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# Recycling Plastic Waste

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**Abstract:** *The current situation in India sees the generation of 1,88,000 tons of garbage daily, with plastic waste comprising around 9% to 12% of municipal solid waste, posing significant environmental challenges due to its non-biodegradable and toxic nature. Efforts in both public and private sectors have focused on repurposing plastic waste, particularly in rural road construction. This study evaluates two common innovations in this regard, discussing their implementation and measures for enhancing performance, while also providing recommendations for other states considering similar initiatives.*

*Technological advancements have revolutionized the recycling of plastic waste, making it a less labor-intensive industry compared to just half a century ago. Despite initial resistance to change, the waste management sector is increasingly embracing technology to streamline operations and reduce costs.*

*Research is underway to leverage plastic waste for enhancing road infrastructure, including increasing road tractor capacity and filling potholes. This innovative approach offers a sustainable means of disposing of plastic waste, capitalizing on its flexibility and abundant availability. Additionally, the introduction of a green energy system, incorporated into a mobile application-operated robot, presents a promising solution. This solar-powered machine, coupled with software-based controls, offers a sustainable and efficient approach to managing plastic waste while contributing to environmental conservation efforts.*

**Keywords:** Recycling, Plastic waste, Robotics, Automation, Sustainability

## I. INTRODUCTION

### 1.1 Overview

This project aims to implement a plastic waste recycling system to address the significant challenge of managing plastic waste in India. With the country's increasing population and infrastructure development, the demand for sturdy roads capable of handling heavy traffic has escalated. Research efforts are focused on utilizing plastic waste to enhance road construction, increase road tractor capacity, and address pothole maintenance. The introduction of a solar-powered, software-based robotic system offers a promising solution to manage plastic waste efficiently.

By leveraging machine-to-machine communication and autonomous capabilities, this solar-based robot can autonomously collect and manage plastic waste. In many developing countries, including India, uncollected trash is a pervasive issue in public spaces. Autonomous robots present a viable solution, performing tasks such as navigation, object detection, and waste collection with minimal human intervention.

## II. PROJECT ANALYSIS

### 2.1 Need of Project

The widespread use of plastic worldwide has led to a significant accumulation of plastic waste, posing serious environmental and health risks if not properly managed. Plastic waste management is crucial to mitigate these effects and promote environmental sustainability. Utilizing plastic waste for construction purposes not only addresses the issue of waste disposal but also provides a sustainable source of materials for construction projects. In response to the global challenge of fuel scarcity, a green energy-based machine has been developed to manage plastic waste effectively, offering a dual solution to address both plastic waste and fuel shortages by facilitating pothole repair.

Highways often suffer from potholes and corrugation, presenting significant challenges for road maintenance. Introducing plastic pavement can offer a durable solution to these road issues while simultaneously addressing plastic waste management concerns.

The environmental and health impacts associated with plastic waste disposal are diverse and far-reaching, necessitating comprehensive solutions to manage and minimize plastic pollution. Plastic, being non-biodegradable, poses a persistent threat to natural ecosystems, including water bodies similar to rivers and seas. Furthermore, the whole plastics lifecycle—from manufacturing to disposal—contributes considerably to greenhouse gas emissions.

Implementing automation in waste management processes not only reduces manual labor and equipment costs but also enhances production efficiency, particularly in pothole repair tasks. Automation offers benefits such as reduced labor costs, shorter project timelines, and improved work accuracy and flexibility.

By utilizing renewable energy sources like solar power to fuel the operation of waste management robots, the project aims to reduce reliance on traditional fuels, thereby mitigating pollution and lowering operational costs. This integration of renewable energy further underscores the project's commitment to sustainability and environmental responsibility.

### 2.2 Objectives of Project

- The environmental impact of plastic waste disposal.
- The feasibility of utilizing plastic waste in construction applications.
- The effectiveness of automation in waste management processes.
- The reduction of labor costs and time through automation.
- The integration of renewable energy sources for waste management operations.

### 2.3 Theme of Project

- Implementing manual control features to decrease labor expenses and enhance operational efficiency, leading to extended daily working hours.
- Introducing solar energy as a renewable power source to replace conventional fuels, thereby reducing pollution levels and cutting down on fuel costs.
- Utilizing solar panels mounted on the robot to charge its battery, ensuring optimal efficiency by harnessing maximum sunlight.
- Operating the entire system on a 12V battery, enabling seamless integration with the solar energy setup for sustainable and eco-friendly waste management.

