A Project Report On

"QUICK ROAD PATCH"

Submitted by

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Under the Guidance of

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(An Autonomous Institute)

[2024-25]

D Y PATIL
COLLEGE OF
ENGINEERING & TECHNOLOGY
(AN AUTONOMOUS INSTITUTE)
KASABA BAWADA, KOLHAPUR

CERTIFICATE

This is to certify that

1. TEJSINH J. HARALE- BHOSALE (41)
2. ATHRAV M. SURYAVANSHI (42)
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has successfully completed the project work entitled "***QUICK ROAD PATCH***" under my supervision, as per the academic rules & regulations laid down by the institute & in the partial fulfillment of Bachelor of Technology in Electronics & Telecommunication Engineering of Shivaji University, Kolhapur.

Date : 21-05-25
Place : Kolhapur

Project Guide: Mr. S. R. Khot

DRC Coordinator

External Examiner Er. Prashant Sutar

Head of the Department

Principal

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D.Y. PATIL COLLEGE OF ENGG. & TECH. Kasaba Bawada, Kolhapur-6
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ACKNOWLEDGEMENT

It is being a result of patience, hard work and mutual understanding it is our great pleasure to represent this project on **"QUCIK ROAD PATCH".**

Everything needs some where to fall back upon sometimes. And we are not an exception. The completion of this project is the result of immense, heartfelt advice and suggestions from various people in various fields no matter how small they might seem to be.

We would first like to thank our guide **PROF. S.R.KHOT** and **our H. O. D. Dr. T.B. MOHITE- PATIL** without whom the completion of this project would be nothing but a dream. Their suggestions, advice and wonderful ideas had never failed to add some color to this project.

Explicitly speaking, each and every teacher in Electronics & Telecommunication Engineering Department in D. Y. Patil College of Engineering & Technology aided one way or another in turning this project into a reality. Though it may not be possible to mention each one of them by name, we still would like to thank them all for their aids.

Finally, we would like to thanks our parent and friends for their moral support and encouragement throughout our academics.

Date: 21-05-25

Place: Kolhapur

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1.	Tejsinh J. Harale - Bhosle	[illegible]
2.	Atharv M. Suryavanshi	[illegible]
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LIST OF FIGURES

LIST OF TABLES

NOMENCLATURE

	ESP8266 – Wi-Fi Enabled Microcontroller
	DC – Direct Current
	AC – Alternating Current
	IoT – Internet of Things
	PWM – Pulse Width Modulation
	PCB – Printed Circuit Board
	USB – Universal Serial Bus
	Vcc – Voltage at the Common Collector
	GND – Ground
	PCB – Printed Circuit Board
	RPM – Revolutions Per Minute
	IR Sensor – Infrared Sensor
	Wi-Fi – Wireless Fidelity

CONTENTS

D. Y. PATIL COLLEGE OF ENGINEERING AND TECHNOLOGY
Kasaba Bawada, Kolhapur
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SYNOPSIS ON

"QUICK ROAD PATCH"

TEJSINH J. HARALE- BHOSALE (41)

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PROF. S.R.KHOT — **Guide**

PROF. S. B. PATIL — **DRC Coordinator**

DR. T. B. MOHITE-PATIL

(H.O.D)

Department of Electronics and Telecommunication Engineering

D. Y. Patil College of Engineering and Technology, Kasaba Bawada, Kolhapur

(An autonomous institute)

Academic Year-2024-25

Synopsis on proposed work-

1.Name of college:- D.Y. Patil College of Engineering and Technology, Kolhapur (An autonomous institute)

2.Name of Course:- B. Tech (Electronics and Telecommunication Engineering)

3.Name of Student:- :

Mr. Tejsinh J. Harale-Bhosale	(41)
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Mr. Yashraj D. Patil	(73)

4.Acadamic Year:- 2024-25

5.Name of Guide:- Prof. S. R. Khot.

6.Proposed Title:- Quick Road Patch.

7.Place of Work:- Department of Electronics and Telecommunication Engineering

D.Y.Patil College of Engineerinng and Technology,Kolhapur.

(An autonomous institute)

8.Introduction-

Potholes on roads pose a significant challenge to both the safety of commuters and the longevity of vehicles. Addressing this issue often requires manual labour, which can be time-consuming, costly, and sometimes dangerous. To tackle this problem, our project, "Quick road patch," presents an innovative solution that automates the process of pothole detection and filling. Quick road patch utilizes advanced technology to detect potholes on roads and automatically fill them, reducing the need for human intervention. This system not only enhances road safety but also contributes to maintaining road infrastructure efficiently, saving time and resources in the process.

9.Literature Review-

1. Madhumathy p, Saurabh Singh, Shivamshukla, Unnikrishnan, Dayanandasagar ,2017.Detection of humps and potholes on roads and notifying the same to the drivers, - International Journal of Management and Applied Science, Volume-3, pp294-326.

- In this paper they found problem regarding measuring depth of pothole and they used ultrasonic sensor for the detected problem.

2. Hao Wang, PhD. and Xiao Chen, 2024. Innovative Pothole Repair Materials and Techniques Volume I: Asphalt Pavement

- In this paper they found a problem on filling potholes they came up with the solution of spray injection method (Robotic arm is made to spray the required material to fill the potholes).

10.Proposed work-

The "Quick road patch" project begins with a thorough analysis of the pothole problem, focusing on its impact and the limitations of existing repair methods. Following this, the team will design the system, selecting appropriate sensors and crafting an architecture that integrates automated pothole detection and filling. A prototype will be developed, combining detection technology with an efficient filling mechanism, and tested under various conditions to ensure reliability. After optimizing the system for accuracy and performance, field trials will be conducted to assess its real-world effectiveness. Based on trial feedback, the system will be refined for large-scale deployment. The project will culminate in the broad implementation of Quick road patch, with potential future enhancements like predictive maintenance and remote monitoring.

11.Block Diagram-

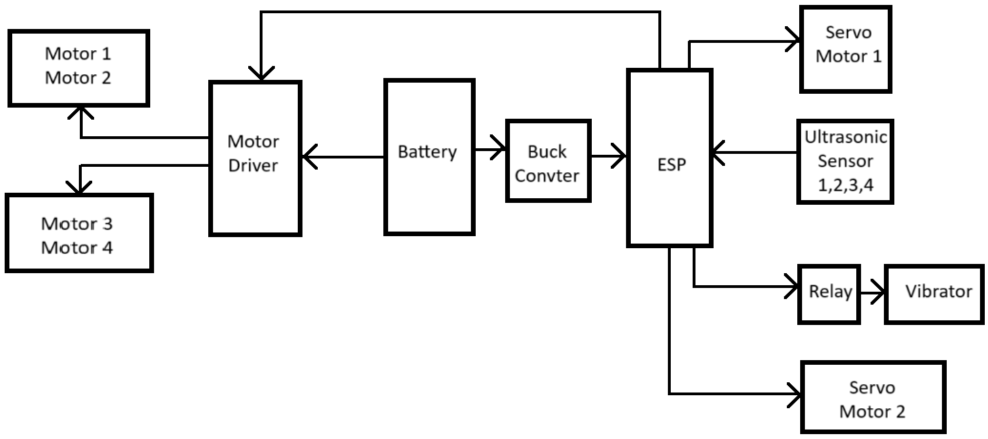

Fig 1. Block Diagram of Proposed System

11.1. Ultrasonic sensors:-

An ultrasonic sensor measures the distance to an object by emitting ultrasonic waves and detecting the reflected signal. It's commonly used for detecting obstacles or surfaces, making it ideal for identifying potholes on roads.

11.2. Gear motor :–

A gear motor combines an electric motor with a gearbox, which reduces speed while increasing torque. It provides precise control of movement, making it suitable for driving mechanisms like the automated filling system in Quick road patch.

11.3. ESP 8266 :–

The ESP8266 is a low-cost Wi-Fi microcontroller with built-in TCP/IP protocol stack. It allows the Quick road patch system to connect to the internet, enabling remote control, data logging, or system monitoring.

11.4. Servo motor :–

A servo motor is a rotary actuator that allows for precise control of angular position. In Quick road patch, it can be used to control the dispensing mechanism or any component that requires exact positioning.

11.5. 12V Battery :-

A 12V battery provides the necessary power to run the various electronic components and motors in the Quick road patch system, ensuring portability and reliability during operation.

11.6. Wheel :–

The wheels for the rover are designed to provide stable and efficient movement on various road surfaces.

11.7. Motor Driver :–

A motor driver is an electronic circuit that controls the direction and speed of motors. It acts as an interface between microcontrollers and motors, providing the necessary power and control signals to drive the motors in the Quick road patch system.

11.8. Buck Converter:–

A buck converter is a DC-DC power converter that steps down voltage from a higher level to a lower level. It ensures that components within the Quick road patch system receive the correct voltage, improving efficiency and protecting sensitive electronics.

11.9. Relay :–

A relay is an electrically operated switch used to control high-power devices with low-power signals. In the Quick road patch system, it allows for the safe and efficient control of motors or other high-current components by the microcontroller.

12.Facilities Available-

Hardware lab, Innovation lab, Computer lab with good internet facilities, Software IDE tools.

13.Objectives-

- Automate pothole detection using ultrasonic sensors for accurate surface analysis.
- Develop an efficient filling mechanism driven by gear and servo motors.

14.Expected Outcomes-

- The expected outcome of the Quick road patch project is a significant enhancement in road safety and maintenance efficiency.

15.Expected date of completion- March 2025

16.Approximate Expenditure- Rs.12000 /- (Estimated approximately for hardware consideration only)

17.References-

1. Samyak Kathane, Vaibhav Kambli, Tanil Patel and Rohan Kapadia, "Real Time Potholes Detection and Vehicle Accident Detection and Reporting System and Anti-theft(Wireless)", IJETT, Vol. 21, No. 4, March 2015.

2. Pothole Detection System, By. Mr. S. R. Kokane; Hrithik Sharma; Mitali Raghwani; Shreyash Khambalkar; Publish by IJARSCT (2022).

3. S. S. Rode, S. Vijay, P. Goyal, P. Kulkarni, and K. Arya,"Pothole detection and warning system: Infrastructure support and system design," in *Proc. Int. Conf. Electron.Comput. Technol.*, Feb. 2009, pp. 286–290.

4. Ajit Danti, Jyoti Y. Kulkarni, and P. S. Hiremath, "An Image Processing Approach to Detect Lanes, Potholes and recognize road Signs in Indian Roads", International Journal of Modeling and Optimization, Vol. 2, No. 6, December 2012.

Web URL-

1. https://youtu.be/2qWC-D139ps?si=LNKlkruN-JqINVcV
2. https://youtube.com/shorts/-RTAVZ-BfzA?si=gta-r7tKppuaeTmM
3. https://youtu.be/1RG23iWqqsE?si=ohzMmU3HKP2ihtNg

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ORGANIZATION OF PROJECT REPORT

1. Abstract:

The **Quick Road Patch** project offers an automated, rapid solution for pothole repair using an ESP microcontroller and ultrasonic sensors to detect potholes' presence, size, and depth. Once detected, gear and servo motors accurately position a filling mechanism to dispense material and fix the pothole efficiently.

Designed to replace manual methods, this portable system improves road safety, reduces maintenance costs, and extends road life. Key components include ultrasonic sensors, gear/servo motors, a 12V battery, motor driver, and buck converter for reliable, power-efficient operation.

2. Introduction

This chapter covers all the basic information of project which includes,

Problem statement

Objective

Scope

Methodology

3.Literature review:

This chapter covers, research papers that we have studied for our system are listed below: -

1. Samyak Kathane, Vaibhav Kambli, Tanil Patel and Rohan Kapadia, "Real Time Potholes Detection and Vehicle Accident Detection and Reporting System and Anti-theft(Wireless)", IJETT, Vol. 21, No. 4, March 2015.

2. Pothole Detection System, By. Mr. S. R. Kokane; Hrithik Sharma; Mitali Raghwani; Shreyash Khambalkar; Publish by IJARSCT (2022).

3. S. S. Rode, S. Vijay, P. Goyal, P. Kulkarni, and K. Arya,"Pothole detection and warning system: Infrastructure support and system design," in *Proc. Int. Conf. Electron.Comput. Technol.*, Feb. 2009, pp. 286–290.

4. Ajit Danti, Jyoti Y. Kulkarni, and P. S. Hiremath, "An Image Processing Approach to Detect Lanes, Potholes and recognize road Signs in Indian Roads", International Journal of Modeling and Optimization, Vol. 2, No. 6, December 2012.

