

PristineProbot: A Surveillance Bot to Survey the Feasibility of Vehicle Movement

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Abstract - The yearly occurrence of unnecessary accidents is a result of bad techniques of construction, no maintenance and repair, various organizations taking charge with unclear responsibilities and bureaucratic indifference. Thousands of politicians vow every year to make road maintenance the priority. However, barely any action is taken. The primary cause of poor maintenance is the manual effort required to repair and clean the roads. This project aims at completely automating the road maintenance by constructing a fully functioning robot called PristineProBot which is a Surveillance Bot. This is a self-driving vehicle intelligently curated to detect any malfunctioning roads and repair them instantaneously. This project overcomes all the limitations of the existing research to build an advanced robot using IoT with several features such as detection of roads that are not levelled, repairing the roads to be levelled, storage of details of blocked roads via its built-in camera and notifying the users of blocked road conditions. These features ensure crystal clear, well-maintained roads.

Key Words: PristineProBot, Self-driving, Built-in camera, Surveillance Bot, IoT

I. INTRODUCTION

In a country like India, the topic like “ABNORMAL, PROBLEMATIC” roads don’t need any introduction. It is very common and easily visible in Indian roads. In fact, in every 5 kilometers, you’ll find a pothole, abnormal, problematic roads. The size and depth of the pothole may vary from place to place. Potholes needed to be taken seriously. Potholes have the capability of causing accidents that may be serious or even fatal. It’s a sinking feeling to see our country’s

roads in such conditions despite our continued efforts to elect better leaders. In this article, we have researched and discussed how potholes, abnormal, problematic is harming people’s lives. Who is responsible for pothole? How many cases are filled for potholes? Is it the government or is it authorities or is it those people who have got the contract? What are the changes required in our laws for pothole accidents? It is truly said that potholes kill more people in a year than a terrorist attack! if garbage is thrown on the road, it will make the environment unclean and invite insects such as cockroaches and flies. Flies, rodents, and other animals are attracted to unattended trash, which transmits diseases.

A major problem that stands in the way of India's ascent to developed country status is the quality of its roads and how it is taken for granted. In India, 60,000 accidents were reported in 2020, all of which were attributable to bad road conditions. The existing research done to prevent road accidents is only focused on the pothole detection but there is hardly any research undertaken to repair the roads. Terrible road conditions are also due to the lack of hygiene on the roads. Improper waste disposal has caused garbage to be accumulated on roads leading to more blocked roads. The primary cause of poor maintenance is the manual effort required to repair and clean the roads. In this era when Internet of Things is prominent in making every concept “smart”, there is no automation done to repair roads and maintain ideal road conditions. This research is to achieve maximum automation in enhancing road infrastructure through regular cleaning, repair, and levelling of roads.

II. LITERATURE REVIEW

Following are the existing applications available:

1. Smart Pothole Detection Using Deep Learning Based on Dilated Convolution

The study aimed to develop an efficient approach for real-time pothole detection using convolution neural networks (CNNs). To improve the training results and reduce computational costs, the researchers introduced a modified VGG16 (MVGG16) network by removing specific convolution layers and employing different dilation rates. Additionally, the study compared the performance of YOLOv5 models (Large (Yl), Medium (Ym), and Small (Ys)) with ResNet101 backbone and Faster R-CNN models with various backbones such as ResNet50(FPN), VGG16, MobileNetV2, InceptionV3, and MVGG16. The results demonstrated that the Ys model was more suitable for real-time pothole detection owing to its speed. Furthermore, the use of the MVGG16 network as the backbone of the Faster RCNN produced better mean precision and shorter inference time compared to other backbones such as VGG16, InceptionV3, and MobilNetV2. Overall, the proposed MVGG16 technique provided a well-balanced solution for pothole detection, considering both accuracy and speed.

2. Convolutional neural networks-based potholes detection using thermal imaging

The study aimed to assess the viability and precision of thermal imaging for detecting potholes. The researchers sought to determine the feasibility and accuracy of thermal imaging in this context and achieved the highest accuracy rate of 97.08% by utilizing a pre-trained convolutional neural network based on residual network models. To conduct the study, the researchers gathered a sufficient amount of data consisting of pothole images captured in various weather and environmental conditions. They then applied data augmentation techniques and adopted a deep learning approach using convolutional neural networks, which is a new approach for this particular problem domain using thermal imaging. The findings of this research can guide future studies on the innovative application of thermal imaging in the field of pothole detection.

