Project Reference Number: **46S_BE_1339**

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

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Introduction / background:

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 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.

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.

Objectives:

Scope of the Project:

1. To tend to the road safety needs and provide hygiene on public roads for citizens of India.
2. 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.
3. PristineProBot is built by us to be an intelligent vehicle that has advanced capabilities of 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.

Objectives of the Project:

1. This robot detects ANY PROBLEM on the road and resolves it by levelling the road
2. Every Sunday (7^{th} day of the week or any frequency required), the robot automatically surveys each and every road of a city to detect ABNORMAL, PROBLEMATIC roads
3. 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!
4. It is completely intelligent-driving so no manual intervention is required
5. 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
6. 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.
7. It records the ABNORMAL, PROBLEMATIC roads in the camera module.

Methodology:

System Architecture

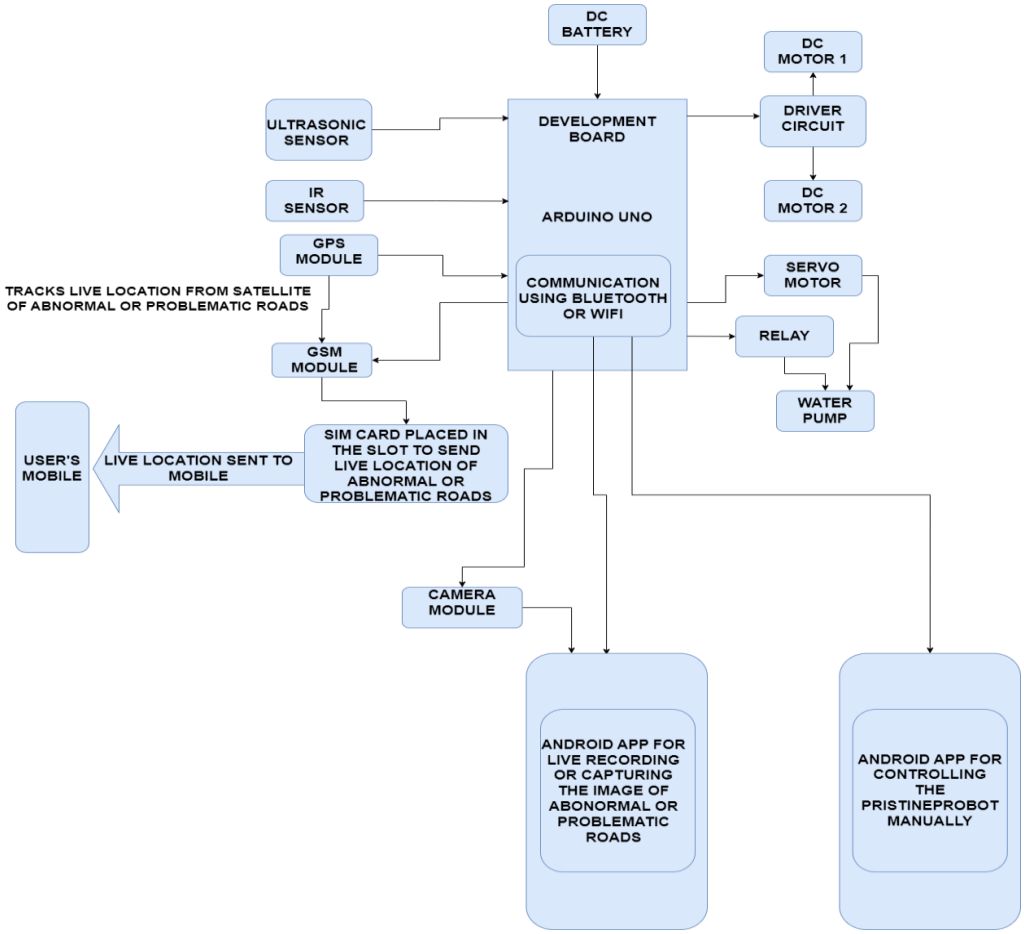

Fig. 1. System Design - The Architecture of PristineProbot

Figure 1 illustrates the system design,

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

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.

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 garbage pile in front of it and alerts with buzzer.

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.

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.

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.

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.

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

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

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.