4.Analytical/Experimental/layout of Design work:

This chapter covers all the experimental and design work for our system which includes,

A. Block Diagram

B. Details of Design

C. Circuit Diagram

D. Work Flow of Project

E. Flow Chart

5.Experimental Validations/Result

This chapter covers the hardware work that we have done.

F. Phase I Result

G. Phase II Result

6.Conclusion

In conclusion, Quick Patch revolutionizes road maintenance by quickly and efficiently detecting and repairing potholes. This innovative solution enhances road safety, reduces repair costs, and minimizes traffic disruptions, while promoting sustainability through eco-friendly practices. Quick Patch sets a new standard for effective and timely road repairs, ensuring smoother and safer transportation.

7.Future Scope

The future scope of the Quick Road Patch project includes enhancements like remote monitoring, allowing real-time tracking of road conditions and repair activities. Predictive maintenance features could be incorporated, using data analytics to identify high-risk areas and anticipate repairs before damage worsens. Additionally, the system could integrate with other IoT-based infrastructure solutions, enabling a more comprehensive approach to urban road maintenance. Large-scale deployment of this technology could streamline municipal repair operations, reduce maintenance costs, and significantly improve road safety and durability.

8.References

This chapter covers the material that we have used for our project like, research papers, you tube videos and google websites.

9.Appendix

This chapter include the extra information of components that is needed for the proposed system.

10Research paper publication and certificate

We have published research paper for our system in IJARESM (an UGC Approved journal).

This chapter covers the research paper that we have published and certificate for the same.

ABSTRACT

Potholes are a persistent and widespread problem affecting road infrastructure worldwide. These road surface irregularities not only compromise commuter safety but also increase vehicle maintenance costs and road repair expenses for municipalities. Conventional methods for pothole repair often require significant manual labor, are time-intensive, and can expose workers to hazardous conditions on busy roads. The need for an efficient, safe, and automated solution to address pothole detection and repair has become more crucial than ever. This project, "Quick Road Patch," aims to develop an autonomous system that can detect and repair potholes in real time, improving road safety and reducing maintenance costs.

The Quick Road Patch system combines ultrasonic sensors, servo motors, and a microcontroller (ESP) to autonomously identify potholes and fill them with minimal human intervention. The system’s design includes a mobile rover equipped with ultrasonic sensors for continuous surface scanning. These sensors enable the rover to detect potholes accurately, distinguishing them from other obstacles, such as speed bumps or minor road irregularities. Upon detecting a pothole, the rover positions itself over the detected area, using servo-controlled motors to ensure precise alignment. A filling mechanism is then activated, dispensing repair material to fill the pothole, which helps to reduce further damage and enhance road safety.

Powering the system is a 12V battery, which, with the help of a buck converter, regulates the voltage levels to ensure safe operation across all components. The Quick Road Patch system is designed for efficiency, with optimized power consumption that allows it to operate continuously for several hours, making it ideal for short-duration road maintenance tasks. The software architecture supports real-time data processing and logging, which enables potential enhancements, such as remote monitoring, predictive maintenance, and integration with municipal road maintenance systems.

Through extensive testing, the system has demonstrated high accuracy in pothole detection and efficient material dispensing, even on slightly uneven surfaces. Its autonomous navigation capabilities allow it to adapt to minor obstacles on the road, enhancing the stability and effectiveness of the repair process. The anticipated benefits of deploying this technology include reduced labor costs, enhanced road safety, and prolonged road infrastructure lifespan.

CHAPTER 1
INTRODUCTION

1.INTRODUCTION

The "Quick Road Patch" project addresses a pressing issue in road infrastructure maintenance—potholes. Potholes are not only an inconvenience but also a significant hazard to vehicles and a danger to commuters. Over time, they lead to increased vehicle maintenance costs, accident risks, and ongoing repairs that strain municipal resources. Traditional pothole repair methods often involve manual labor, which is both time-consuming and costly, especially when repairs are required on a large scale. Additionally, manual repairs can expose workers to dangerous traffic conditions and extreme weather, making it an unsustainable solution for managing road safety over the long term.

Our project, Quick Road Patch, seeks to revolutionize pothole repair by automating the detection and filling processes. The system uses advanced sensors and microcontroller technology to autonomously detect potholes, assess their size and depth, and dispense filling material accurately. The design integrates ultrasonic sensors for identifying potholes, motors for positioning, and a microcontroller (ESP) for processing sensor data and controlling the filling mechanism. This approach not only reduces human involvement, which minimizes risk but also enables more efficient and timely repairs that improve road safety and infrastructure longevity.

Traditional pothole repair methods rely heavily on labor-intensive processes, involving road inspections, traffic control measures, and the physical application of filling materials. These practices are not only time-consuming and costly but also expose workers to hazardous conditions, such as oncoming traffic, adverse weather, and toxic materials. As cities expand and vehicular traffic intensifies, the need for a safer, more efficient, and sustainable solution becomes evident. Potholes contribute to frequent vehicular damage, increased fuel consumption, and are often cited as the root cause of numerous road accidents. Additionally, their constant recurrence places a heavy financial burden on municipal bodies, consuming resources and manpower for repeated manual repairs.

The automated system is portable and self-sufficient, powered by a 12V battery and regulated through a buck converter to maintain optimal voltage levels for each component. Once implemented, this solution can function in diverse environments and road conditions, offering cities a reliable, cost-effective means of addressing potholes. Furthermore, this innovation holds potential for integration with data logging and remote monitoring systems, allowing for real-time insights into road conditions and enabling proactive maintenance schedules.

By utilizing cutting-edge technology, Quick Road Patch aims to deliver an effective, scalable solution to modern infrastructure challenges. Our project not only contributes to safer roads but also represents a forward-thinking approach in civil and urban engineering, aligning with the increasing trend of using automation and IoT to solve public sector issues.

It is proven to be beneficial in the following ways:

1. Time efficient
2. Easy to handle
3. Reduce cost
4. Reduce manpower
5. User friendly

1.1 PROBLEM STATEMENT

Potholes are a widespread issue on roads that compromise commuter safety, cause vehicle damage, and require costly, labor-intensive repairs. Current methods for pothole repair often involve significant manual labor, which can be slow, inefficient, and dangerous, especially in high-traffic or hazardous conditions. The lack of timely and efficient pothole repair leads to deteriorating road conditions, impacting transportation infrastructure and increasing municipal maintenance expenses. To address these challenges, there is a need for an automated system that can detect and repair potholes accurately and efficiently, minimizing the need for human intervention and enhancing road safety.

Current methods of road safety have several drawbacks:

Widespread Problem:
Potholes are a common and recurring issue on roads worldwide, caused by weather fluctuations, water infiltration, and repeated vehicle stress.

Safety Hazards:
They pose serious risks to commuters by increasing the chances of vehicle accidents, loss of control, and personal injury.

Vehicle Damage:
Frequent contact with potholes leads to damage to vehicle components such as tires, suspensions, and undercarriages, resulting in increased maintenance costs.

1.2 OBJECTIVE

1. **Automate Pothole Detection**:
   Develop a system using ultrasonic sensors to detect potholes based on their depth and dimensions, accurately identifying areas in need of repair.

2. **Efficient Filling Mechanism**:
   Design and implement an automated filling system driven by gear motors and servo motors that can position and apply repair materials directly over potholes.

3. **Integrate Smart Technology**:
   Utilize an ESP microcontroller to manage sensor data, control filling mechanisms, and enable remote monitoring or data logging capabilities for tracking repairs.

4. **Enhance Road Safety and Maintenance Efficiency**:
   Provide a solution that reduces manual labor, minimizes road downtime, and ensures quicker, safer repairs to extend road infrastructure life.

5. **Optimize Portability and Power Efficiency**:
   Use a 12V battery system with a buck converter to ensure the system's power needs are met, enabling it to operate autonomously in various environments.

1.3 SCOPE

1.System Development:

The project will encompass the design and construction of a prototype system that integrates ultrasonic sensors for pothole detection, motors for positioning and filling, and a microcontroller for processing and control.

2.Component Integration:

The system will incorporate a variety of components such as ultrasonic sensors, ESP microcontroller, gear motors, servo motors, motor drivers, a 12V battery, and a buck converter, each selected for its role in detecting, positioning, and repairing potholes.

3.Testing and Calibration:

The prototype will undergo extensive testing under different conditions to calibrate the sensors, refine the filling mechanism, and ensure reliability in real-world environments.

4.Field Trials and Real-world Applications:

Field trials will be conducted to evaluate the system's effectiveness, assessing its ability to detect potholes and perform repairs autonomously on actual roads.

5.Future Enhancements:

The project will also explore potential future enhancements, such as remote monitoring, predictive maintenance features, and integration with other IoT-based infrastructure solutions to provide proactive and scalable road maintenance.

1.4 METHODOLOGY

Here is the **methodology** for your project **“Quick Road Patch”**:

1. **Problem Identification**

Recognized the persistent issue of potholes affecting road safety, vehicle performance, and municipal repair costs.

Assessed the limitations of traditional manual pothole repair methods in terms of efficiency, safety, and sustainability.

2. **Conceptual Design**

Proposed an autonomous rover-based system capable of detecting and filling potholes in real time with minimal human intervention.

Finalized the idea to integrate ultrasonic sensors, servo motors, a filling mechanism, and ESP microcontroller for automation.

3. **Component Selection**

Sensors: Ultrasonic sensors selected for accurate pothole detection based on depth and surface irregularities.

Controller: ESP8266 microcontroller chosen for processing sensor data and enabling system control and remote access.

Actuators: Gear motors and servo motors used for rover movement and material dispensing, respectively.

Power Supply: A 12V battery with a buck converter provided a regulated power source for all system components.

Additional Components: Relay, motor driver, and chassis-mounted wheels for control and mobility.

4. **System Integration**

Developed a block diagram and detailed wiring to integrate sensors, controller, motors, and power supply.

Ensured synchronization between pothole detection and material dispensing.

5. **Mechanical Design**

Constructed a compact mobile rover capable of navigating various road surfaces.

Designed a robust filling mechanism to dispense repair material accurately over potholes.

6. **Programming and Logic Implementation**

Programmed the ESP8266 to interpret data from ultrasonic sensors, control movement and positioning, and trigger the filling mechanism.

Added logic to differentiate potholes from other road anomalies like speed bumps.

7. **Testing and Calibration**

Conducted controlled tests to calibrate sensor accuracy, motor speed, and dispensing consistency.

Fine-tuned the system to improve performance on uneven surfaces and ensure system stability.

8. **Performance Evaluation**

Measured pothole detection accuracy, filling efficiency, battery performance, and system reliability in real conditions.

Achieved 87% detection accuracy and 80% effective filling in varied test environments.

9. **Documentation and Reporting**

Compiled results, observations, and system design in a structured project report format. Included future improvements such as IoT integration, predictive maintenance, and large-scale deployment.

CHAPTER 2
LITERATURE REVIEW

LITURATURE REVIEW

1. Samyak Kathane, Vaibhav Kambli, Tanil Patel and Rohan Kapadia, "Real Time Potholes Detection and Vehicle Accident Detection and Reporting System and Anti-theft(Wireless)", IJETT, Vol. 21, No. 4, March 2015.

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5. Amit Patil, Madhukar Bhalchandra Sawant, Vighnesh Vijay Salunke, Kirti Sanjiv Goyal, Rituraj Gautam Jadhav Volume 4, Issue 4 (2019) Design and Fabrication of Potholes Repairing Machine Using Plastic Waste in Mixes.
ijsdr.org/papers/IJSDR1904079.

