
🛠️ Working Guide

This section explains how the autonomous pothole-fixing robot functions step by step, combining **sensor logic**, **motor control**, and **live video streaming**.

🧠 1. Power ON and Initialization

- Power on the **Arduino-based robot** and the **Raspberry Pi 3 B+**.
- Raspberry Pi boots and starts **live video streaming** automatically (if autostart is enabled).
- Arduino initializes all sensors and motors.

🔍 2. Pothole Detection

- The **ultrasonic sensor**, placed at the front center, continuously measures surface height.
- If a significant drop in height is detected (indicating a pothole), the robot triggers alignment mode.

🎯 3. Alignment Using IR Sensors

- The robot uses **four IR sensors**:
  - IR_LEFT, IR_CENTER_LEFT, IR_CENTER_RIGHT, IR_RIGHT
- These sensors help align the robot such that the pothole lies precisely under the **servo-controlled sand gate**.
- IR readings determine if the robot should:
  - **Turn Left** (if more detection on right sensors)
  - **Turn Right** (if more detection on left sensors)
  - **Move Forward** (when centered)

🤖 4. Movement Control

- Controlled using **4 DC motors**:
  - M1 (Left Rear), M2 (Left Front)
  - M3 (Right Front), M4 (Right Rear)
- Motor control is handled using an **L293D Motor Driver Shield**, with movement functions coded in Arduino:
  - moveForward(), moveBackward()

- turnLeft(), turnRight()
- stopMoving()

🛢️ 5. Sand Dumping (Pothole Fix)

- Once aligned and directly above the pothole, the robot:
  1. Stops all motors.
  2. Activates the **servo motor** connected to a sand gate.
  3. The servo rotates to release sand into the pothole.
  4. After a few seconds, it closes the gate.

📹 6. Live Video Streaming (via Raspberry Pi)

- The **Raspberry Pi Camera** captures real-time footage of the process.
- Streaming starts with the start_stream.sh script.
- Video is broadcasted over UDP at port 8080 using ffmpeg.
- View the stream using VLC:
- Media → Open Network Stream → udp://<RPI_IP>:8080

🔁 7. Looping Operation

- After dumping sand, the robot resumes scanning the road for the next pothole.
- This loop continues until the robot is manually stopped or powered off.
