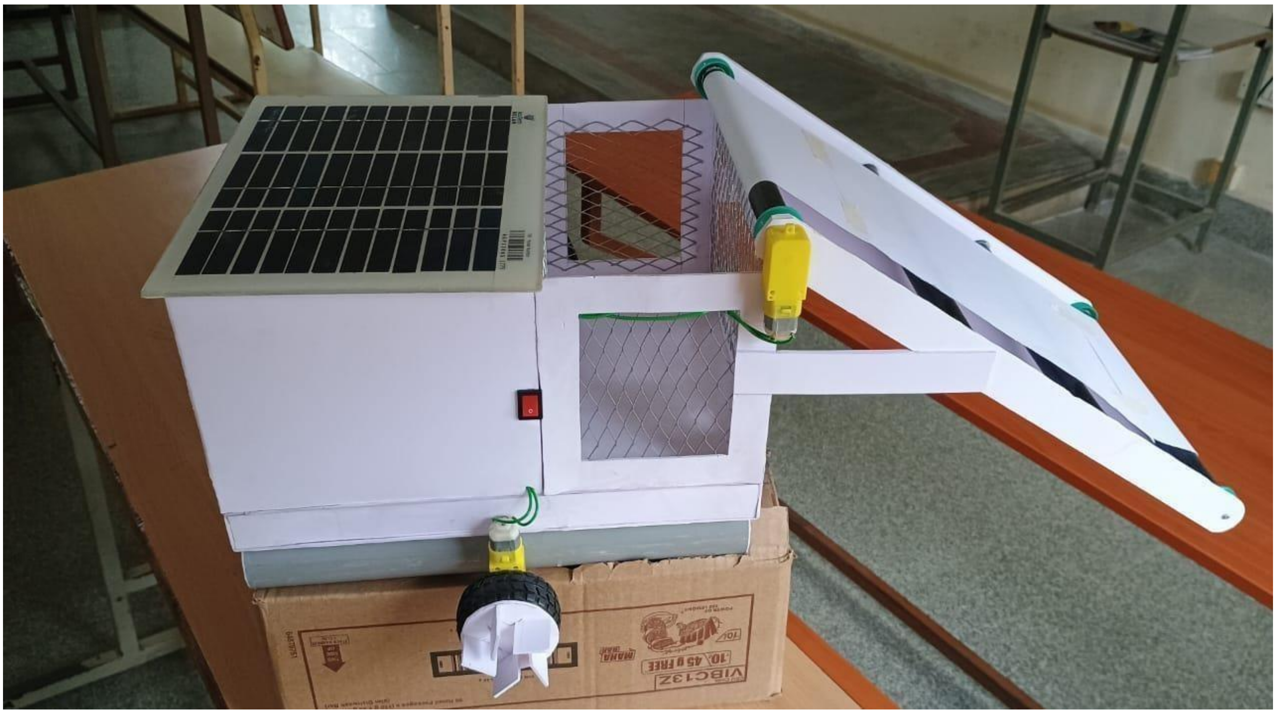
Table 6: Specifications of solar panel

Panel Type	Monocrystalline or Polycrystalline (Monocrystalline is typically more efficient and durable)
Panel Efficiency	15% to 22% (Monocrystalline panels are usually 18-22%, Polycrystalline is around 15-17%)