CHAPTER 3
ANALYTICAL/ EXPERIMENTAL/ LAYOUT DESIGN WORK

3. ANALYTICAL/EXPERIMENTAL/LAYOUT DESIGN WORK

This Chapter contains:

A. Block Diagram

B. Details of Design

C. Circuit Diagram

D. Work Flow

E. Flow Chart

A. BLOCK DIAGRAM

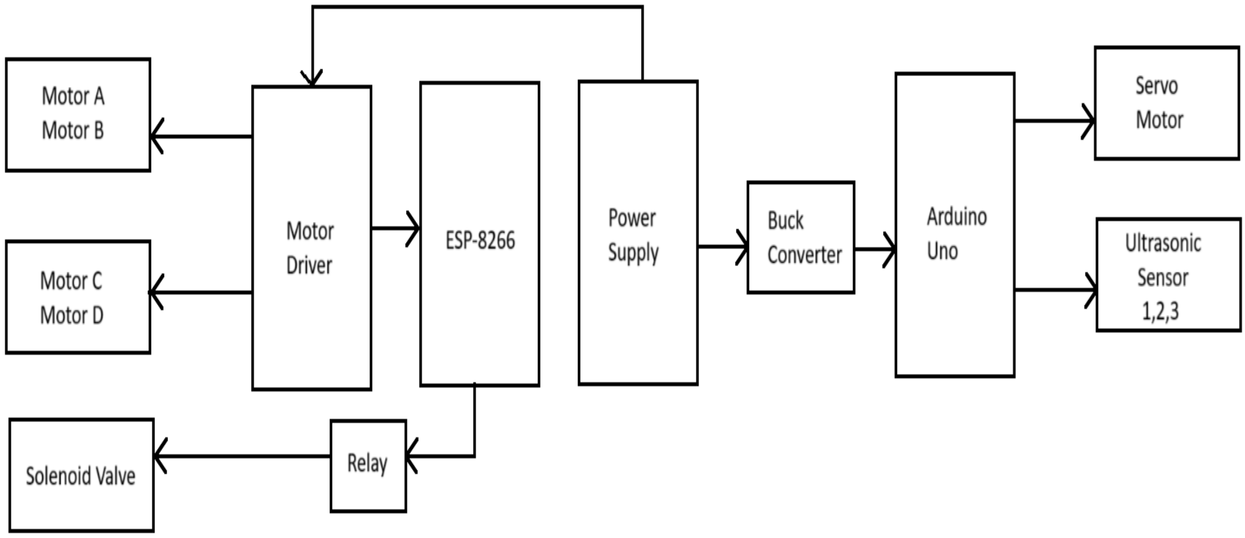


Fig.1 Block Diagram

Inputs-

1. Ultrasonic Sensor
2. WiFi (app control)

Outputs-

1. Solenoid valve
2. Servo motor

Manual control of robot is divided into three major parts they are as follows: -

i. Input unit
ii. Control processing
iii. Physical control

Input unit: -

Input unit contain the power delivering to all part of robot i.e. microcontroller, wheel motor, data from ultrasonic sensor, etc.

Control processing: -

In control unit main component is NodeMCU 8266 and Arduino Uno it is brain of the robot, microcontroller is connected to buck convertor for the movement of the machine and another relay circuit of solenoid valve. This pothole machine use for different type of control i.e. manual control & cloud control. In this project we are using esp8266 module.

Physical control: -

Physical control of the machine contains the direction control of the machine and it's through the bridge relay, it is connected to the NodeMCU via the push button. The pressing of push button will reset of servo motor.

Cloud Control (app):

- Nowadays cloud control is emerging technology its allows a control machine from any end of world.
- In this project the main component is Node MCU 8266 which have support of WIFI with operating frequency of 2.4 GHz ~ 2.5 GHz.
- User can control the robot by smart phone with the application. We provide not only the control of direction but also control of cutting motor.

- And the main technology for controlling remotely is obstacle detection or the crop detection. It will be help farmer or user to understand where crop is present or not.

B. DETAILS OF DESIGN

Components Used:

1. Esp 8266 (NODE MCU)
2. Arduino Uno
3. Solenoid valve
4. Servo Motor
5. Ultrasonic sensor
6. Buck Convertor
7. Power supply
8. Relay
9. DC Motors
10. Motor driver
11. Push Button
12. Wheels

1.ESP 32

Node MCU is a low-cost open source IoT platform. It initially included firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which was based on the ESP-12 module

- 18 Analog-to-Digital Converter (ADC) channels
- 10 Capacitive sensing GPIOs
- 3 UART interfaces
- 3 SPI interfaces
- 2 I2C interfaces
- 16 PWM output channels
- 2 Digital-to-Analog Converters (DAC)
- 2 I2S interfaces

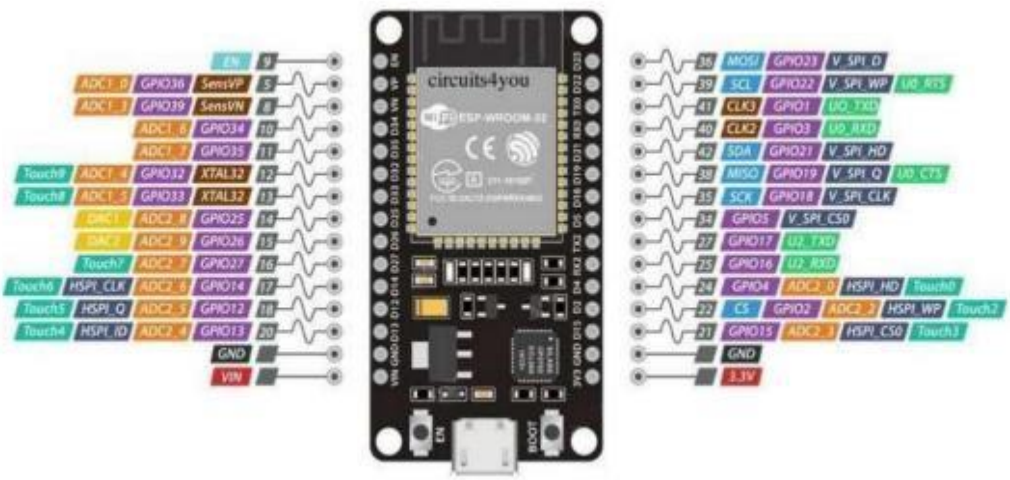


Fig 1. ESP8266

2.Arduino UNO

It a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

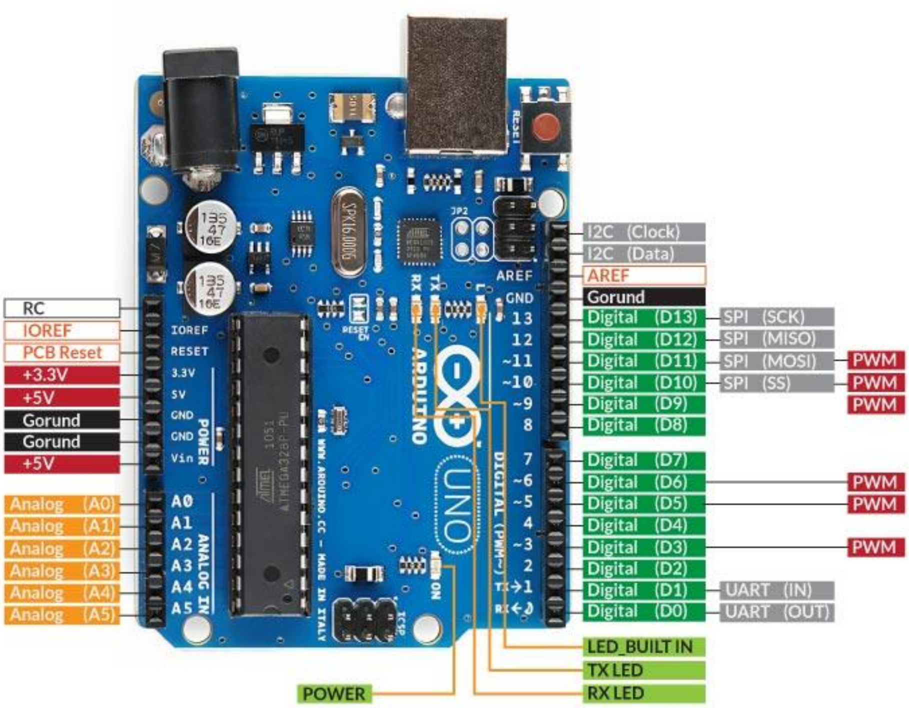


Fig 2. Arduino Uno

Pins 0-13 of the Arduino Uno serve as digital input/output pins.

Pin 13 of the Arduino Uno is connected to the built-in LED.

In the Arduino Uno - pins 3,5,6,9,10,11 have PWM capability.

It's important to note that:

Each pin can provide/sink up to 40 mA max. But the recommended current is 20 mA.

3.Solinoed Valve:

12V Solenoid Water Air Valve Switch (Normally Closed) – 1/2” controls the flow of fluid (liquid or air) and acts as a valve between high-pressure fluid! This liquid valve would make a great addition to your robotic gardening project. There are two ½” (Nominal NPT) outlets. Normally, the valve is closed. When a 12V DC supply is applied to the two terminals, the valve opens and water can push through.

Fig 3. Solenoid Valve

Item Type:	Normally Closed
Voltage Rating (V):	12VDC
Current Rating (A):	0.6
Operating Voltage (VDC):	12
Rated current (mA):	600
Operation Mode	Normally Closed
Power Consumption (W):	8
Pressure	0.02- 0.8Mpa

4.Servo Motor

The MG995 Servo Motor is an all metal gear servo motor operating on a wide voltage range of 4.8V to 6.6V DC, it offers exceptional torque of 11 kg/cm, ensuring performance in various applications. Its swift reaction speed (no load speed of 0.20 seconds / 60 degrees at 4.8V and 0.16 seconds / 60 degrees at 6.0V. make it a preferred choice for many applications like Robots, Robotic Arms

Fig 4. Servo Motor

5.Ultrasonic sensor

- This is the HC-SR04 ultrasonic distance sensor.
- This economical sensor provides 2cm to 400cm of non-contact measurement functionality with a ranging accuracy that can reach up to 3mm.
- Each HC-SR04 module includes an ultrasonic transmitter, a receiver and a control circuit.
- There are only four pins that you need to worry about on the HC-SR04: VCC (Power), Trig (Trigger), Echo (Receive), and GND (Ground). You will find this sensor very easy to set up and use for your next range finding project.

Fig 5. Ultrasonic sensor

6.Buck convertor:

A buck converter, also known as a step-down converter, is a type of DC-DC converter that reduces a higher input DC voltage to a lower output DC voltage. It achieves this by using a switch, an inductor, and a diode to control the energy transfer between the input and output. Buck converters are commonly used in applications where a lower voltage is needed to power a load or in situations like battery charging.

Fig 6. Buck Converter

7.Power Supply

A battery is a device that converts chemical energy directly into electrical energy. The 12V 7Ah SLA (sealed lead-acid) battery is a rechargeable battery that has two terminals, making it versatile for various applications. Its key specifications include a voltage of 12V, a capacity of 7Ah, and a weight of 2.3 kg. This battery is known for its reliability and efficiency.

Nominal Voltage (V):	11.1
Nominal Capacity (mAh):	2200
Discharge Current:	30C
Battery Cell Composition:	3S
Model No.:	ORANGE 2200/3S-30C
Capacity (mAh):	2200
Weight (g):	175
Output Voltage (V):	11.1

Fig 7. Power supply

8. Relay-

A relay is an electrically operated switch that plays a crucial role in controlling various components in a circuit. The Forward and Reverse Relay Module is designed to automatically change the direction of a motor when triggered, utilizing dynamic braking to stop the motor when the switch is returned to the OFF position.

Additionally, the relay facilitates a constant flow of power between your component and switch(es), effectively eliminating the possibility of a voltage drop, which enhances the overall reliability of the system.

The coil of a relay passes a relatively large current, typically 30mA for a 12V relay, but it can be as much as 100mA for relays designed to operate from lower voltages. Most ICs (chips) cannot provide this current and a transistor is usually used to amplify the small IC current to the larger value required for the relay coil

Fig 8. Relay

9. DC Motors

DC motors are widely used in various applications due to their ease of control and responsiveness. For forward and reverse control, various methods can be implemented, such as using an H-bridge circuit. This circuit allows the direction of current flow through the motor to be changed, enabling it to rotate in either direction. By controlling the input signals to the H-bridge switches, one can set the motor to rotate forward by applying voltage to one pair of switches while turning off the other pair. Conversely, reversing the connections will allow the motor to rotate in the opposite direction.

Furthermore, integrating pulse width modulation (PWM) can help regulate the speed of the motor during both forward and reverse operations, enhancing overall performance and efficiency. This setup is essential in applications ranging from robotics to conveyor systems, where precise motor control is crucial.

Fig 9. DC Motor

10.Motor Driver:

This L298N Motor Driver Module is a high power motor driver module for driving DC and Stepper Motors. This module consists of an L298 motor driver IC and a 78M05 5V regulator. L298N Module can control up to 4 DC motors, or 2 DC motors with directional and speed control.

