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IMPLEMENTATION OF ROBOTIC-BASED WASTE COLLECTOR AND SEGREGATOR USING IoT

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ABSTRACT

The Seashore Plastic Waste Collection and Recycling System is an innovative solution designed to address coastal plastic pollution. By leveraging IoT technology, ultrasonic sensors, waste sorting mechanisms, and real-time messaging, the system enhances the efficiency of plastic waste collection and recycling along seashores. It utilizes motor-driven conveyors, ultrasonic sensors, motor drivers, an IoT module, and dedicated waste bins to automate the waste management process. This automation reduces manual labor and improves operational efficiency by streamlining the movement of plastic waste from the seashore to waste bins. The IoT module provides real-time data to a centralized control system, while dedicated waste bins facilitate easy transportation for recycling. The system aims to contribute to cleaner coastal environments and promote sustainable waste disposal practices by optimizing recycling efficiency and minimizing the environmental impact of coastal cleanup efforts. Additionally, it effectively segregates plastic waste based on moisture content and material properties.

1. INTRODUCTION

The Seashore Plastic Waste Collection & Recycling System is a comprehensive approach to combating plastic pollution in coastal areas worldwide. It integrates advanced technology with environmental stewardship to efficiently manage plastic waste along coastlines. The system features automated collection mechanisms strategically placed across coastal regions, utilizing sensor-based sorting technology to segregate various types of plastic waste. Designed with sustainability in mind, the system minimizes its environmental footprint while maximizing operational efficiency. Collected plastic waste undergoes rigorous sorting and processing before being transformed into reusable materials at state-of-the-art recycling facilities. Community engagement and public awareness initiatives are essential components of the system. Collaborations with local governments, environmental organizations, and other stakeholders underscore a collective commitment to preserving oceans, safeguarding marine ecosystems, and promoting a cleaner, healthier planet for future generations. The Seashore Plastic Waste Collection & Recycling System exemplifies a unified effort to protect marine environments and ensure a sustainable future.

Existing System

Ubuntoo has developed a dedicated sub-platform called "Greenhouse" to ensure global coverage of environmental solutions. This platform provides updates on organizations, movements, and technologies offering innovative solutions to plastic pollution, food waste, and sustainable fashion. Coordinated by Venkatesh Kini, a co-founder of Ubuntoo, the platform focuses on collecting technological solutions to prevent or reduce marine litter across the plastics value chain. It considers technologies for litter detection and capture, integrated waste management, and solutions to tackle riverine and beach litter. However, the platform does not include technologies related to wastewater treatment or impact remediation of marine litter. The platform curates technologies suitable for preventing or reducing plastic marine litter, sourced from existing solutions, expert judgment, and public campaigns. Additionally, UNEP has issued a call for contributions to the Ad-Hoc Open-Ended Expert Group on Marine Litter and Microplastics.

Need for System Analysis

- System analysis is a systematic examination of a system's components, processes, and objectives.
- It identifies strengths, weaknesses, opportunities, and threats.
- Techniques include requirements gathering, data modeling, and process mapping.
- The goal is to optimize system functionality, usability, and value, maximizing benefits for stakeholders and enhancing overall system performance.

3.2 Proposed System

The **Smart Seashore Plastic Waste Collection and Recycling System** is an innovative solution designed to manage plastic waste along seashores. This system employs advanced technologies such as real-time feedback, automated waste transportation via motors and conveyors, precise waste sorting with ultrasonic sensors, optimized collection routes using IoT technology, and efficient control through a microcontroller and motor drivers. It offers instant feedback on collection status and system parameters, ensuring transparency and ease of operation. By optimizing collection routes, the IoT technology minimizes fuel consumption and environmental impact. Additionally, the conveyor-to-box mechanism streamlines the transition from collection to recycling in an automated and eco-friendly manner.

Working Principle

The Seashore Plastic Waste Collection and Recycling System automates and enhances the plastic waste collection and recycling process through a combination of various components. It utilizes an Arduino Uno microcontroller as the central control unit, while ultrasonic sensors detect obstacles, monitor the conveyor belt's position, and check the fill levels of waste collection tanks. Other components include IR sensors, moisture sensors, a servo motor, relays, motor drivers, and multiple motors.

Motor Driver

A motor driver acts as a current amplifier that converts a low-current signal from a microcontroller into a higher current signal to control and drive a motor. Typically, a transistor functions as a switch to drive the motor in a single direction. To reverse the motor’s direction, an H-bridge circuit is used. This circuit, which resembles the letter "H," employs four switches arranged strategically to allow control over the motor’s direction and operation.

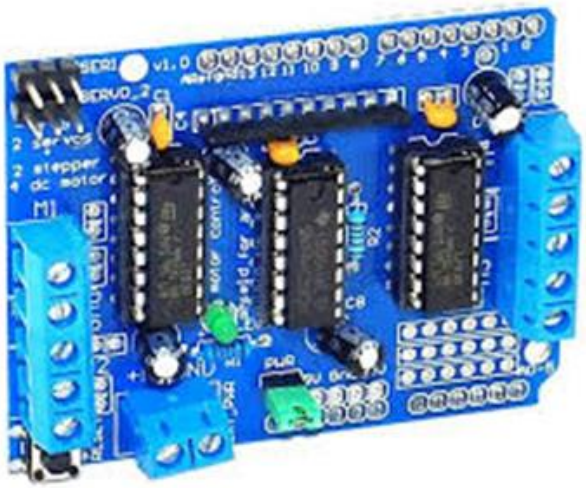

Figure1.1: Motor Driver

Ultrasonic Sensor

An ultrasonic sensor emits high-frequency sound waves and detects the echo reflected back from nearby objects. It operates by sending out these waves and measuring the time it takes for them to bounce back. This time difference is used to determine the object's distance. Ultrasonic sensors typically have a specified detection range that can vary from a few centimeters to several meters, depending on the model and application.