3. Monitoring of road damage detection systems using image processing methods and Google Map

The aim of this research is to create a system that detects potholes on highways and provides crucial road contour damage information to drivers by reporting it on Google Maps. This system intends to improve road safety for drivers by warning them of potential hazards on the road. The system employs two Raspberry Pi 2 embedded devices as a management center for data collection, a 6M NEO U-box Global Positioning System (GPS) sensor to geotag location, and a CSI camera interface for capturing images of road surface contours. The system is subject to testing at different stages and times to ensure its effectiveness. The results demonstrate that the system effectively detects and identifies the location of potholes on Google Maps, giving road users crucial information on the condition of the road ahead.

4. Overview of Road Traffic Management Solutions based on IoT and AI

This article presents a comprehensive analysis of road traffic management solutions. It proposes a classification and evaluation of these solutions, including Traffic Guidance, Traffic Light Control, and Network Traffic Management. The article begins by introducing routing mechanisms, followed by traffic light-based solutions, and approaches to traffic control management. Additionally, the authors suggest potential areas for future research in the field of urban road traffic management. The article highlights the various methods used to collect traffic data, including Wireless Sensor Networks (WSN), VANET, and Cameras and image processing. Furthermore, the paper evaluates the effectiveness of these approaches in minimizing traffic congestion at intersections.

5. Enhanced pothole detection system using YOLOX algorithm

This research explores the efficacy of YOLOX, an object detection algorithm, for pothole detection. The focus of the study is on training and evaluating the YOLOX model, which achieves an AP value of 85.6% and has a compact size of 7.22 MB. The developed

system allows users to upload images of potholes in their area, which are then validated by the YOLO algorithm. The pothole's location is then displayed on a map. Additionally, the paper discusses several approaches to alleviate traffic congestion at intersections, such as utilizing Wireless Sensor Networks (WSN), VANET, and Cameras and image processing. The article concludes by presenting promising directions for future research on urban road traffic management.

III. PROPOSED SYSTEM

1. Scope

To tend to the road safety needs and provide hygiene on public roads for citizens of India. Common outcomes defective roads unnecessary accidents are a result of bad techniques of construction, no maintenance and repair, various organizations taking charge with unclear responsibilities and bureaucratic indifference. Thousands of politicians vow every year to make road maintenance the priority. However, barely any action is taken. The primary cause of poor maintenance is the manual effort required to repair and clean the roads. This project aims at completely automating the road maintenance by constructing a fully functioning robot called PristineProBot. PristineProBot is built to be an intelligent vehicle that has advanced capabilities of self-driving, damage-detection, and damage-repair. It is constructed using intricate hardware and software technology. It accurately detects any damage in the roads such as potholes and fixes it instantaneously.

2. Objectives

The main objectives of the project are as follows:

This robot detects ANY PROBLEM on the road and resolves it by levelling the road. Every Sunday (7th day of the week or any frequency required), the robot automatically surveys each and every road of a city to detect ABNORMAL, PROBLEMATIC roads. This robot can contribute to Swachh Bharath because it also detects any garbage or dust piles present on the road and cleans it as and when. It is completely self-driving so no

manual intervention is required. Built-in camera that stores images of ALL roads with problems so that a traveler gets to know instantly if there is any damage to the road. In case the authority like BBMP just wants to detect problems and resolve it later, it sends a message to the authority with the exact Google maps location so that the BBMP can record the problems and resolve it at a later time. It records the ABNORMAL, PROBLEMATIC roads in the database (Memory card) the list of all roads that are damaged.