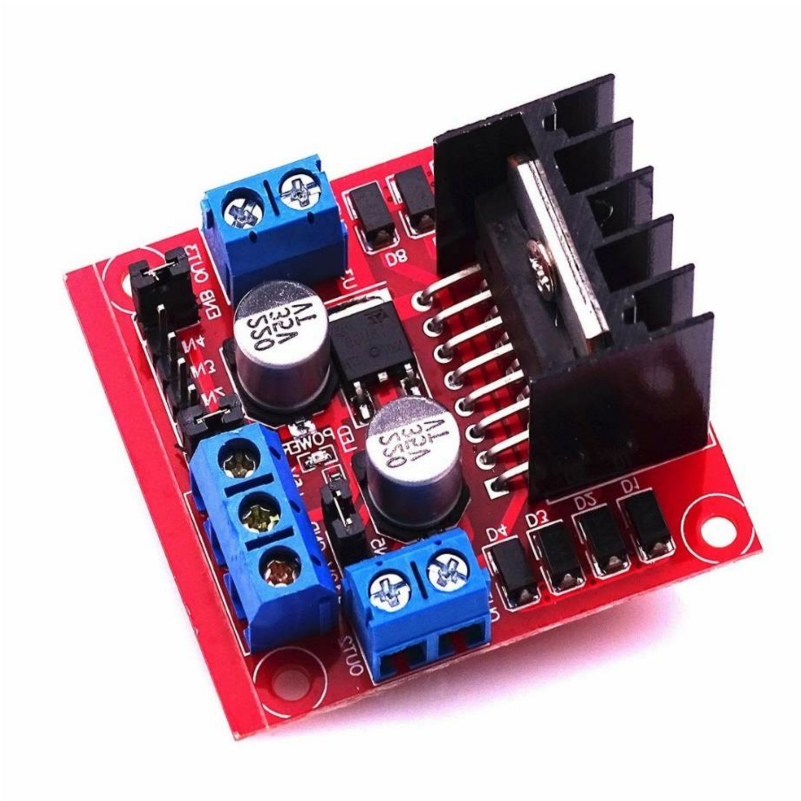


Fig 10. Motor Driver

11.Push Button:

Push buttons can be explained as simple power controlling switches of a machine or appliance. These are generally metal or thermoplastic switches that are intended to grant easy access to the user. The idea of electric circuits is that the electricity should be able to flow uninterrupted through multiple wires and components. However, circuits that are always complete aren't as useful as the ones that work only when required.

Fig 11. Push Button

12.Wheel-

The wheels of this product are designed for optimal performance and safety, featuring a robust build that ensures durability and stability during use. Made from high-quality materials, these wheels provide extra safety, making them suitable for a variety of applications, from heavyduty tasks to everyday mobility needs. Wheels are used to move the robot.

Fig 12. Wheels

C. Circuit Diagram

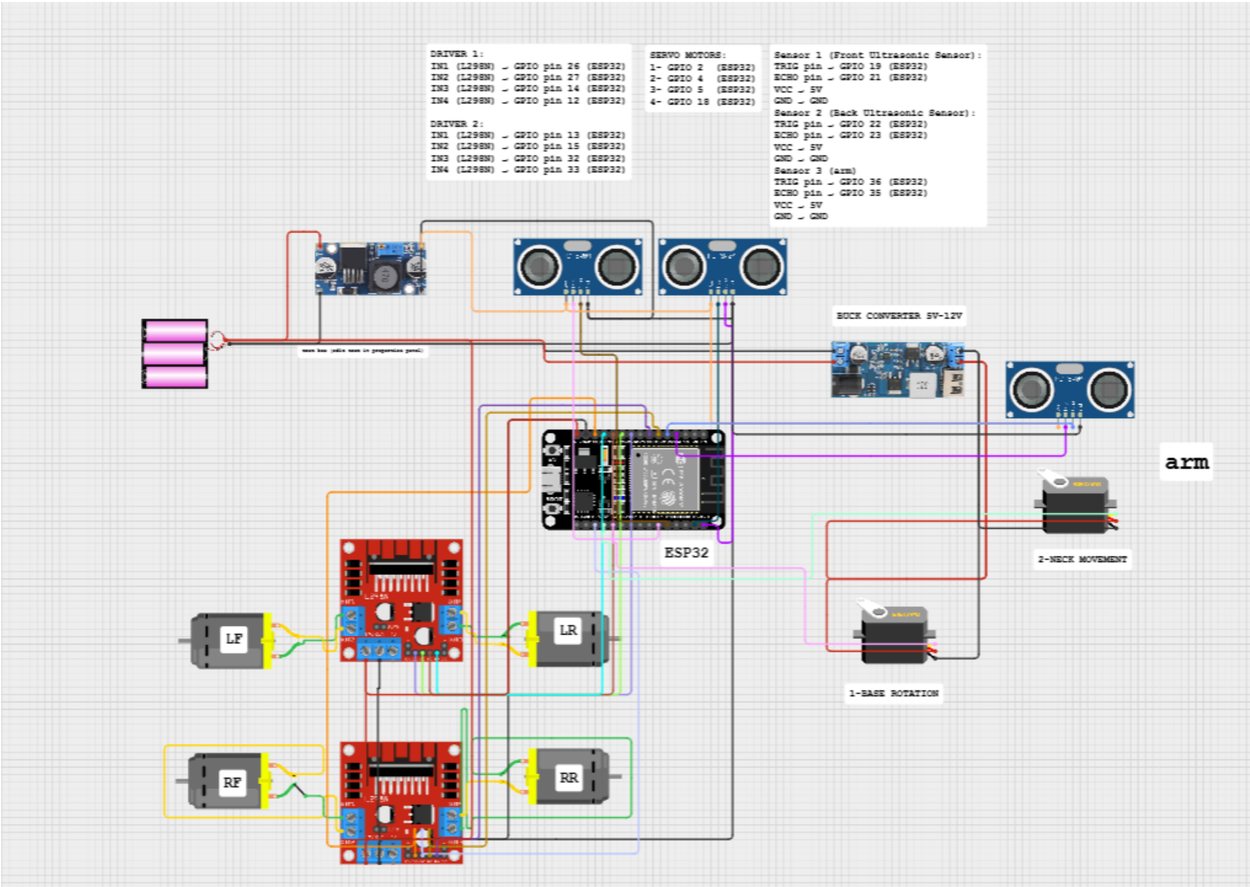


Fig 13. Circuit Diagram

The provided circuit diagram represents the hardware layout of the **Quick Patch** pothole detection and repair robot, which is designed using an **ESP32 microcontroller** as the central control unit. The ESP32 is responsible for managing the movement of the robot, reading sensor data, and controlling servo motors that perform repair tasks. It acts as the main interface between the sensors, motor drivers, and actuators.

At the heart of the system are two **L298N motor driver modules**, each connected to two **DC motors**. These four motors drive the robot's wheels, labeled as LF (Left Front), LR (Left Rear), RF (Right Front), and RR (Right Rear). The motor drivers receive control signals from the ESP32 through specific GPIO pins, which dictate the direction and operation of each motor. This setup enables precise maneuvering of the robot over the road surface.

To sense its environment, the robot is equipped with three **ultrasonic sensors**. Two of them are mounted on the front and back of the robot for obstacle and pothole detection. The third ultrasonic sensor is positioned near the robotic arm, likely to assist in measuring distance during the repair operation. These sensors are connected to designated GPIO pins on the ESP32 for sending and receiving ultrasonic pulses (via Trig and Echo pins), allowing the robot to detect potholes and obstacles in real-time.

The repair mechanism involves two **SG90 servo motors**: one for the **base rotation** and another for the **neck movement** of the robotic arm. These servos allow the arm to move accurately and apply patching material precisely over the detected potholes. The servos are powered by a regulated 5V supply and receive PWM control signals from the ESP32.

The entire system is powered by a **battery pack**, which is regulated using a **buck converter (5V–12V)** to ensure safe voltage levels for all components. This ensures consistent operation of the ESP32, motor drivers, sensors, and servos without overloading the circuits.

In summary, this circuit diagram illustrates a smart, autonomous robot that integrates sensors, motor drivers, and actuators under the control of the ESP32 to detect and repair potholes efficiently. It represents a practical application of embedded systems, robotics, and automation for road maintenance.

D. WORK FLOW

Quick road patch using ESP8266 NodeMCU

1. Start

2. Requirement and planning

- Define control features

3. Coding Part

4. Power Supply

Battery provides power to ESP32, motor, and other components.

5. Establish wireless communication between WiFi app and ESP8266

- Measure distance and Detect potholes.

6. Read Ultrasonic Sensor

7. Process Data in ESP8266 NodeMCU and arduino uno

8. Analyze sensor input and commands

9. Control Relays

Relay 1 (4-Relay Module): Controls solenoid valve Modal (movement mechanism).

10. Perform Task

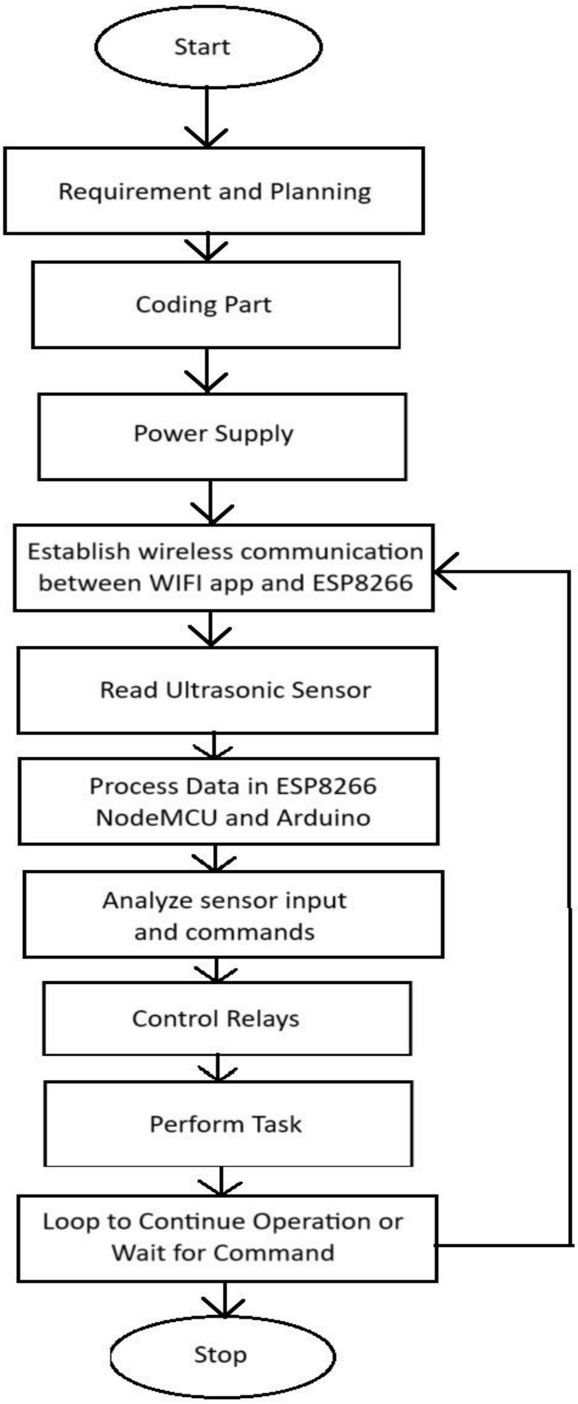
Machine navigates area.

Servo moves continuously and stops when the pothole is detected.