Data Flow Diagrams

Data Flow Diagram - Level 0

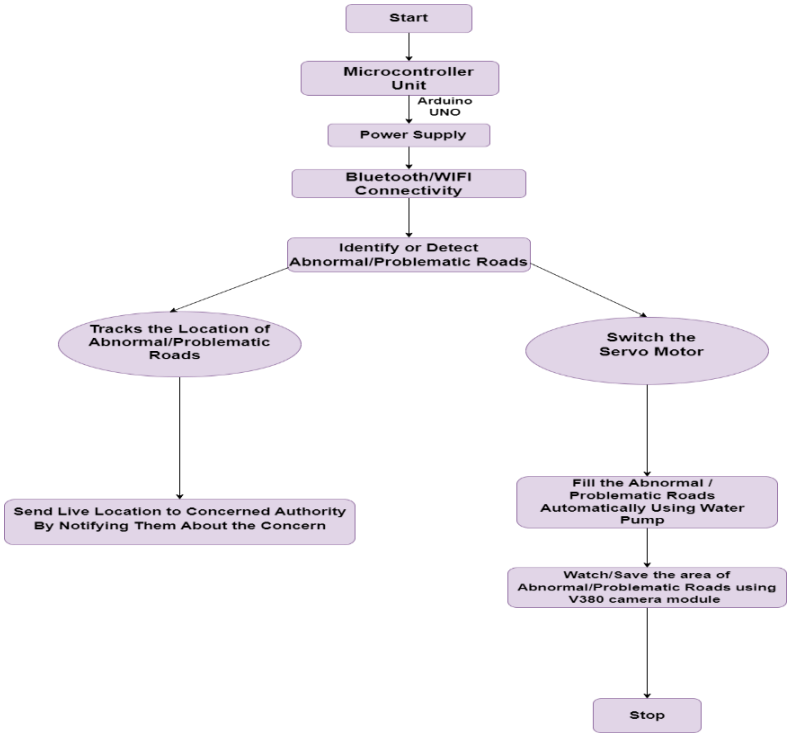

Fig. 2. High Level Design: Context Level DFD for PristineProbot

Figure 2 is a context level data flow diagram which illustrates the content diagram or say overview of the whole system. It is designed to be an at- a-glance view, showing the system as single high-level process. The above diagram represents that 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 and fills the potholes automatically.

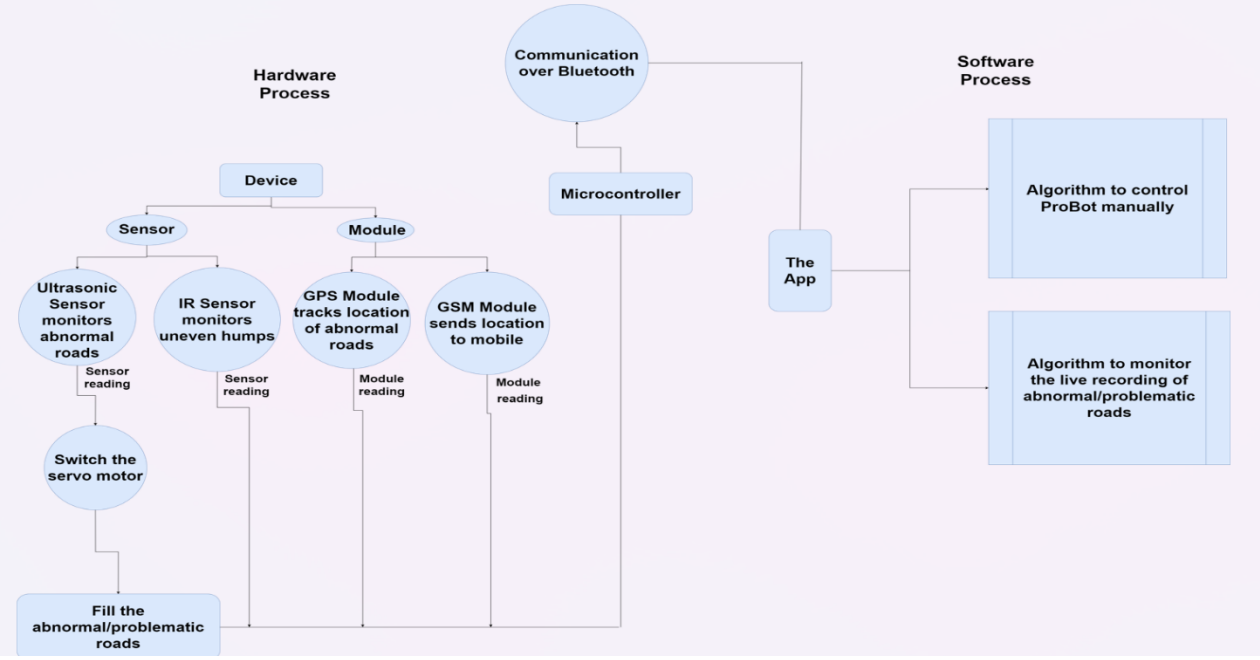

Fig. 3. High Level Design: Process Level DFD for PristineProbot

Figure 3 illustrates the data flow from a process perspective. DFD depicts basic modules in the system and flow of data among various modules. Here the diagram is broken and classified into hardware and software process. In hardware module consists of:

1. **Sensors:** IR Sensor, Ultrasonic Sensor
2. **Modules:** GPS, GSM Modules
3. **Motors:** DC Motors, Servo Motor

Both Hardware and software process is connected using a Bluetooth Module. In software process android app is developed for direction and movement control and another app is developed for watching live recordings of pile of garbage, uneven humps, abnormal or problematic roads.