IV. METHODOLOGY

1. System Design

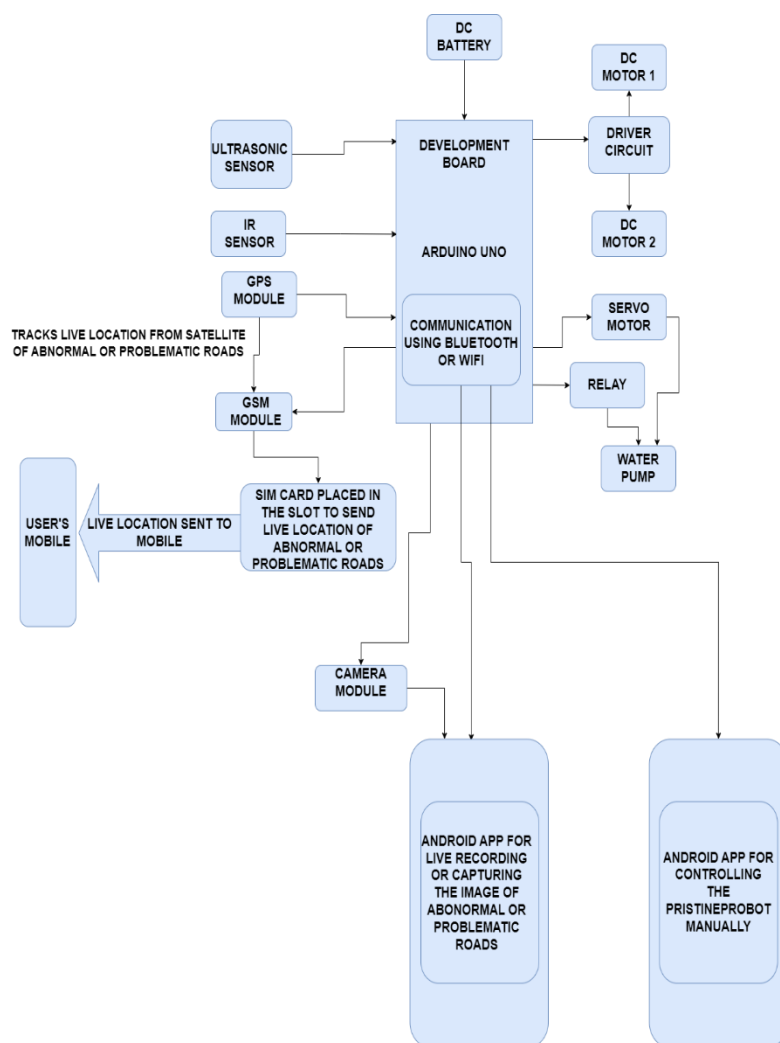


Fig -1: System Architecture

1.1 DC Motor: DC battery is used to move the PristineProBot in any give direction. It is basically for movement of the surveillance bot forward, backward, left and right. DC motors normally have just two leads, one positive and one negative.

1.2 Ultrasonic Sensor: It uses SONAR (Sound Navigation and Ranging) principle for detecting abnormal or problematic roads. It has a transmitter and receiver from which sound hits an object in front of it and bounces back and sends it to receiver.

1.3 Infrared Sensor: It uses principle of optics which uses IR LED as transmitter and photodiode as receiver. IR LED transmits the infrared light and detects uneven humps in front of it and sends it to photodiode by which the surveillance bot gets to know about the uneven hump in front of it.

1.4 GPS Module: It uses principle of Trilateration which detects the exact location of the abnormal or problematic roads using three or more positions of satellite. The GPS receiver measures the distance to each satellite by the amount of time it takes to receive a transmitted signal.

1.5 GSM Module: It uses the location tracked by GPS Module and sends the exact location of uneven humps, garbage piles, abnormal or problematic roads to mobile as an alert notification via SMS.

1.6 Servo Motor: This motor helps to fill in the potholes automatically when IR sensor and Ultrasonic sensor detects any abnormal or problematic roads. It uses principle of Vortex Electromagnetic Waves.

1.7 Water Pump: This is connected to servo moto which is used for rotation. As soon as a pothole is detected on the road it switches in the direction and fills it automatically.

1.8 Camera Module: This module helps to live record and save the location of uneven humps, garbage piles, abnormal or problematic roads.

1.9 Bluetooth Module: This module is used to connect the surveillance bot to an android app which is used for movement and direction control.

1.10 Arduino UNO: Arduino UNO is a low-cost, flexible, and easy-to-use programmable open-source microcontroller board which is used to connect all the sensors, modules.