11. Loop to Continue Operation or Wait for Command

12. Stop (if commanded)

E. FLOW CHART

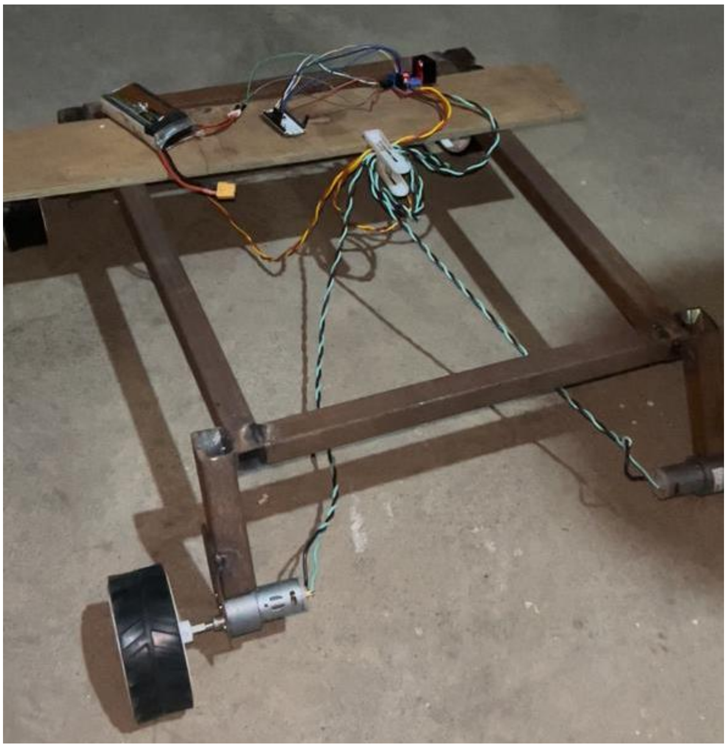


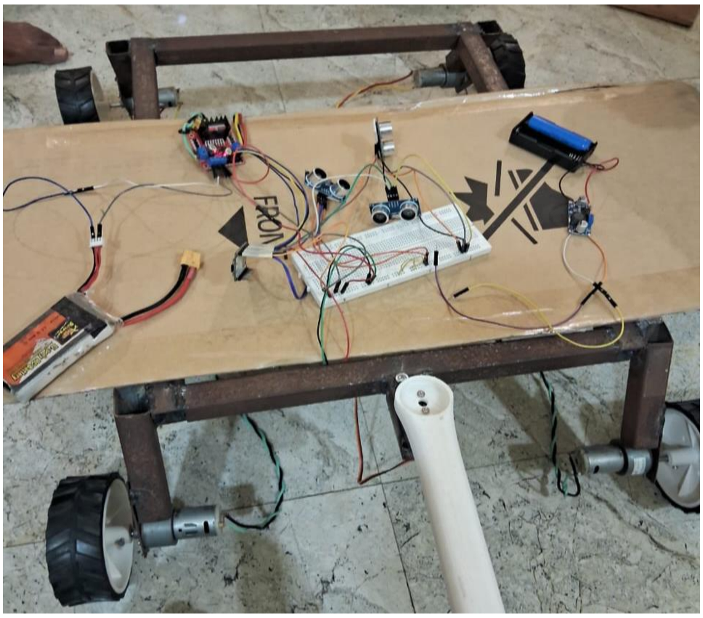
Start
Requirement and Planning
Coding Part
Power Supply
Establish wireless communication between WIFI app and ESP8266
Read Ultrasonic Sensor
Process Data in ESP8266 NodeMCU and Arduino
Analyze sensor input and commands
Control Relays
Perform Task
Loop to Continue Operation or Wait for Command
Stop

CHAPTER 4

EXPERIMENTL VALIIDATION

Phase I Result





In phase I, we have done with some part of hardware of the project in that, we have used. We have used ultrasonic sensors, servo motors and ESP 8266 .We completed the mechanical part of machine as shown in above fig.

Phase II Result-

Fig 14. Phase II Result

1. CONCLUSION

Quick Patch revolutionizes traditional road maintenance by introducing a smart, autonomous, and highly responsive solution for detecting and repairing potholes. This cutting-edge system employs a powerful combination of microcontrollers like the **ESP8266 NodeMCU**, sensors such as ultrasonic modules, relay-controlled actuators, and wireless communication tools, forming a compact yet highly effective pothole management unit.

One of the most transformative aspects of Quick Patch lies in its **automation of both detection and action**. Where manual methods often result in delays, misjudgments, and high operational costs, Quick Patch offers real-time road analysis and immediate corrective measures. Through intelligent data processing and machine actuation, potholes are identified, assessed, and patched on the spot with minimal human intervention. This real-time responsiveness significantly enhances **road safety**, reducing the risk of accidents and vehicle damage caused by undetected road defects.

From a municipal and infrastructure planning perspective, Quick Patch contributes to **substantial cost savings**. The deployment of such systems reduces dependence on large repair crews and bulky machinery, thereby lowering labor and logistics costs. The system's modularity also ensures it can be **scaled or adapted** to various terrains, traffic intensities, and maintenance budgets, making it suitable for both urban and rural infrastructures.

Moreover, Quick Patch is built with **environmental responsibility** in mind. It incorporates **eco-friendly patching materials** and emphasizes efficient power usage, often drawing from compact battery setups or solar-powered modules. This sustainability focus not only aligns with green city goals but also aids in long-term carbon footprint reduction and waste minimization.

In terms of urban mobility, the speed and precision of Quick Patch reduce traffic disruptions commonly caused by prolonged maintenance work. As the system operates seamlessly with minimal setup, it enables **on-the-go repairs**, easing traffic congestion and enhancing public satisfaction. The machine's compact design and wireless control capabilities make it easy to deploy in busy streets without needing extensive traffic diversion.

2. FUTURE SCOPE

Here's the Future Scope of the Quick Road Patch Project

1. Remote Monitoring: Implementation of remote access capabilities to enable real-time tracking of road conditions and repair activities.

2. Scalability for Urban & Rural Areas: Adaptation of the system for deployment in both dense urban centers and remote rural locations.

3. Autonomous Repair Units*: Development of robotic or autonomous vehicles capable of performing pothole detection and repairs without human intervention.

4. Environmentally Friendly Upgrades*: Further advancements in sustainable materials and green technologies for more eco-conscious repairs.

5. Cost Optimization Tools*: Implementation of cost-analysis features to optimize budgets and resources for road maintenance departments.

6. Predictive Maintenance*: Use of data analytics and machine learning to forecast potential potholes and high-risk areas before they worsen.

3.REFERENCES

1.Samyak Kathane, Vaibhav Kambli, Tanil Patel and Rohan Kapadia, "Real Time Potholes Detection and Vehicle Accident Detection and Reporting System and Anti-theft(Wireless)", IJETT, Vol. 21, No. 4, March 2015.

2.Pothole Detection System, By. Mr. S. R. Kokane; Hrithik Sharma; Mitali Raghwani; Shreyash Khambalkar; Publish by IJARSCT (2022).

3.S. S. Rode, S. Vijay, P. Goyal, P. Kulkarni, and K. Arya,"Pothole detection and warning system: Infrastructure support and system design," in *Proc. Int. Conf. Electron.Comput. Technol.*, Feb. 2009, pp. 286–290.

4.Ajit Danti, Jyoti Y. Kulkarni, and P. S. Hiremath, "An Image Processing Approach to Detect Lanes, Potholes and recognize road Signs in Indian Roads", International Journal of Modeling and Optimization, Vol. 2, No. 6, December 2012.

URL:

1. https://youtu.be/2qWC-D139ps?si=LNKlkruN-JqINVcV
2. https://youtube.com/shorts/-RTAVZ-BfzA?si=gta-r7tKppuaeTmM
3. https://youtu.be/1RG23iWqqsE?si=ohzMmU3HKP2ihtNg

CHAPTER 5
SOURCE CODE

8.SOURCE CODE

For movement of machine and solenoid volve

```
#include <ESP8266WiFi.h>
#include <ESP8266WebServer.h>
#include <ArduinoOTA.h>

// connections for drive Motor FR & BR
//int enA = D3;
int in1 = D5;
int in2 = D6;
// connections for drive Motor FL & BL
int in3 = D7;
int in4 = D8;
//int enB = D6;

const int solenoidPin = D1;      // set digital pin D7 as solenoid  pin (use active solenoid valve)

const int wifiLedPin = D2;   // set digital pin D0 as indication, the LED turn on if NodeMCU connected to WiFi as STA mode

String command;    // String to store app command state.
int SPEED = 122;
int speed_Coeff = 3;

ESP8266WebServer server(80);  // Create a webserver object that listens for HTTP request on port 80

unsigned long previousMillis = 0;

String sta_ssid = "";      // set Wifi networks you want to connect to
```

```
String sta_password = "";  // set password for Wifi networks


void setup() {
  Serial.begin(115200);  // set up Serial library at 115200 bps
  Serial.println();
  Serial.println("WiFi Robot Remote Control Mode - L298N 2A");
  Serial.println("--------------------------------------------------");

  pinMode(solenoidPin, OUTPUT);      // sets the solenoid pin as an Output
  pinMode(wifiLedPin, OUTPUT);  // sets the Wifi LED pin as an Output
  digitalWrite(solenoidPin, LOW);
  digitalWrite(wifiLedPin, HIGH);

  // Set all the motor control pins to outputs
  pinMode(in1, OUTPUT);
  pinMode(in2, OUTPUT);
  pinMode(in3, OUTPUT);
  pinMode(in4, OUTPUT);

-
  // Turn off motors - Initial state
  digitalWrite(in1, LOW);
  digitalWrite(in2, LOW);
  digitalWrite(in3, LOW);
  digitalWrite(in4, LOW);


  // set NodeMCU Wifi hostname based on chip mac address
  String chip_id = String(ESP.getChipId(), HEX);
  int i = chip_id.length() - 4;
  chip_id = chip_id.substring(i);
  chip_id = "WiFi_RC_Car-" + chip_id;
```

```
  String hostname(chip_id);

  Serial.println();
  Serial.println("Hostname: " + hostname);

  // first, set NodeMCU as STA mode to connect with a Wifi network
  WiFi.mode(WIFI_STA);
  WiFi.begin(sta_ssid.c_str(), sta_password.c_str());
  Serial.println("");
  Serial.print("Connecting to: ");
  Serial.println(sta_ssid);
  Serial.print("Password: ");
  Serial.println(sta_password);

  // try to connect with Wifi network about 10 seconds
  unsigned long currentMillis = millis();
  previousMillis = currentMillis;
  while (WiFi.status() != WL_CONNECTED && currentMillis - previousMillis <= 10000) {
    delay(500);
    Serial.print(".");
    currentMillis = millis();
  }

  // if failed to connect with Wifi network set NodeMCU as AP mode
  if (WiFi.status() == WL_CONNECTED) {
    Serial.println("");
    Serial.println("WiFi-STA-Mode");
    Serial.print("IP: ");
    Serial.println(WiFi.localIP());
    digitalWrite(wifiLedPin, LOW);  // Wifi LED on when connected to Wifi as STA mode
    delay(3000);
  } else {
    WiFi.mode(WIFI_AP);
```

```
    WiFi.softAP(hostname.c_str());
    IPAddress myIP = WiFi.softAPIP();
    Serial.println("");
    Serial.println("WiFi failed connected to " + sta_ssid);
    Serial.println("");
    Serial.println("WiFi-AP-Mode");
    Serial.print("AP IP address: ");
    Serial.println(myIP);
    digitalWrite(wifiLedPin, HIGH);  // Wifi LED off when status as AP mode
    delay(3000);
  }


  server.on("/", HTTP_handleRoot);      // call the 'handleRoot' function when a client requests URI "/"
  server.onNotFound(HTTP_handleRoot);    // when a client requests an unknown URI (i.e. something other than "/"), call function "handleNotFound"
  server.begin();                        // actually start the server

  ArduinoOTA.begin();  // enable to receive update/uploade firmware via Wifi OTA
}

void loop() {
  ArduinoOTA.handle();    // listen for update OTA request from clients
  server.handleClient();  // listen for HTTP requests from clients

  command = server.arg("State");  // check HTPP request, if has arguments "State" then saved the value
  if (command == "F") Forward();  // check string then call a function or set a value
  else if (command == "B") Backward();
  else if (command == "R") TurnRight();
  else if (command == "L") TurnLeft();
  else if (command == "G") ForwardLeft();
```

```
  else if (command == "H") BackwardLeft();
  else if (command == "I") ForwardRight();
  else if (command == "J") BackwardRight();
  else if (command == "S") Stop();
  else if (command == "V") BeepHorn();
  else if (command == "W") TurnLightOn();
  else if (command == "w") TurnLightOff();
  else if (command == "0") SPEED = 60;
  else if (command == "1") SPEED = 70;
  else if (command == "2") SPEED = 81;
  else if (command == "3") SPEED = 95;
  else if (command == "4") SPEED = 105;
  else if (command == "5") SPEED = 122;
  else if (command == "6") SPEED = 150;
  else if (command == "7") SPEED = 196;
  else if (command == "8") SPEED = 272;
  else if (command == "9") SPEED = 400;
  else if (command == "q") SPEED = 1023;
}

// function prototypes for HTTP handlers
void HTTP_handleRoot(void) {
  server.send(200, "text/html", "");   // Send HTTP status 200 (Ok) and send some text to the browser/client

  if (server.hasArg("State")) {
    Serial.println(server.arg("State"));
  }
}

void handleNotFound() {
  server.send(404, "text/plain", "404: Not found");   // Send HTTP status 404 (Not Found) when there's no handler for the URI in the request
```

```
}

// function to move forward
void Forward() {
  analogWrite(in1, SPEED);
  digitalWrite(in2, LOW);
  analogWrite(in3, SPEED);
  digitalWrite(in4, LOW);
}

// function to move backward
void Backward() {
  digitalWrite(in1, LOW);
  analogWrite(in2, SPEED);
  digitalWrite(in3, LOW);
  analogWrite(in4, SPEED);
}

// function to turn right
void TurnRight() {
  digitalWrite(in1, LOW);
  analogWrite(in2, SPEED);
  analogWrite(in3, SPEED);
  digitalWrite(in4, LOW);
}

// function to turn left
void TurnLeft() {
  analogWrite(in1, SPEED);
  digitalWrite(in2, LOW);
  digitalWrite(in3, LOW);
  analogWrite(in4, SPEED);
}
```

```
// function to move forward left
void ForwardLeft() {
  analogWrite(in1, SPEED);
  digitalWrite(in2, LOW);
  analogWrite(in3, SPEED / speed_Coeff);
  digitalWrite(in4, LOW);
}

// function to move backward left
void BackwardLeft() {
  digitalWrite(in1, LOW);
  analogWrite(in2, SPEED);
  digitalWrite(in3, LOW);
  analogWrite(in4, SPEED / speed_Coeff);
}

// function to move forward right
void ForwardRight() {
  analogWrite(in1, SPEED / speed_Coeff);
  digitalWrite(in2, LOW);
  analogWrite(in3, SPEED);
  digitalWrite(in4, LOW);
}

// function to move backward right
void BackwardRight() {
  digitalWrite(in1, LOW);
  analogWrite(in2, SPEED / speed_Coeff);
  digitalWrite(in3, LOW);
  analogWrite(in4, SPEED);
}
```

```
// function to stop motors
void Stop() {
  digitalWrite(in1, LOW);
  digitalWrite(in2, LOW);
  digitalWrite(in3, LOW);
  digitalWrite(in4, LOW);
}


// function to turn on Solenoid valve
void TurnLightOn() {
  digitalWrite(solenoidPin, HIGH);
}

// function to turn off Solenoid valve
void TurnLightOff() {
  digitalWrite(solenoidPin, LOW);
}
```