Figure 1.2: Ultrasonic Sensor

Arduino Microcontroller

The Arduino Uno is a popular microcontroller board based on the ATmega328P chip. It is widely used for prototyping and DIY electronics projects due to its simplicity, versatility, and ease of use. The board features a compact design with a microcontroller at its core, along with I/O pins, power connectors, and communication interfaces. Its straightforward layout makes it accessible for both beginners and experienced users. Programming is done using the Arduino IDE, which provides a user-friendly platform for writing, compiling, and uploading code.

Figure1.3: Ardiuno Microcontroller

LCD Display

A 16x2 LCD (Liquid Crystal Display) is a common alphanumeric display module used in electronic projects and devices. It consists of a grid of liquid crystal cells that either allow light to pass through or block it, depending on the voltage applied. Most 16x2 LCD displays feature an integrated LED backlight for visibility in low-light conditions. A controller chip, such as the HD44780 or a compatible variant, manages the display's operation, addressing individual pixels, interpreting commands, and handling data input and output.

Figure 1.4: LCD Display

IoT Module

The ESP8266 module is a low-cost Wi-Fi module that integrates a microcontroller unit with Wi-Fi functionality, making it ideal for IoT applications. It features a microcontroller based on the Xtensa LX106 architecture, responsible for executing user-programmed tasks, handling Wi-Fi communication, and interfacing with external devices. The module supports various Wi-Fi standards, including 802.11 b/g/n, and comes preloaded with firmware for Wi-Fi functionality and TCP/IP networking. Users can program the module using the Arduino IDE or other development platforms to create custom IoT applications, web servers, or client devices.

Figure 1.5: IoT Module

Conveyor

A conveyor system is mechanical equipment used in manufacturing, distribution, logistics, and material handling. It utilizes various movement mechanisms such as belt conveyors, roller conveyors, chain conveyors, and screw conveyors, each with unique design and operational principles. These systems move materials along a predefined path, ensuring efficient transportation of goods between locations.

IR Sensor

An infrared (IR) sensor detects infrared radiation in its environment and is used in applications like motion detection, temperature measurement, object detection, and communication. It consists of an emitter that emits infrared radiation and a detector that receives and analyzes it. The sensor interprets these signals to determine the presence, distance, or temperature changes of objects, enabling various applications.

Figure 1.6: IR Sensor

Servo Motor

A servo motor is a rotary actuator that provides precise control of angular position, velocity, and acceleration. It includes a DC motor, a geartrain, a feedback potentiometer (or encoder), and a control circuit. Servo motors are utilized in robotics, remote-controlled vehicles, industrial automation, and aerospace for accurate movement control. The motor shaft connects to the

geartrain, which reduces speed while increasing torque. The feedback potentiometer or encoder informs the control circuit about the motor shaft's position.

Figure 1.7: Servo Motor

3.3. Advantages:

- Smart Seashore Plastic Waste Collection and Recycling System.
- Integrates ultrasonic sensors and microcontrollers for efficient waste collection and sorting.
- Automates waste transportation and route optimization, reducing manual labor and operational costs.
- Provides real-time feedback for transparency and accountability in waste management.
- Enables quick adjustments and troubleshooting, improving operational efficiency and public engagement.
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3.4. Architecture Diagram:

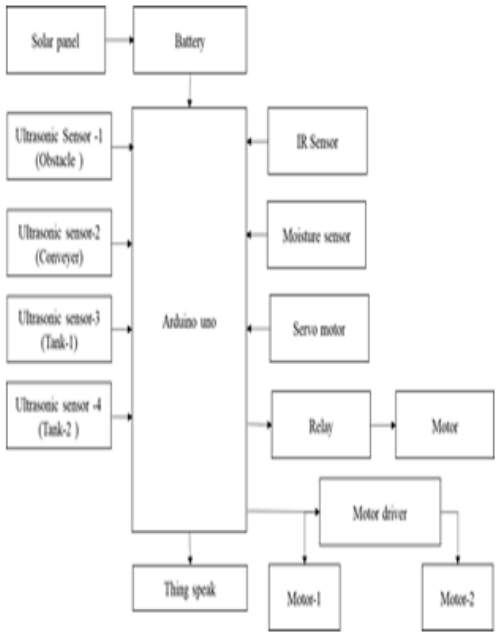

Figure 1.8: Architecture Diagram

Conclusion:

The Seashore Waste Collection System is a pioneering solution for coastal waste management, leveraging advanced technologies and innovative design. It incorporates solar panels for sustainable energy use, reducing its carbon footprint. Powered by an Arduino Uno microcontroller and ultrasonic sensors, the system offers precise and automated waste collection, optimizing efficiency and resource utilization. Its capability to segregate wet and dry waste enhances waste management, facilitating proper disposal and recycling. This comprehensive approach contributes to cleaner, healthier shorelines for present and future generations.

Future Enhancement:

The system could be further enhanced by incorporating artificial intelligence to recognize debris and other obstacles in its path. Future prototypes could include solar panels for eco-friendliness, a 3D printer for melting plastic debris into bins, and advanced AI for fully automated operation.

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