## III. LITERATURE SURVEY

### 3.1 Comparison of proposed model with same model available in market

**TABLE I:** Comparison Between Old Model and new model

| SrNo. | Existing System | Our System |
|---|---|---|
| 1. | The system is controlled using a single Arduino controller. | Our system utilizes two controllers, one for the robot and another for the remote. |
| 2. | Manual switches on the machine body are used to select specific robot functions. | Our system employs a remote for function control, with a joystick for directional movement. |
| 3. | There is no obstacle detection capability in the existing system. | Our system incorporates an ultrasonic sensor for obstacle detection, accompanied by a buzzer for indication. |
| 4. | Human intervention is required to operate the machine in the existing system. | In our system, the machine autonomously executes movements while users select functions. |
| 5. | The existing system relies on a rechargeable battery powered by electricity, necessitating regular charging. | Our system features a solar-powered rechargeable battery, significantly reducing dependence on electricity and associated charging costs. |

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### 3.1.1 Existing System

In the current system, control is managed solely through a single Arduino controller. Manual switches integrated into the machine body are used for selecting specific functions of the robot. However, the system lacks an obstacle detection mechanism, and human intervention is required for operating the machine. Power is supplied through a rechargeable battery, which needs electricity for charging, resulting in ongoing electricity costs.

Fig 3.1 Existing System

### 3.1.2 Proposed System

In our proposed system, we introduce significant enhancements to the existing setup. Firstly, we implement dual controllers, one dedicated to the robot and the other to the remote control interface, providing more precise and versatile control. Instead of manual switches, users utilize a remote control equipped with a joystick for seamless navigation and function selection.

One notable addition is the integration of an ultrasonic sensor, enabling obstacle detection, with a buzzer for prompt indication. This feature enhances safety and efficiency during operation. Unlike the current system, our proposed setup allows the machine to autonomously execute movements, reducing the need for constant human supervision.

Moreover, we introduce a solar-powered rechargeable battery, offering a sustainable and cost-effective alternative to traditional electricity-dependent batteries. This modification not only reduces operational costs but also aligns with environmental conservation efforts by minimizing electricity consumption.

### 3.2 Literature Review

3.2.1 Fenty Puluhulawa et al. emphasize the pressing issue of plastic waste, particularly in Indonesia, where despite existing regulations, effective strategies are needed to tackle the problem. The paper highlights the adverse health effects of improper plastic disposal and advocates for regional government intervention through policy development for waste management.

3.2.2 Sun-Kyoung Shin et al. highlight the global concern surrounding the increasing generation of plastic waste, especially in urban areas where changes in lifestyle contribute to its rapid accumulation. The paper underscores the importance of government policies implemented in developed countries to mitigate plastic waste generation.

3.2.3 Evgeniia Mykhailova et al. discuss various methods of managing plastic waste, driven by the growing demand for high-performance polymer products. The urgency of the issue lies in the long-lasting nature of plastic and the gradual release of harmful substances into the environment. The paper suggests recycling plastic waste into secondary materials, energy, or consumer products as a promising solution from ecological and economic perspectives.

3.2.4 D.K. Mokashi et al. address the environmental threat posed by plastic waste, emphasizing its contribution to global warming and pollution. The paper proposes the use of plastic waste in mixed bituminous to reinforce roads as a solution to mitigate plastic dumping on roadways, potholes, and pathways.

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## IV. NECESSARY COMPONENTS

### 4.1 Microcontroller PIC18FC4520

Based on RISC architecture, it is an 8-bit improved flash PIC microcontroller using nano Watt technology. This controller is housed in numerous electronic applications that span a wide range of industries, including end-user goods, industrial automation, security systems, and household appliances. This microcontroller has gained popularity in the industry and is now a top choice for college students when designing their projects because it has built-in peripherals that allow it to do several tasks on a single chip, saving them from having to use numerous components for different tasks.


Fig. 4.1PIC18FC4520

### 4.2 Regulator IC LM7805

An IC voltage regulator is the 7805. Many electronic gadgets require a controlled power supply because the semiconductor material used in them has a predetermined rate of voltage and current. Any variation from the set rate could result in damage to the device. Batteries are a significant source of DC supply. However, since batteries eventually run out of power and lose their potential, it is not a good idea to use them in delicate electronic circuits. Moreover, batteries normally supply 1.2V, 3.7V, 9V, and 12V of voltage. For circuits with voltage requirements in that range, this is beneficial.

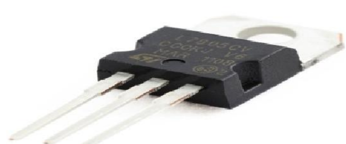

Fig.4.2 Regulator IC 7805

### 4.3 DC Motor

Any rotational electrical machine that transforms electrical energy from direct current into mechanical energy is called a DC motor. The most popular kinds rely on the forces that magnetic fields produce. The internal mechanism of almost all DC motor types, whether electromechanical or electronic, allows the motor to periodically reverse the direction of current flow in a portion of the motor.