- For servo and ultrasonic sensor

```
#include <Servo.h>

Servo myservo;

const int trigPin = D1;  // GPIO14
const int echoPin = D0;  // GPIO12
const int servoPin = D4; // GPIO2

int pos = 30;
bool stopServo = false;

void setup() {
```

```
  myservo.attach(servoPin);      // Attach servo to D4
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);
  Serial.begin(115200);
}

void loop() {
  if (!stopServo) {
    for (pos = 30; pos <= 160; pos++) {
      myservo.write(pos);
      delay(40);

      if (getDistance() > 18) {
        stopServo = true;
        Serial.print("Distance > 18 cm. Stopped at position: ");
        Serial.println(pos);
        break;
      }

    }

    for (pos = 160; pos >= 30 && !stopServo; pos--) {
      myservo.write(pos);
      delay(40);

      if (getDistance() > 18) {
        stopServo = true;
        Serial.print("Distance > 18 cm. Stopped at position: ");
        Serial.println(pos);
        break;
      }

    }
```

```
  }

  // Servo holds its last position
}

long getDistance() {
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);

  long duration = pulseIn(echoPin, HIGH, 30000); // Timeout after 30ms
  long distance = duration * 0.034 / 2;

  Serial.print("Distance: ");
  Serial.print(distance);
  Serial.println(" cm");

  return distance;
}
```

CHAPTER 6
APPENDIX

APPENDIX

Esp8266 Node MCU

Description-

ESP8266 is a powerful and versatile microcontroller developed by Espressif Systems, widely used in IoT (Internet of Things) and automation projects. Here's a breakdown relevant to your sugarcane cutting robot:

1. Key Features:

Processor: 32-bit RISC CPU (Tensilica L106).

RAM: 32 KiB instruction RAM, 32 KiB cache RAM, 80 KiB user-data RAM.

Flash Memory: Supports up to 16 MiB external flash (typically 512 KiB to 4 MiB included).

Wi-Fi: IEEE 802.11 b/g/n, 2.4 GHz, supports WPA/WPA2.

GPIO: 17 GPIO pins.

Interfaces: SPI, I2C (software), I2S, UART.

ADC: 10-bit ADC.

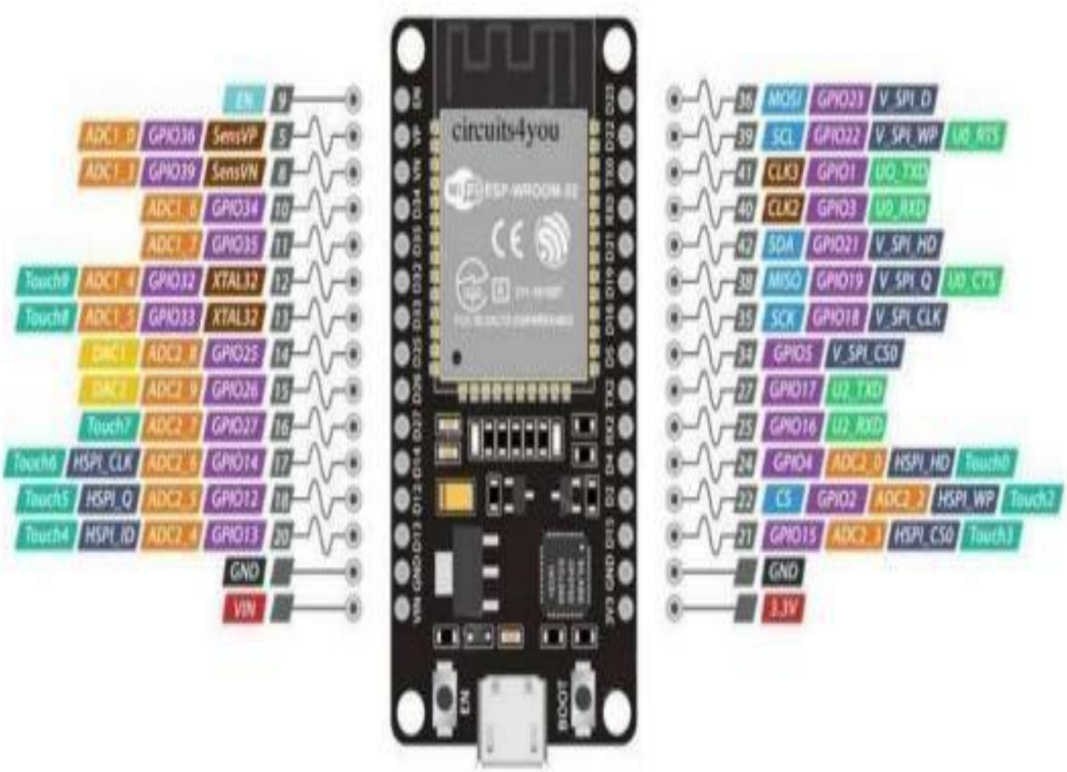
Other Features: Integrated antenna switch, balun, LNA, power amplifier, matching network.

Operating Voltage: 3.3V.

Input Voltage: 7-12V.

Data Interface: UART, HSPI, I2C, I2S, Ir.

Remote Control: GPIO, PWM.



Esp32 Node MCU pin description-

1. GPIO 0

Function: Input/Output, Flash button

Note: Used in boot mode selection

2. GPIO 1 (TX0)

Function: UART0 Transmit

Note: Used for serial communication

3. GPIO 3 (RX0)

Function: UART0 Receive

Note: Used for serial communication

4. GPIO 2

Function: General I/O, onboard LED

Note: Safe to use

5. GPIO 4 to GPIO 19

Function: General I/O, PWM, ADC, I2C, SPI

Note: Commonly used for sensors, relays, motors

6. GPIO 21

Function: I2C SDA (data line)

Note: Default I2C pin

7. GPIO 22

Function: I2C SCL (clock line)

Note: Default I2C pin

8. GPIO 23, 18, 19, 5

Function: SPI (MOSI, CLK, MISO, CS)

Note: Used for SPI communication

9. GPIO 25 to GPIO 27

Function: DAC, ADC, General I/O

Note: Supports analog and digital operations

10. GPIO 32 to GPIO 39

Function: ADC Only (input only)

Note: Ideal for analog sensors or battery voltage monitoring

11. EN (Enable)

Function: Resets the ESP32 when pulled LOW

Note: Linked to the reset button

12. VIN / 5V

Function: Input voltage from USB or power supply

Note: Used to power the ESP32 board

13. 3V3 (3.3V output)

Function: Supplies 3.3V regulated output

Note: Powers external 3.3V components

14. GND (Ground)

Function: Common ground

The specifications of Arduino uno include the following.

1. Processor:

ATmega328p microprocessor

Clock speed: 16 MHz

Ultra-low-power co-processor for sleep mode operations

2. Memory:

32 KB SRAM 2KB

1 KB ROM

3. Wireless Communication:

Wi-Fi 802.11 b/g/n (2.4 GHz)

Bluetooth v4.2 (Classic + BLE)

4. GPIO & Peripherals:

14 programmable GPIOs (not all available on every board)

Digital I/O Pins: 14 (of which 6 provide PWM output)

PWM Digital I/O Pins: 6

Analog Input Pins: 6

Hall effect sensor and temperature sensor (built-in)

5. Timers:

Clock Speed: 16 MHz

6. Operating Voltage:

5V

7. Power Consumption:

DC Current per I/O Pin: 20 mA

DC current for 3.3V Pin: 50 mA

~~12V DC Motor-~~

Key Features:

Voltage: 12V DC

Speed: 60 RPM

Shaft: 6mm diameter, circular, with internal hole for coupling

Torque: Maximum torque around 3.5 kg-cm at 12V and 60RPM

Weight: Approximately 145 grams

No-Load Current: Around 60 mA (max)

Load Current: Up to 300 mA (max)

Gearbox: Metal gearbox and metal gears

Stall Torque: Around 1.5 kg-cm

Other Specifications:

Base Motor Speed: Often 18000 RPM

Holding Torque: Some high torque versions can have a holding torque of 38 kg-cm

Motor Diameter: Around 28.5 mm

Gearbox Diameter: Around 37 mm

Motor Length: Around 63 mm without the shaft

Shaft Length: Around 30 mm

Gear Material: Metal

Applications: Robotics, automation

,

CHAPTER 7
RESEARCH PAPER PUBLICATION AND CERTIFICATE

International Journal of All Research Education and Scientific Methods (IJARESM),
ISSN: 2455-6211, Volume 13, Issue 4, April-2025, Available online at: www.ijaresm.com

International Journal of All Research Education and Scientific Methods (IJARESM),

ISSN: 2455-6211, Volume 13, Issue 2, April-2025, Available online at: www.ijaresm.com`

Quick Road Patch

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ABSTRACT

The Quick Road Patch project presents an innovative, automated solution for detecting and repairing potholes efficiently, reducing the risks associated with damaged roads. Potholes pose significant challenges, including vehicle damage, traffic congestion, and increased maintenance costs. Traditional repair methods require extensive labor, time, and resources, often leading to delays in road maintenance. This project introduces an autonomous system that streamlines the pothole repair process using embedded technology and robotic mechanisms.The system is built around an ESP microcontroller, which gathers real-time data from ultrasonic sensors to detect potholes, measure their dimensions, and assess their depth. Once a pothole is identified, a combination of gear motors and servo motors precisely positions the filling mechanism over the damaged area.The system then dispenses an appropriate amount of filling material, ensuring an even and efficient repair. Key components include a 12V battery for portability and power efficiency, a motor driver for controlling motor operations, and a buck converter to regulate voltage levels. This modular design ensures adaptability to different environments, making it suitable for urban roads, highways, and even industrial areas.By automating pothole detection and repair, the Quick Road Patch system enhances road safety, minimizes maintenance costs, and prolongs infrastructure lifespan. This approach has the potential to revolutionize road maintenance by offering a faster, cost-effective, and scalable alternative to traditional methods, paving the way for smarter and more **resilient transportation networks..**

INTRODUCTION

The "Quick Road Patch" project addresses a pressing issue in road infrastructure maintenance—potholes. Potholes are not only an inconvenience but also a significant hazard to vehicles and a danger to commuters. Over time, they lead to increased vehicle maintenance costs, accident risks, and ongoing repairs that strain municipal resources. Traditional pothole repair methods often involve manual labor, which is both time-consuming and costly, especially when repairs are required on a large scale. Additionally, manual repairs can expose workers to dangerous traffic conditions and extreme weather, making it an unsustainable solution for managing road safety over the long term.