2. Sequence Diagram

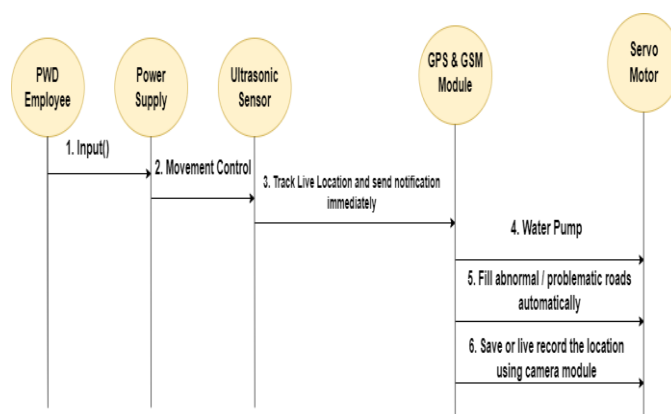


Fig -2: Sequence Diagram

1. Public Welfare Department (PWD) employee provides input which is power supply to surveillance bot which helps for movement and direction control.
2. Power supply helps the bot to move in all the direction.
3. The ultrasonic sensor detects the abnormal and problematic roads and sends the data or information to GSM Module.
4. GPS Module tracks the exact location of the affected areas of roads.
5. GSM Module collects the data of GPS Module and sends immediate alert notification to mobile via SMS.
6. Servo motor turns on the water pump and fills the potholes automatically.

7. Camera module helps to store and see live recording of affected areas of the road.

3. Use Case Diagram

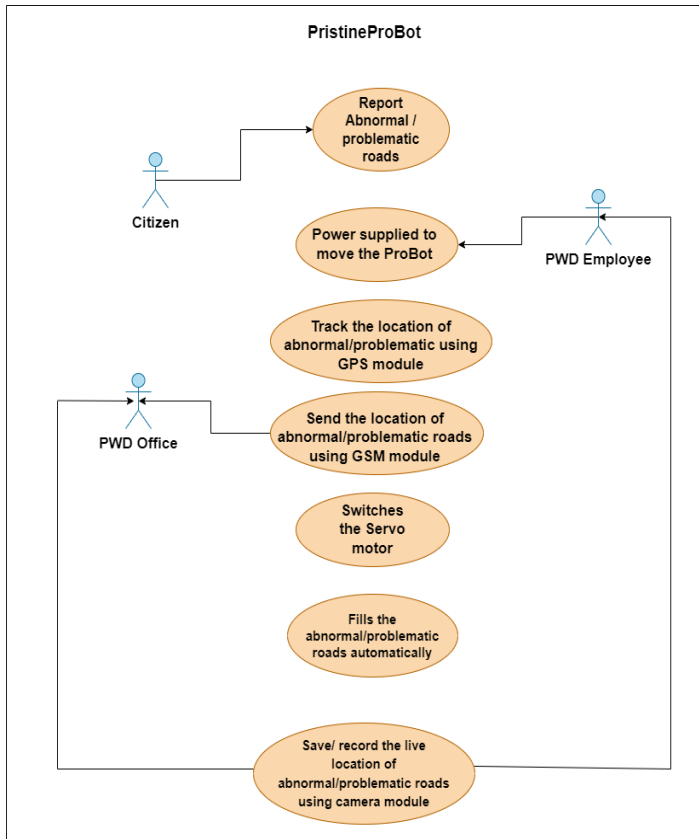


Fig -3: Use case Diagram

When citizens report any abnormal or problematic roads, they can report it to any PWD office. PWD office assigns a PWD employee to take action. PWD employee supplies power to surveillance bot which helps in direction and movement control. As soon as the bot detects the any uneven humps, garbage piles, abnormal or problematic roads, using IR and Ultrasonic sensors it tracks the exact location of the affected areas using GPS Module, and sends immediate location to PWD office for easy tracking via SMS using GSM Module. Further PWD office can also save the images of affected areas of roads and also live record them and see them on an android app.