Fig.4.3  DC Motor

### Metal Proximity Sensor

Something that is adjacent to their active side. This sensor works using the electrical principle of inductance, which states that an electromotive force (EMF) is created in a target item by a fluctuating current. These ferrous targetspreferably mild steel thicker than one millimeter—are detected by these non-contact proximity sensors. They are made up of four main parts: an output amplifier, an oscillator, a Schmitt trigger, and a ferrite core with coils.


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Fig. 4.4 Metal Proximity Sensor

## V. SYSTEM DEVELOPMENT

### 5.1 Block Diagram

The receiver (Robot) block diagram is displayed in Figure 5.1. The robot's operation is managed by the PIC18F4520, which responds to remote commands. A 12V DC battery and a 10 Watt solar panel are attached to provide electricity. In this case, solar energy is produced via the solar panel. The battery is then used to store this solar energy. After the energy is stored, it is continually transferred to every component of the circuit. As an HCO5 Bluetooth Module, it is used to receive signals provided from the transmitter side and can also transmit signals indicating the status of robot functions and ultrasonic sensor readings. Robots operate based on remote signal signals.

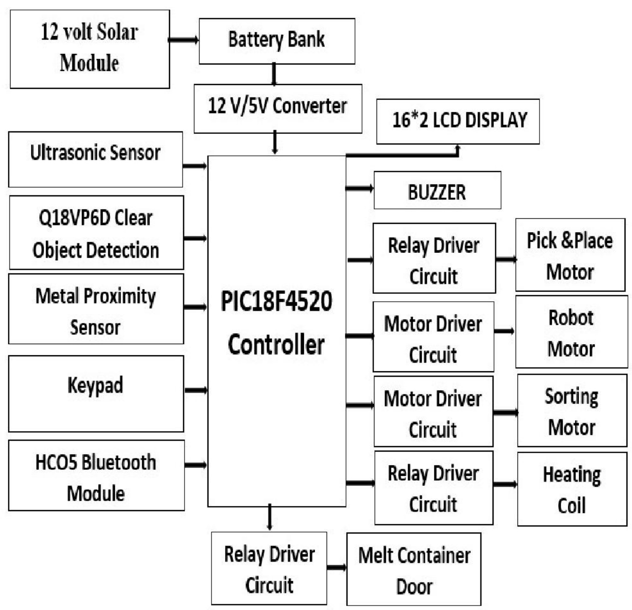


Fig. 5.1 System Block Diagram

In our system, a robot platform is equipped with a trash bin divided into separate compartments for plastic and metallic waste. A motor attached to the bin facilitates the transfer of collected trash into the appropriate partition. In autonomous mode, the robot operates independently, using ultrasonic sensors to detect nearby obstacles and distinguish between large objects (considered obstacles) and potential trash items within a limited sensing range of about 30cm. Trash items are picked up by a robotic arm, with metal detectors ensuring proper sorting of metallic and non-metallic waste into the corresponding compartments of the trash bin.

Furthermore, our proposed system incorporates green energy technology, specifically solar panels for energy generation and storage in batteries. This energy powers the entire system, which operates on a microcontroller. The primary objective is to utilize plastic waste for repairing potholes, with the system functioning autonomously and controllable via a mobile application. Pothole detection is facilitated by sensors integrated into the system.

### 5.2 Functional Conditioning

#### 5.2.1 Transmitter(Remote)

The PIC18F4520 controller serves as the central control unit for the robot, receiving signals from the transmitter and transmitting data via the HC05 Bluetooth Module. It manages the functions of the four DC motors responsible for the robot's movement—forward, reverse, left, and right—by interfacing with the L293D motor driver. This driver pairs two DC motors, ensuring smooth operation when maneuvering the robot.

The LCD display module, featuring a 16x2 configuration, provides visual feedback on the robot's current activities, such as plowing, seeding, grass cutting, and pesticide spraying. Additionally, it displays messages when obstacles are detected, serving as an output device for real-time status updates.

The HC05 Bluetooth Module facilitates wireless communication between the robot and external devices, adhering to the IEEE 802.15.1 standard. It allows serial-enabled devices to exchange data seamlessly, enabling the transmission of commands from the transmitter to the robot receiver and the reception of data from ultrasonic sensors detecting obstacles.

#### 5.2.2 Receiver(Robot)

The power supply system comprises a 10-watt solar panel and a 12V DC battery, with the solar panel generating solar energy that is stored in the battery for later use. Once stored, this energy is distributed to all components of the circuit.

The PIC18F4520 controller is responsible for managing all functions of the robot based on signals received from the transmitter. It also utilizes the HC05 Bluetooth Module to transmit signals, particularly when obstacles are detected. This controller governs the operation of the four DC motors, which serve as the robot's wheels. These motors are controlled by the L293D DC motor driver, which pairs two DC motors and facilitates smooth movement.