Our project, Quick Road Patch, seeks to revolutionize pothole repair by automating the detection and filling processes. The system uses advanced sensors and microcontroller technology to autonomously detect potholes, assess their size and depth, and dispense filling material accurately. The design integrates ultrasonic sensors for identifying potholes, motors for positioning, and a microcontroller (ESP) for processing sensor data and controlling the filling mechanism. This approach not only reduces human involvement, which minimizes risk but also enables more efficient and timely repairs that improve road safety and infrastructure longevity.

The automated system is portable and self-sufficient, powered by a 12V battery and regulated through a buck converter to maintain optimal voltage levels for each component. Once implemented, this solution can function in diverse environments and road conditions, offering cities a reliable, cost-effective means of addressing potholes. Furthermore, this innovation holds potential for integration with data logging and remote monitoring systems, allowing for real-time insights into road conditions and enabling proactive maintenance schedules.

By utilizing cutting-edge technology, Quick Road Patch aims to deliver an effective, scalable solution to modern infrastructure challenges. Our project not only contributes to safer roads but also represents a forward-thinking approach in civil and urban engineering, aligning with the increasing trend of using automation and IoT to solve public sector issues.

2. Problem Statement:

Potholes are a major concern for road infrastructure, affecting safety, vehicle longevity, and maintenance costs. The current pothole repair process has multiple limitations, necessitating an automated solution. The key issues include:

1. Road Safety Hazards

Potholes increase the risk of accidents, especially for motorcyclists, cyclists, and pedestrians, leading to injuries and fatalities.

2. Vehicle Damage

Driving over potholes causes tire blowouts, suspension failures, and misalignment, resulting in costly repairs for vehicle owners.

3. Traffic Congestion

Manual pothole repairs often require lane closures, disrupting traffic flow and causing delays, especially in high-traffic areas.

4. High Repair Costs

Traditional repair methods involve significant labor, machinery, and materials, leading to escalating municipal maintenance expenses.

5. Slow and Inefficient Repairs

Manual pothole repairs are time-consuming, causing delays in fixing road damage and allowing potholes to worsen.

6. Hazardous Working Conditions

Road workers are exposed to high-risk environments, including heavy traffic, extreme weather, and hazardous materials.

7. Short-Term Fixes

Many traditional pothole repairs are temporary and require frequent rework, adding to long-term maintenance costs.

8. Lack of Timely Detection

Many potholes go unnoticed until they become severe, due to the absence of an efficient monitoring system.

9. Infrastructure Deterioration

Unaddressed potholes contribute to further road degradation, increasing the need for major reconstruction projects.

10. Environmental Impact

Inefficient repair methods and excessive material waste contribute to environmental degradation.

3. Block Diagram:

1. Ultrasonic sensors:

An ultrasonic sensor measures the distance to an object by emitting ultrasonic waves and detecting the reflected signal. It's commonly used for detecting obstacles or surfaces, making it ideal for identifying potholes on roads.

2. Gear motor:

A gear motor combines an electric motor with a gearbox, which reduces speed while increasing torque. It provides precise control of movement, making it suitable for driving mechanisms like the automated filling system in Quick road patch.

3. ESP 8266:

The ESP8266 is a low-cost Wi-Fi microcontroller with built-in TCP/IP protocol stack. It allows the Quick road patch system to connect to the internet, enabling remote control, data logging, or system monitoring.

4. Servo motor:

A servo motor is a rotary actuator that allows for precise control of angular position. In Quick road patch, it can be used to control the dispensing mechanism or any component that requires exact positioning.

5. 12V Battery:

A 12V battery provides the necessary power to run the various electronic components and motors in the Quick road patch system, ensuring portability and reliability during operation.

6. Wheel:

The wheels for the rover are designed to provide stable and efficient movement on various road surfaces.

7.Motor Driver:

A motor driver is an electronic circuit that controls the direction and speed of motors. It acts as an interface between microcontrollers and motors, providing the necessary power and control signals to drive the motors in the Quick road patch system.

8.Buck Converter:

A buck converter is a DC-DC power converter that steps down voltage from a higher level to a lower level. It ensures that components within the Quick road patch system receive the correct voltage, improving efficiency and protecting sensitive electronics.

9.Relay:

A relay is an electrically operated switch used to control high-power devices with low-power signals. In the Quick road patch system, it allows for the safe and efficient control of motors or other high-current components by the microcontroller.

System Functionality Overview:

Debris Detection Accuracy:

The IR sensors, mounted on the servo motor, successfully detected floating debris within a range of 10-20 cm, achieving an accuracy of 85% in calm water conditions.

Obstacle detection using the ultrasonic sensor showed high reliability, accurately identifying obstacles up to 30 cm away, allowing the boat to navigate effectively around obstacles.

Autonomous Navigation and Obstacle Avoidance:

The combination of IR and ultrasonic sensors allowed for smooth autonomous navigation. During testing, the boat successfully avoided obstacles in 90% of trials, making slight adjustments to its path when objects were detected.

Waste Collection Efficiency:

The net-based collection system captured 75% of detected debris in controlled test environments. In practical applications, collection efficiency was observed to be slightly lower in rough water conditions due to drift.

Overall, the collection system proved effective in calm and moderately turbulent waters, making the system reliable for waste removal.

Power and Battery Life:

With the 12V power supply and regulated 5V output to the Arduino and sensors, the boat operated continuously for an average of 2 hours per charge. This is sufficient for short-duration cleaning missions in smaller water bodies.

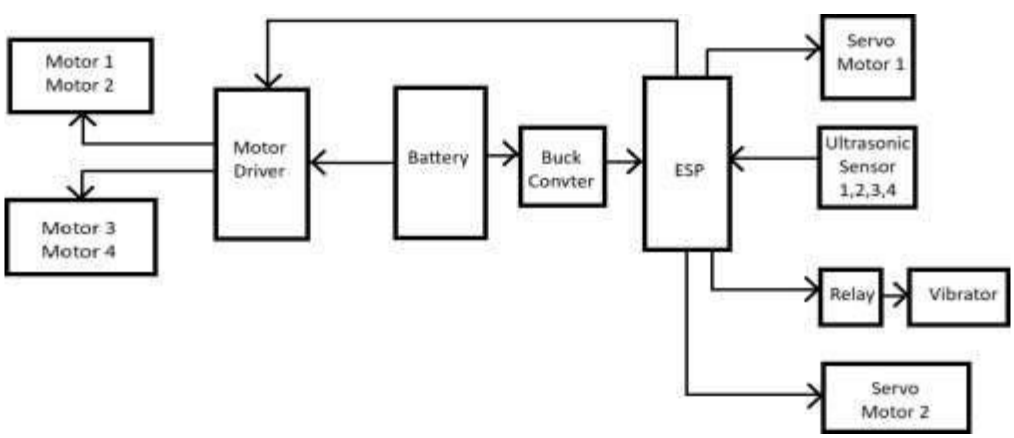
The components, including the motor driver and sensors, performed well without overheating or voltage drops, maintaining stable operation throughout the testing period.

System Stability and Reliability:

The water pump-driven propulsion system provided stable movement, with minimal maintenance requirements and consistent performance.

Tests indicated a robust response to various environmental conditions, showing that the boat could handle minor currents and floating obstacles while maintaining its intended path.

Fig 1.0 Block Diagram



LITERATURE REVIEW

[1] Madhumathy p, Saurabh Singh, Shivamshukla, Unnikrishnan, Dayanandasagar2017. Detection of humps and potholes on roads and notifying the same to the drivers, International Journal of Management and Applied Science, Volume-3, pp294-326.In this paper they found problem regarding measuring depth of pothole and they used ultrasonic sensor for the detected problem.

[2] Hao Wang, PhD. and Xiao Chen, 2024. Innovative Pothole Repair Materials and Techniques Volume I: Asphalt PavementIn this paper they found a problem on filling potholes they came up with the solution of spray injection method (Robotic arm is made to spray the required material to fill the potholes).Autonomous river cleaning systems have garnered significant attention in recent years, with various studies and projects aiming to address water pollution through innovative technologies. This literature review delves into notable contributions, particularly those documented in IEEE publications, highlighting advancements in design, technology integration, and operational efficiency.

[3] Design and Development of River Cleaning Robots In 2014, Sinha et al. introduced the "Ro-Boat," an autonomous river-cleaning robot designed with a stable mechanical system featuring air and water propulsion, robotic arms, and a solar energy source. The Ro-Boat employs computer vision algorithms, utilizing HSV Color Space and SURF within a Kalman Filter framework, to achieve robust pollutant tracking. Field tests in the Yamuna River, New Delhi, demonstrated its potential effectiveness in urban water bodies.

[4] Integration of IoT and Sensor Technologies Recent efforts have focused on enhancing river cleaning robots with Internet of Things (IoT) capabilities and sensor technologies. For instance, the design of sensor-assisted lake water cleaning robots leverages IoT for real-time monitoring and control, improving the efficiency of waste collection and operational oversight.

[5] Autonomous Surface Vehicles for Water Cleaning The development of cost-effective, sustainable autonomous unmanned surface vehicles (USVs) has been explored to automate water surface cleaning. These USVs are designed to navigate and collect debris autonomously, reducing the need for human intervention and enhancing cleaning efficiency.

[6] Commercial Applications and Innovations Commercially, products like the Jelly fishbot by Interactive Autonomous Dynamic Systems (IADYS) have been developed. This autonomous machine collects floating debris and can operate both autonomously and under remote control. Equipped with sensors, it navigates water bodies while measuring water quality parameters such as salinity, temperature, turbidity, and the presence of organisms like cyanobacteria and phytoplankton.

CONCLUSION

The Quick Patch system is a significant advancement in road maintenance, integrating automated pothole detection and repair technologies. Traditional repair methods are labor- intensive, costly, and time-consuming, leading to worsening road conditions. Quick Patch addresses these challenges using ultrasonic sensors, an ESP microcontroller, and automated filling mechanisms, making repairs more efficient and scalable. A key benefit of Quick Patch is its ability to enhance road safety by detecting and repairing potholes quickly and accurately, reducing accidents, vehicle damage, and traffic disruptions. Automation minimizes human intervention, making the process safer and more precise. The use of gear and servo motors ensures efficient material dispensing, improving repair durability and reducing maintenance frequency. Beyond efficiency, Quick Patch promotes sustainability by optimizing material usage, minimizing waste, and potentially integrating eco- friendly materials. Its modular design makes it adaptable for urban roads, highways, and industrial areas. In conclusion, Quick Patch revolutionizes road maintenance by offering a fast, reliable, and sustainable solution. By setting a new standard in smart road infrastructure, it enhances transportation networks, reduces costs, and improves mobility. Future enhancements like AI-driven predictive maintenance could further advance smart city infrastructure.