Use Case Diagram

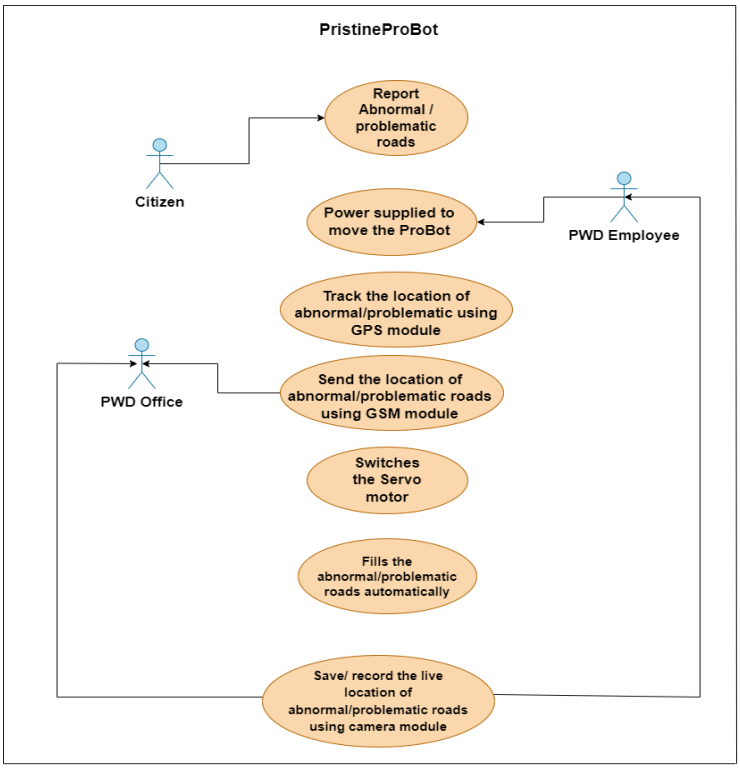

Fig. 4. Use Case Diagram of PristineProbot

Figure 4 illustrates the use case diagram of PristineProbot. The diagram describes

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.

Modules

Hardware Modules

1. **Pseudo code and working of Ultra Sonic Sensor Module**

   An ultrasonic sensor typically uses a **Timing Algorithm** in Arduino to measure distance based on the time it takes for a sound wave to travel from the sensor to an object and back.

```
distance = ultrasonic(); /////ULTRASONIC CODE
 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);
  }
```

2. **Pseudo code and working Servo Module**

   The Servo library in Arduino provides an easy way to control servo motors using **Pulse Width Modulation (PWM) Algorithm.**

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

3. **Pseudo code and working GPS Module**

Trilateration is a technique used in Global Positioning System to determine the position of a potholes on the Earth's surface. It works by measuring the distances from the receiver to three or more satellites in orbit and using this information to calculate the receiver's precise location.

```
if (gps.location.isValid() )
 {
   latitude = (gps.location.lat());  //Storing the Lat and Lon.
   longitude = (gps.location.lng());

  Serial.print("LAT:  ");
  Serial.println(latitude,6);  // float to x decimal places
  Serial.print("LONG:  ");
  Serial.println(longitude, 6);
```

4. **Pseudo code and working GSM Module**

Global System for Mobile Communications, which is a standard for digital cellular communications used for mobile phones and other wireless devices. Authentication and Encryption: The GSM module uses the Authentication and Key Agreement (AKA) algorithm to verify the identity of the user and to encrypt the data being transmitted over the network.

```
long_lat = String(float(latitude)) +","+String(float(longitude));
 Link="https://www.google.com/maps/search/?api=1&query="+String(long
_lat); SMS = "Alert: potholes detected "+
```

5. **Pseudo code and working Infrared Sensor Module**

Threshold Detection is algorithm used in IR sensors for object detection and proximity sensing. An infrared sensor is a device that detects and measures infrared radiation, which is a type of electromagnetic radiation.