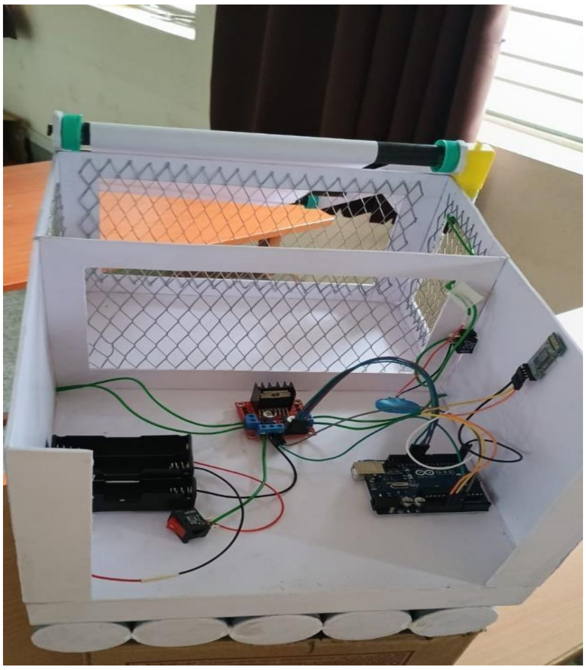
Power Output (Wattage)	10W to 100W (Depending on the power needs of the trash collector's motor, sensors, and other equipment)
Voltage	12V, 24V, or 48V (Depends on the system requirements; most systems use 12V or 24V for small to medium-scale applications)
Current	0.5A to 8A (Varies depending on wattage and voltage of the solar panel)
Operating Voltage	12V (most common for small systems) or 24V (for higher efficiency and larger systems)
Open Circuit Voltage (Voc)	18V to 22V (For 12V systems, this is the voltage when the panel is not connected to a load)
Short Circuit Current (Isc)	1.5A to 5A (Typically, for a 12V panel, this could be 1.5A to 5A depending on panel wattage)
Power Tolerance	±5% to ±10% (Indicates the margin of variance from the nominal panel power output)
Temperature Coefficient	-0.4%/°C to -0.5%/°C (Panel efficiency decreases slightly with increased temperature)
	600V to 1000V (depending on the type of solar panel and system design, typically for larger systems)
Frame Material	Anodized aluminum or stainless steel (for corrosion resistance, especially in marine environments)
Charge Controller Compatibility	Compatible with PWM (Pulse Width Modulation) or MPPT (Maximum Power Point Tracking) charge controllers

Maximum Power (Pmax)	Typically, 10W to 100W per panel (depending on the system size and requirements of the trash collector)
Storage Battery Compatibility	Compatible with 12V or 24V deep cycle batteries (depending on system size and design)
Glass Type	Tempered glass or toughened glass (Resistant to damage from water, debris, and UV exposure)
Temperature Range	-40°C to 85°C (Solar panels should operate effectively in a wide range of temperatures)

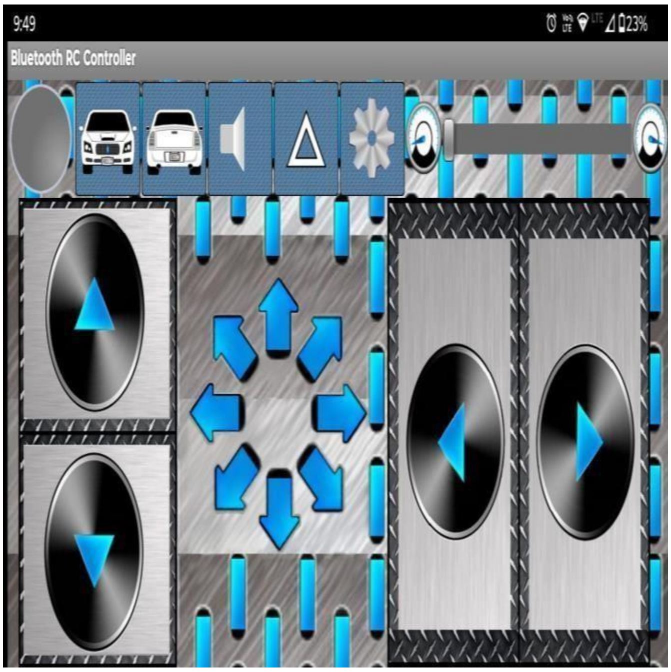
PHOTOS BLOG



Working model of Solar powered water trash collector



Circuit connection between Arduino Uno, Motor driver, Bluetooth HC05, Charging Module, Rechargeable batteries



Controlling the movement of boat through Bluetooth RC controller mobile application

PROJECT EXIBITION

Photo with Principal and HOD

Photo with Project guide

Photo with Project Co-Ordinator

Photo with panel member