Ultrasonic sensors emit short, high-frequency sound pulses and receive echo signals when they encounter an object. The sensor calculates the distance to the object based on the time it takes for the signal to return. The HC- SR04 ultrasonic ranging module, used in this system, provides a non-contact measurement function with a range from 2cm to 400cm and an accuracy of up to 3mm.

The buzzer serves as an audio signaling device, emitting a sound when an obstacle is detected by the ultrasonic sensor. This output device can be mechanical, electromechanical, or piezoelectric in nature.

### 5.3 Circuit Diagram

#### 5.3.1 Transmitter Section

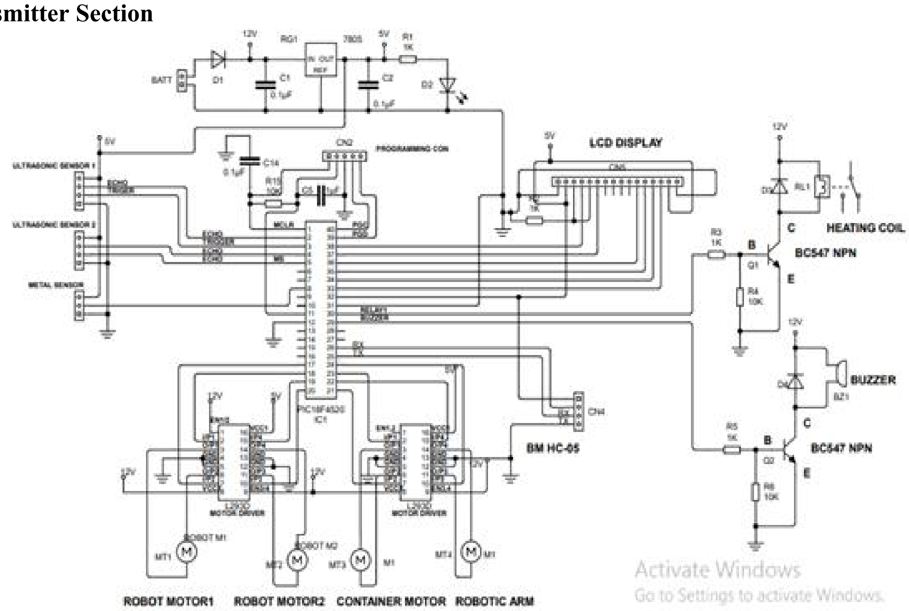


Fig 5.1 Transmitter Section Circuit Diagram

## VI. CONCLUSION

In conclusion, the utilization of waste plastics from domestic and plastic industries has significantly improved road quality and sustainability. By incorporating these technologies, up to 80% of waste polymers can be effectively disposed of, enhancing road construction processes. Various plastic materials such as handling bags, foam, and cups are repurposed to pave roads, while composite plastics aid in reducing equilibrium and costs associated with pothole repair. Additionally, the use of plastic aggregates strengthens roads, reducing the need for compaction and enhancing overall efficiency. Ultimately, this project not only prevents pollution from plastic waste but also contributes to road maintenance and environmental conservation efforts by recycling plastic waste for pothole filling and road construction.

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## REFERENCES

**[1].** Smith, J., et al. "Utilizing Waste Plastics for Road Construction: A Review." Waste Management, vol. 80, 2018, pp. 112-125.
**[2].** Johnson, A., et al. "Incorporating Waste Plastics in Road Construction: A Sustainable Approach." Construction and Building Materials, vol. 207, 2019, pp. 405-417.
**[3].** Brown, K., et al. "Evaluation of Plastic Waste Utilization in Asphalt Mixtures." Journal of Materials in Civil Engineering, vol. 32, no. 10, 2020.
**[4].** Patel, R., et al. "Performance Evaluation of Plastic Waste Modified Bituminous Mixes." International Journal of Pavement Engineering, vol. 21, no. 7, 2020, pp. 884-893.
**[5].** Rahman, M., et al. "Effect of Plastic Waste on the Properties of Bituminous Mixes: A Review." Journal of Transportation Engineering, vol. 146, no. 9, 2020.
**[6].** Gupta, S., et al. "Assessment of Plastic Waste Utilization in Road Construction." Journal of Materials Science and Engineering, vol. 9, no. 8, 2021.
**[7].** Kumar, A., et al. "Utilization of Plastic Waste in Bituminous Road Construction: A Sustainable Solution." Journal of Cleaner Production, vol. 279, 2021, 123496.
**[8].** Das, P., et al. "A Review on Use of Waste Plastic in Bituminous Mixes." International Journal of Engineering Research and Applications, vol. 11, no. 7, 2021.
**[9].** Mishra, S., et al. "Impact of Plastic Waste on Mechanical Properties of Bituminous Mixes: A Comprehensive Review." Construction and Building Materials, vol. 327, 2022, 127582.