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

Results and Conclusions

Snapshots of The Completed Prototype

Fig. 5. Working Prototype

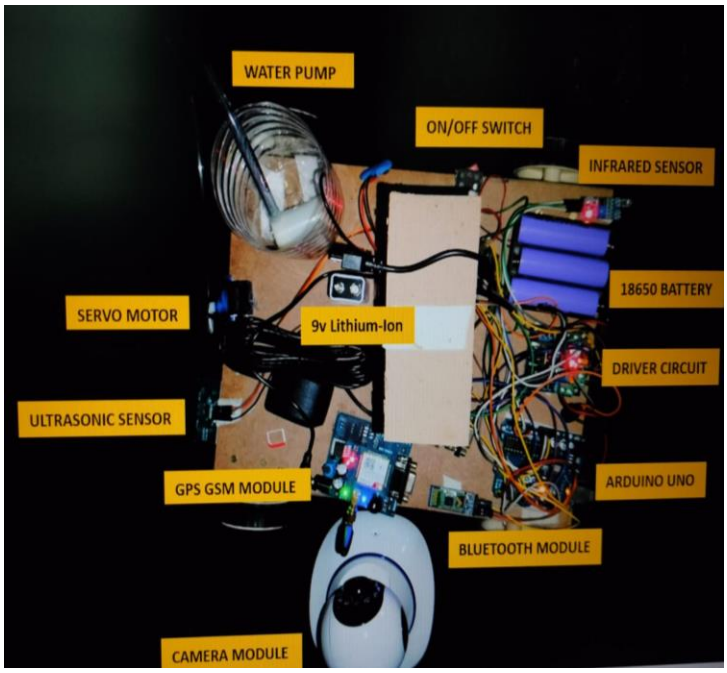

Fig. 6. Circuit and components of the prototype

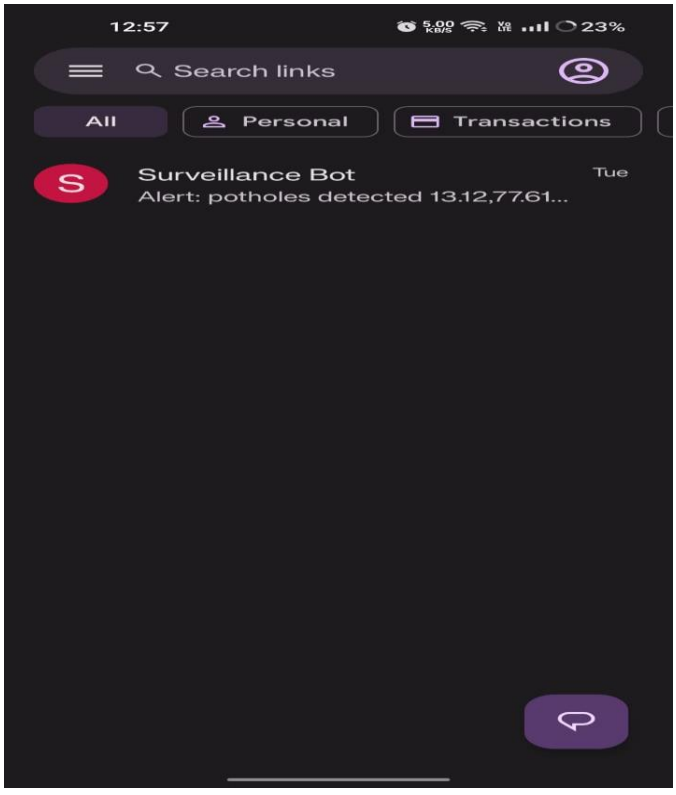

Fig. 7. Live Location Tracking of Pothole

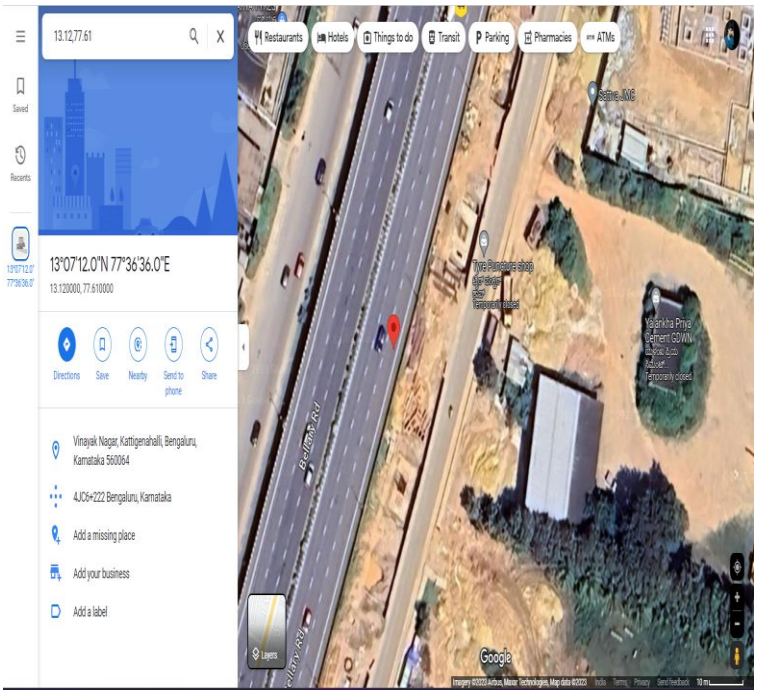