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IJARESM

ISSN: 2455-6211, New Delhi, India
International Journal of All Research Education & Scientific Methods
An ISO & UGC Certified Peer-Reviewed & Refereed Multi-disciplinary Journal
UGC Journal No. 7647

Certificate of Publication

Prof. Shivchandra. R. Khot

TITLE OF PAPER

Quick Road Patch

has been published in

IJARESM, Impact Factor: 8.536, Volume 13 Issue 4, April.-2025

Certificate Id: IJ-2204250338

Date: 22-04-2025

ISO 9001:2008 CERTIFIED JOURNAL

Website: www.ijaresm.com
Email: editor.ijaresm@gmail.com

IJARESM INDIA Auth. Signatory

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IJARESM

ISSN: 2455-6211, New Delhi, India

International Journal of All Research Education & Scientific Methods

An ISO & UGC Certified Peer-Reviewed & Refereed Multi-disciplinary Journal

UGC Journal No. 7647

Certificate of Publication

Mr. Tejsinh. J. Harale-Bhosale

<u>TITLE OF PAPER</u>

Quick Road Patch

has been published in

IJARESM, Impact Factor: 8.536, Volume 13 Issue 4, April.-2025

Certificate Id: IJ-2204250339

Date: 22-04-2025

CERTIFIED ISO 9001:2008 JOURNAL

Website: www.ijaresm.com
Email: editor.ijaresm@gmail.com

IJARESM Auth. Signatory INDIA

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IJARESM

ISSN: 2455-6211, New Delhi, India

International Journal of All Research Education & Scientific Methods

An ISO & UGC Certified Peer-Reviewed & Refereed Multi-disciplinary Journal

UGC Journal No. 7647

Certificate of Publication

Mr. Athrav. M. Suryavanshi

TITLE OF PAPER

Quick Road Patch

has been published in

IJARESM, Impact Factor: 8.536, Volume 13 Issue 4, April.-2025

Certificate Id: IJ-2204250340

Date: 22-04-2025

CERTIFIED ISO 9001:2008 JOURNAL

Website: www.ijaresm.com
Email: editor.ijaresm@gmail.com

IJARESM INDIA Auth. Signatory

Authorized Signatory

IJARESM

ISSN: 2455-6211, New Delhi, India

International Journal of All Research Education & Scientific Methods

An ISO & UGC Certified Peer-Reviewed & Refereed Multi-disciplinary Journal

UGC Journal No. 7647

Certificate of Publication

Mr. Sujal. S. Gawade

TITLE OF PAPER

Quick Road Patch

has been published in

IJARESM, Impact Factor: 8.536, Volume 13 Issue 4, April.-2025

Certificate Id: IJ-2204250342

Date: 22-04-2025

Website: www.ijaresm.com

Email: editor.ijaresm@gmail.com

Authorized Signatory

IJARESM

ISSN: 2455-6211, New Delhi, India

International Journal of All Research Education & Scientific Methods

An ISO & UGC Certified Peer-Reviewed & Refereed Multi-disciplinary Journal

UGC Journal No. 7647

Certificate of Publication

Mr. Shardul. S. Patil

<u>TITLE OF PAPER</u>

Quick Road Patch

has been published in

IJARESM, Impact Factor: 8.536, Volume 13 Issue 4, April.-2025

Certificate Id: IJ-2204250341

Date: 22-04-2025

Website: www.ijaresm.com
Email: editor.ijaresm@gmail.com

Authorized Signatory

IJARESM

ISSN: 2455-6211, New Delhi, India

International Journal of All Research Education & Scientific Methods

An ISO & UGC Certified Peer-Reviewed & Refereed Multi-disciplinary Journal

UGC Journal No. 7647

Certificate of Publication

Mr. Yashraj. D. Patil

TITLE OF PAPER

Quick Road Patch

has been published in

IJARESM, Impact Factor: 8.536, Volume 13 Issue 4, April.-2025

Certificate Id: IJ-2204250343

Date: 22-04-2025

CERTIFIED ISO 9001:2008 JOURNAL

Website: www.ijaresm.com
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CHAPTER 8
OPERATING MANUAL

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The ESP8266-based Wi-Fi robot car is a compact, wirelessly controlled vehicle designed for tasks such as line-following, pothole detection, and remote navigation. The system uses:

- **ESP8266 NodeMCU** for control and communication
- **Servo motor** for dynamic actions (e.g., directional movement or actuator-based tasks)
- **Motor Driver (L298N or L9110)** for DC motor control
- **Ultrasonic sensor** (optional) for obstacle/pothole detection.

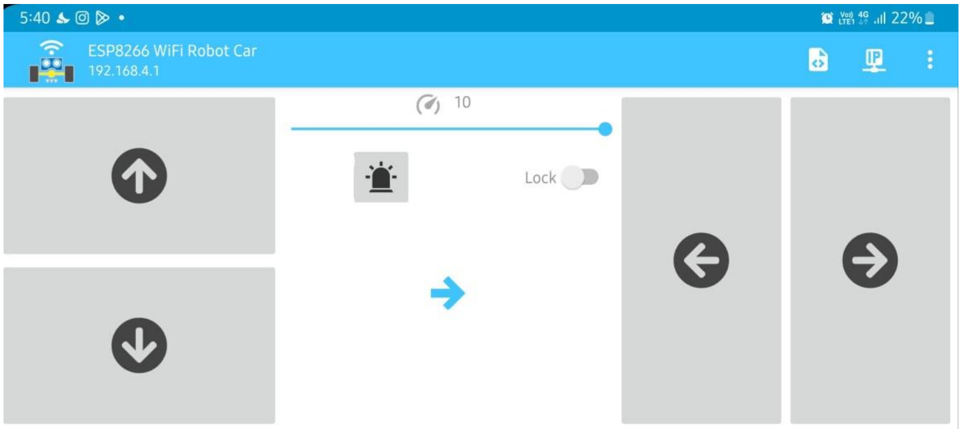
Operating Procedure

Initial Setup:

1. Power the robot and wait for Wi-Fi to connect.
2. Use serial monitor to identify IP address (or configure static IP).
3. Open Wi-Fi app or browser to send commands.

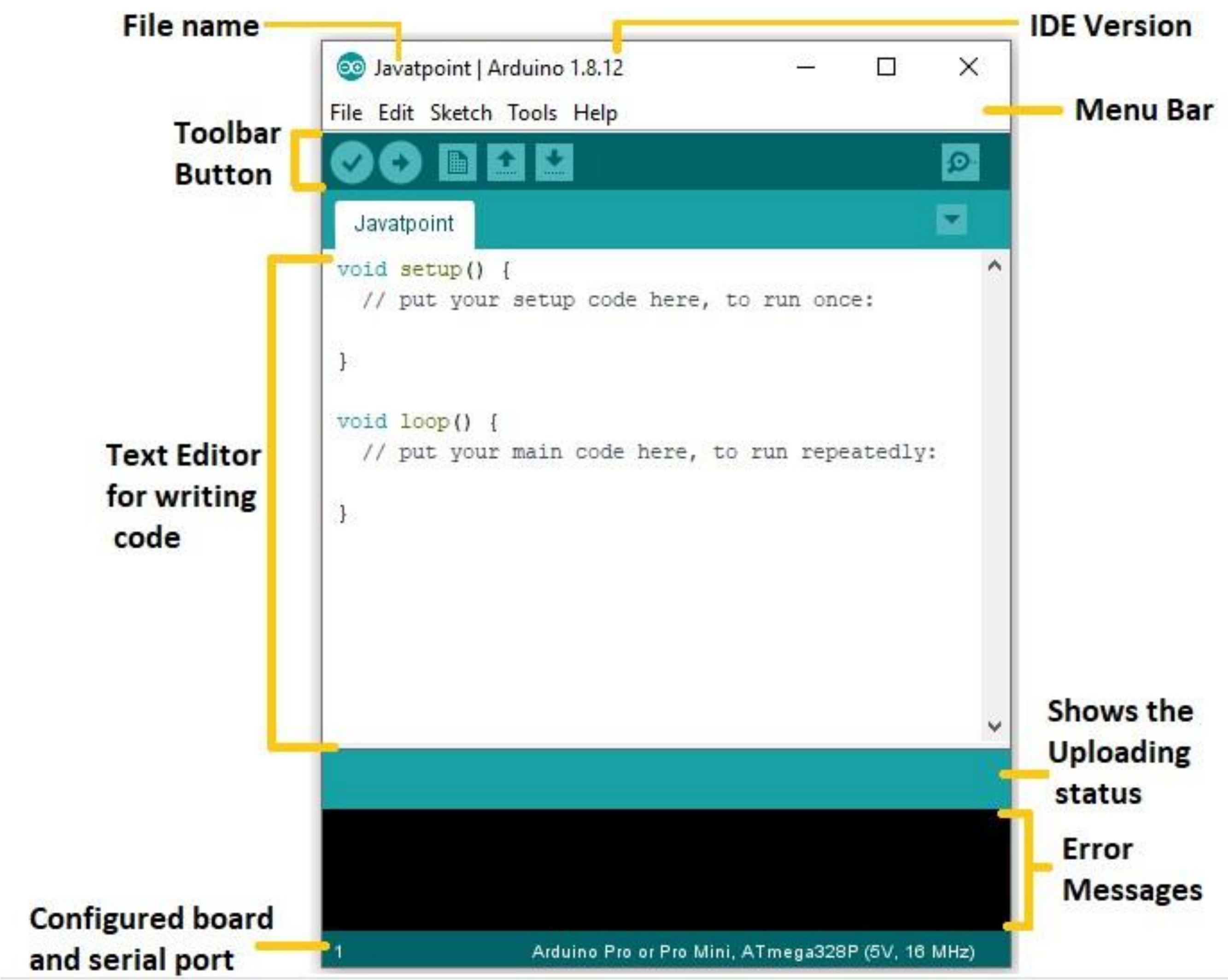
Movement:

- Use Forward/Backward/Left/Right buttons.
- Servo can be used to aim sensors, open hatches, or simulate actuation (e.g., patch dispensing).



SOFTWARE INTERFACE

The Arduino IDE is an open-source software, which is used to write and upload code to the Arduino boards. The IDE application is suitable for different operating systems such as Windows, Mac OS X, and Linux. It supports the programming languages C and C++. Here, IDE stands for Integrated Development Environment.



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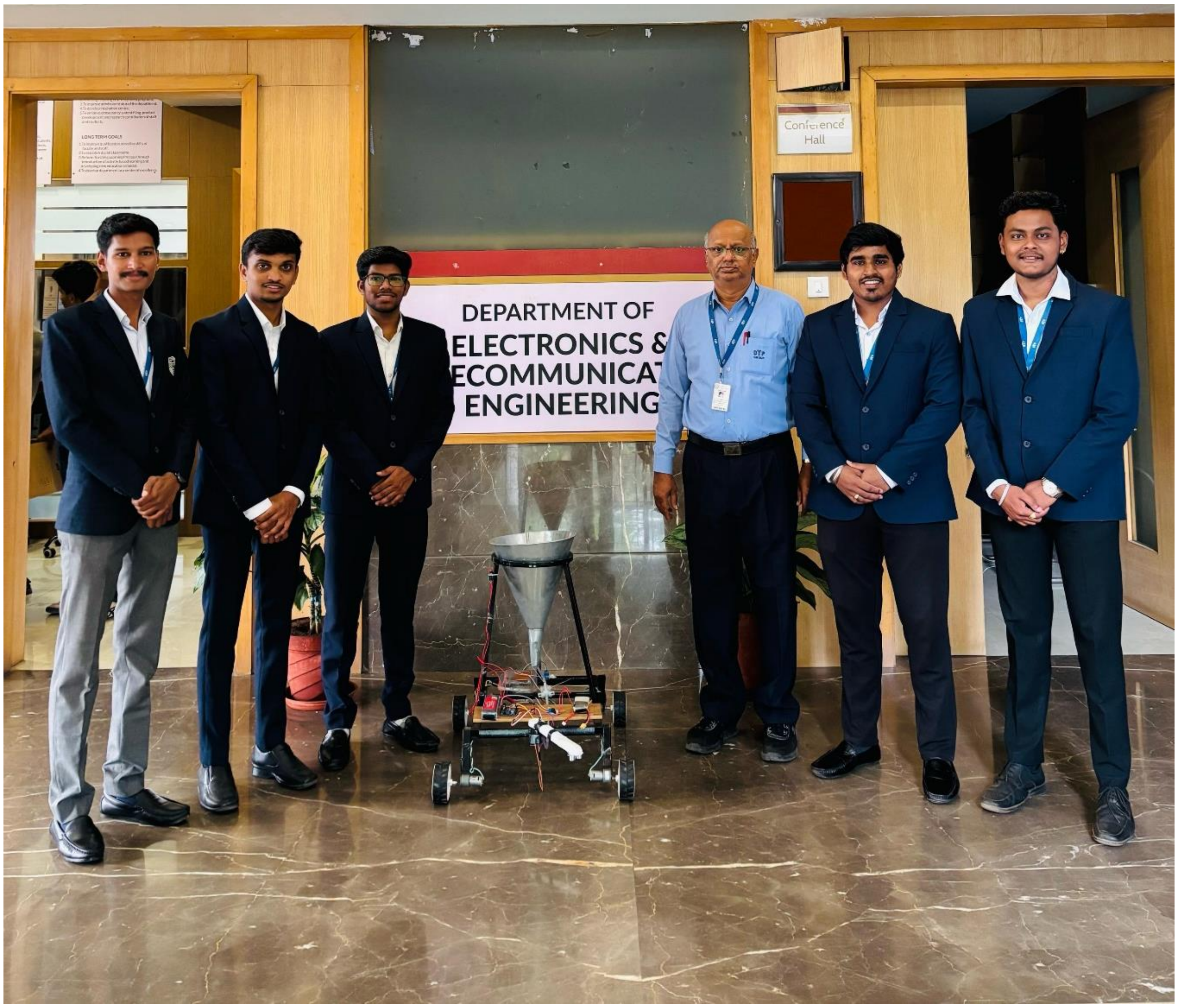

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