4. Data Flow Diagram

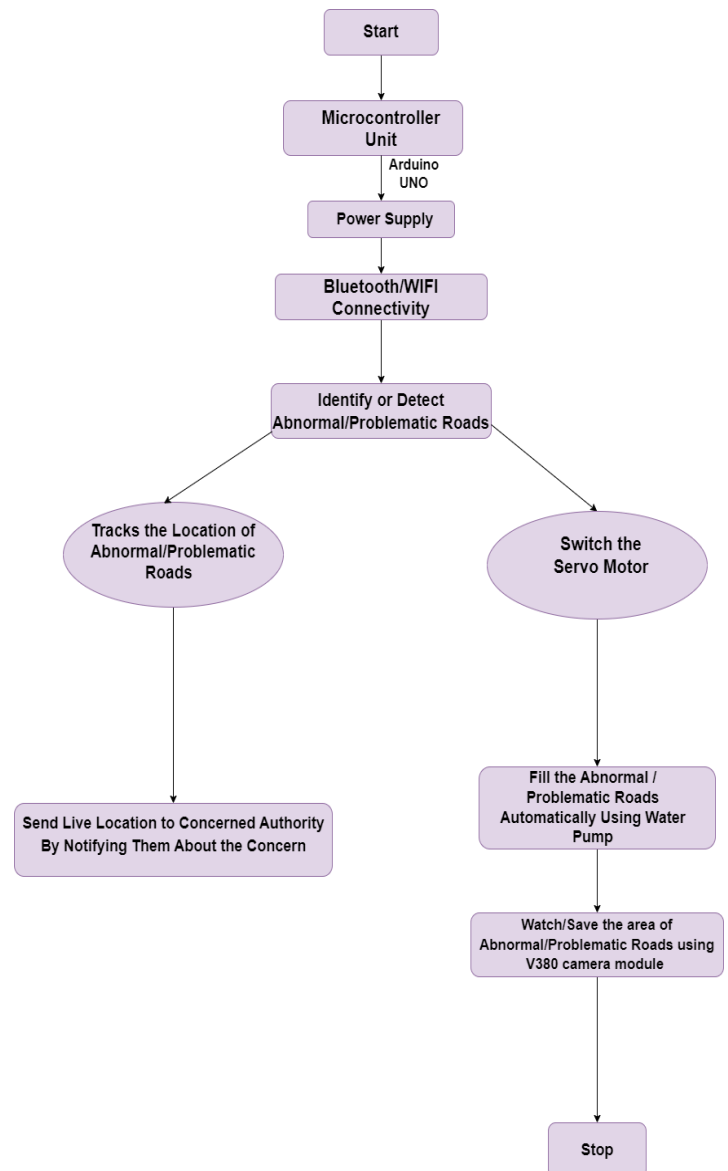


Fig -4: Data Flow Diagram

When an Arduino Uno receives power supply it starts moving in the direction using Bluetooth module which is controlled by an android app. As soon as it detects pile of garbage, uneven humps, abnormal or problematic it tracks the location and also switches servo motor and fills the potholes automatically.

V. PSEUDOCODE OF THE IMPLEMENTED ALGORITHMS

A. Pseudocode and working of the PristineProbot

```
distance = ultrasonic();  
Serial.println(distance);  
distance = duration * 0.034 / 2;  
if (distance > 6)  
{  
    hold();  
    servo.write(90);  
    digitalWrite(pump,HIGH);  
    delay(5000);  
    digitalWrite(pump,LOW);  
    servo.write(180);  
}
```

[Program snippet of the sensors to record the abnormal or problematic roads and fill it automatically]

B. Pseudocode and working of the GPS and GSM Module

```
if (gps.location.isValid() )  
{  
    latitude = (gps.location.lat());  
    longitude = (gps.location.lng());  
    Serial.print("LAT: ");  
    Serial.println(latitude,6);  
    Serial.print("LONG: ");  
    Serial.println(longitude, 6);  
}
```

[Program snippet of the sensors to track and send live location via Google Maps]

C. Pseudocode and working of the Relay Module

```
servo.write(90);  
digitalWrite(pump,HIGH);  
delay(5000);  
digitalWrite(pump,LOW);  
servo.write(180);
```

[Program snippet of the sensor to cut power supply immediately after pothole is filled]

D. Pseudocode and working of the Infrared Module

```
if(val==1)  
{  
    digitalWrite(buzzer,LOW);  
}  
else  
{  
    digitalWrite(buzzer,HIGH);  
}
```

[Program snippet of the sensor to track garbage piles and aid other drivers with buzzer alarm]

VI. RESULTS

Following are the snap shots of the PristineProbot:

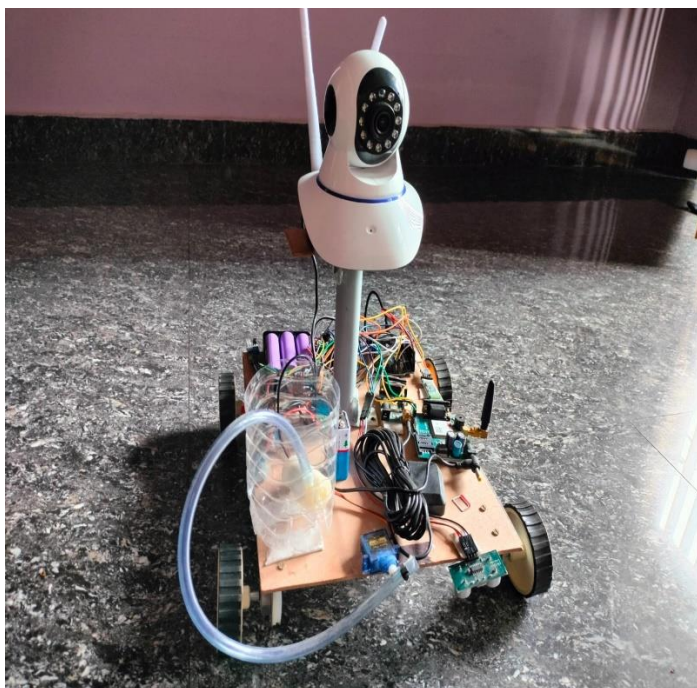


Fig -5: The PristineProbot

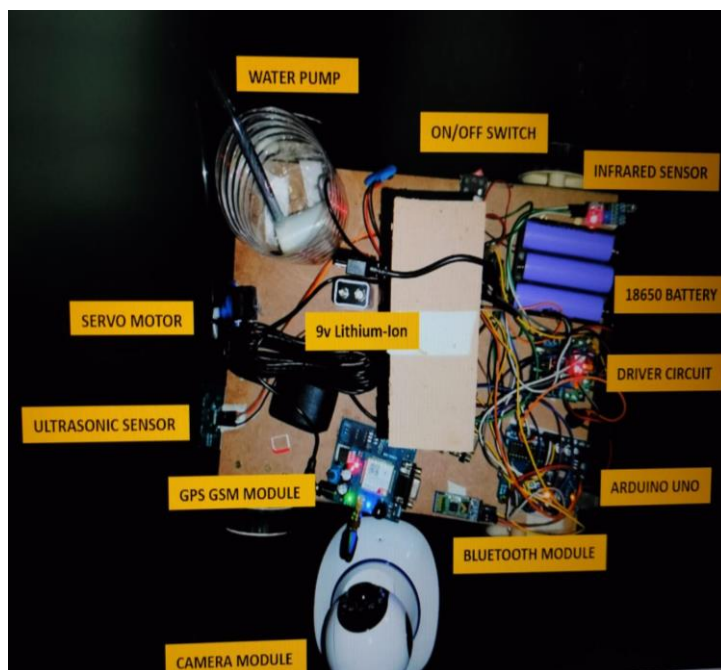


Fig -7: Components of PristineProbot

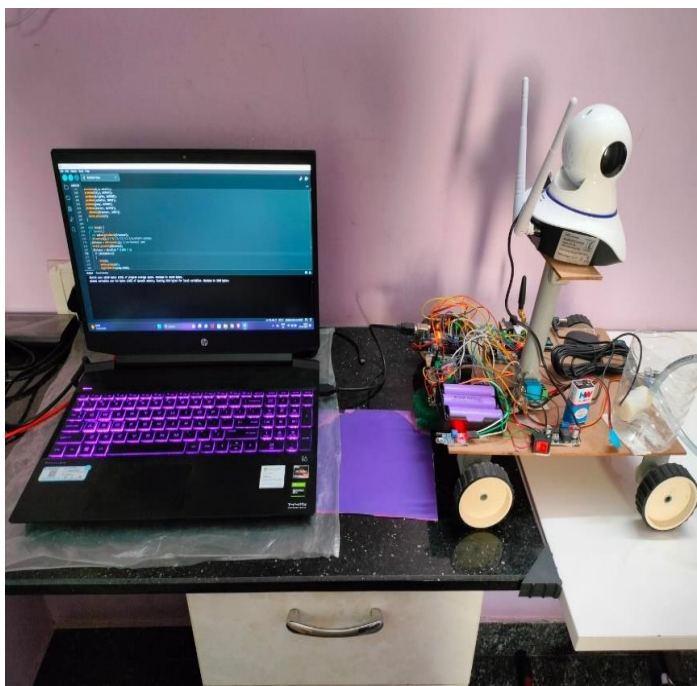


Fig -6: Arduino Code Input

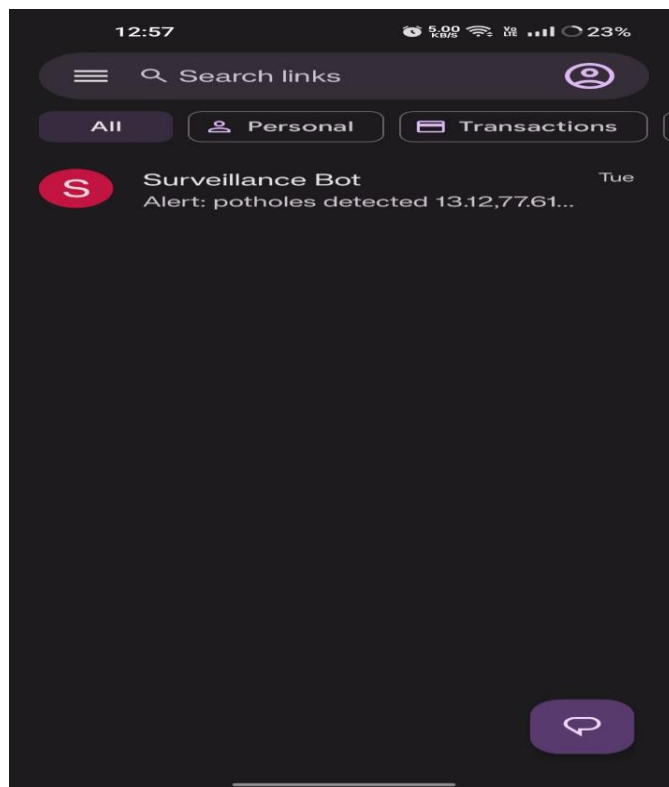


Fig -8: Live Location Tracking of Pothole

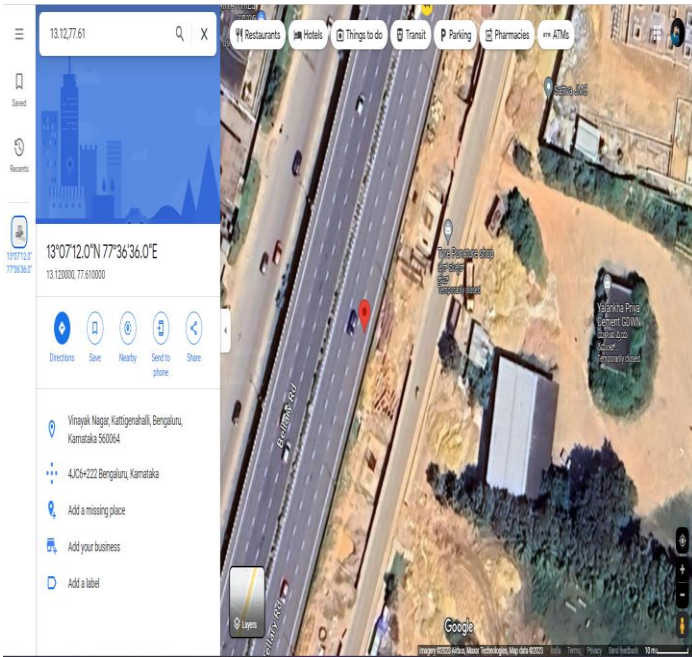


Fig -9: Live Location Tracking of pothole via Google maps



Fig -10: App designed for movement control of PristineProBot

VII. CONCLUSION

PristineProBot automatically detects and fills abnormal roads and cleans the road that could be a valuable solution to address some of the most common problems faced by cities and municipalities worldwide and especially in India. By leveraging the power of automation and robotics, such a device could significantly reduce the time, effort, and costs associated with manual road repair. The development and deployment of such a robot would require significant investment and effort, the potential benefits could be substantial, including reduced road maintenance and cleaning costs, increased efficiency and safety, and improved quality of life for citizens.

VIII. FUTURE ENHANCEMENT

In addition to the current capabilities of PristineProBot that automatically fills abnormal or problematic roads and cleans the road, there are several potential enhancements that could be considered in the future. One enhancement could be the integration of artificial intelligence and machine learning algorithms, which would enable the robot to learn from its experiences and adapt to new situations. For example, the robot could identify the types of garbage it collects and sort them for recycling or disposal.

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BIOGRAPHIES



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