Fig. 8. Live Location Tracking of pothole via Google maps

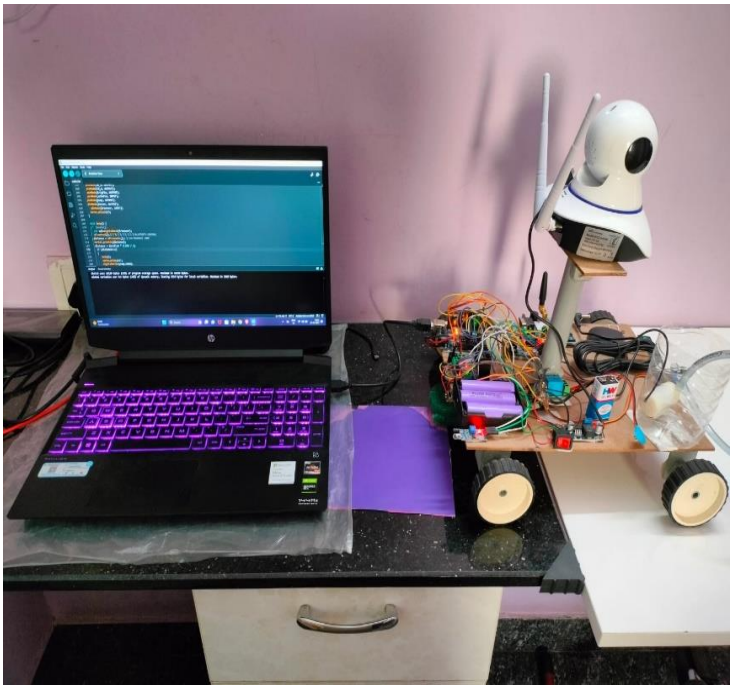

Fig. 9. Arduino Code Input

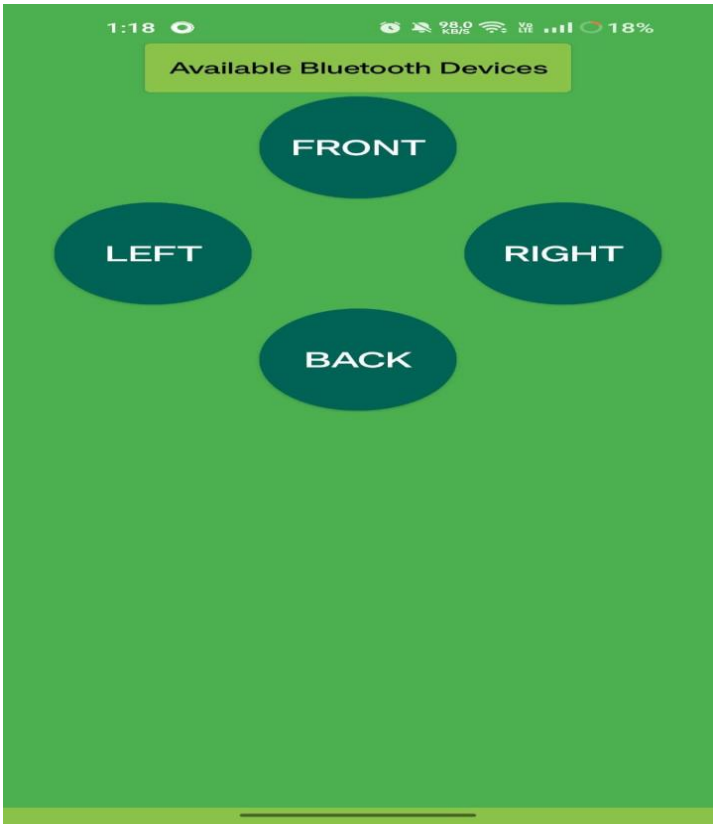

Fig. 9. App designed for movement control of PristineProbot

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.

Scope for future work

Future enhancements would be to:

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.