CONTROL SYSTEMS

CASE STUDY 2

KEY OBJECTIVES OF THE MODEL-

- LINE FOLLOWING
- OBSTACLE DETECTION AND AVOIDANCE
- VOICE CONTROLLED THROUGH MOBILE APP

REGISTRATION NO.

24BME0562

22BME0048

COMPONENTS–

- CHASSIS
- 150RPM BO GEAR MOTOR
- IR SENSORS
- ARDUINO UNO R3
- L298N MOTOR DRIVER
- BO WHEEL
- FF-FM-MM JUMPER WIRES
- HC-SR04 ULTRASONIC SENSORS
- SG90 SERVO MOTOR
- 18650 LI-ION BATTERY
- HC05 BLUETOOTH MODULE
- IR RECIEVER

WORKING PRINCIPLE OF THE MODEL

1. Line Following

- Uses **IR sensors** (or light sensors) placed at the bottom.
- White surface reflects IR light; black surface absorbs it.
- Sensors detect whether the robot is on the line (black) or off it (white).
- Microcontroller (e.g., Arduino) processes sensor input.
- Based on input, it adjusts motor speed/direction (left/right) to keep the robot on track.
- Continuous feedback loop ensures the robot follows the line smoothly.

2. Obstacle Detection and Avoidance

- Uses **ultrasonic sensor** (or IR proximity sensor) to detect obstacles.
- The sensor sends ultrasonic waves; reflected waves are received back.
- Time taken for echo return is used to calculate distance.
- If obstacle distance < threshold, microcontroller takes decision to stop or turn.
- Robot changes its path (left/right) or stops completely to avoid collision.
- Keeps repeating the process to move safely without hitting obstacles.

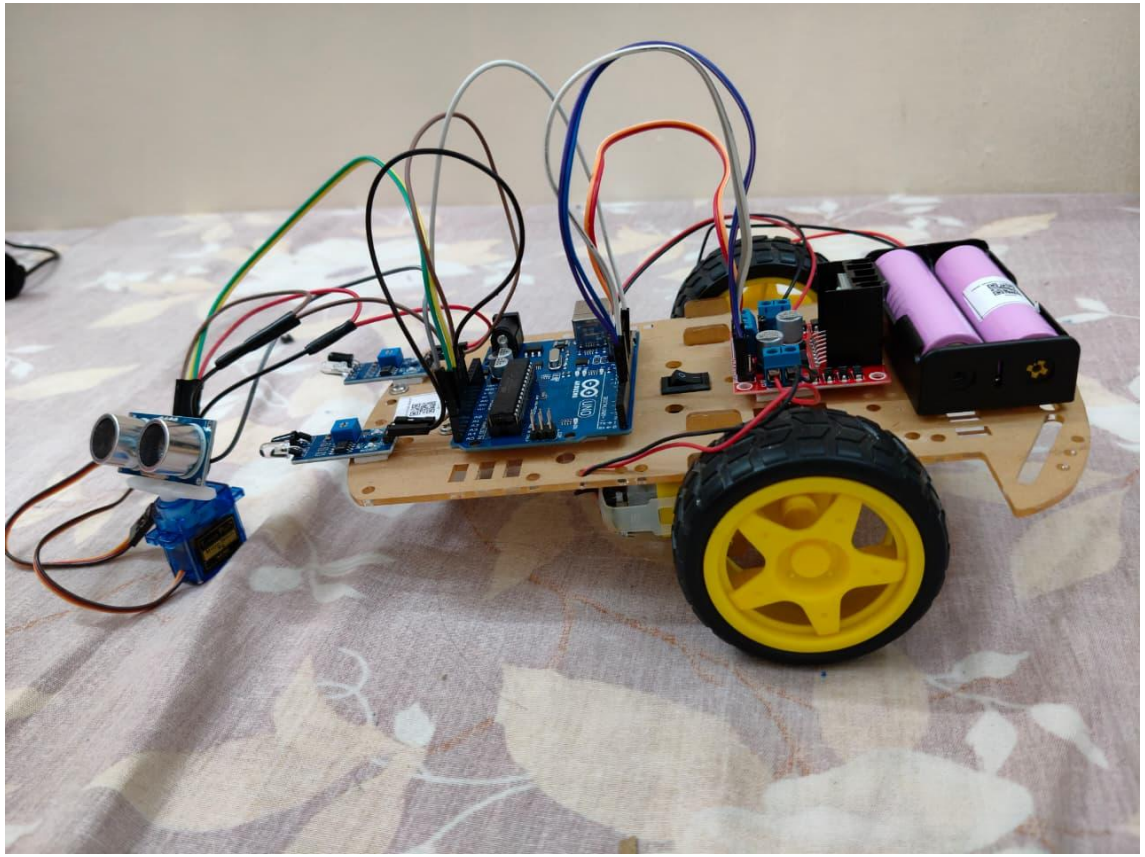
3. Voice Controlled (via Mobile App)

- Uses **Bluetooth module (HC-05)** connected to a microcontroller.
- Mobile app takes **voice commands** (e.g., "Forward", "Left", "Stop") and converts them into text signals.
- These commands are transmitted via Bluetooth to the robot.
- Microcontroller decodes the received command.
- Controls the motors accordingly:
  - "Forward" → both motors ON forward
  - "Backward" → both motors ON reverse
  - "Left/Right" → one motor ON, one OFF
  - "Stop" → both motors OFF

PREVIOUS STATUS OF THE MODEL–

- Currently, we have assembled and created the working model for the line following and obstacle detections.
- We have tested the line following using the black tape and improvised the code in Arduino IDE for reducing errors while functioning such as determining the correct path and reduced diversion from the path.
- We also have prepared the model for obstacle detection and currently working on its coding. After proper preparation and execution, further we will look to improvise the code to reduce error and proper detection as well as avoidance.
- After proper functioning of obstacle detection and avoidance we will go for adding the Bluetooth module and test the robot via voice command and the IR receivers.

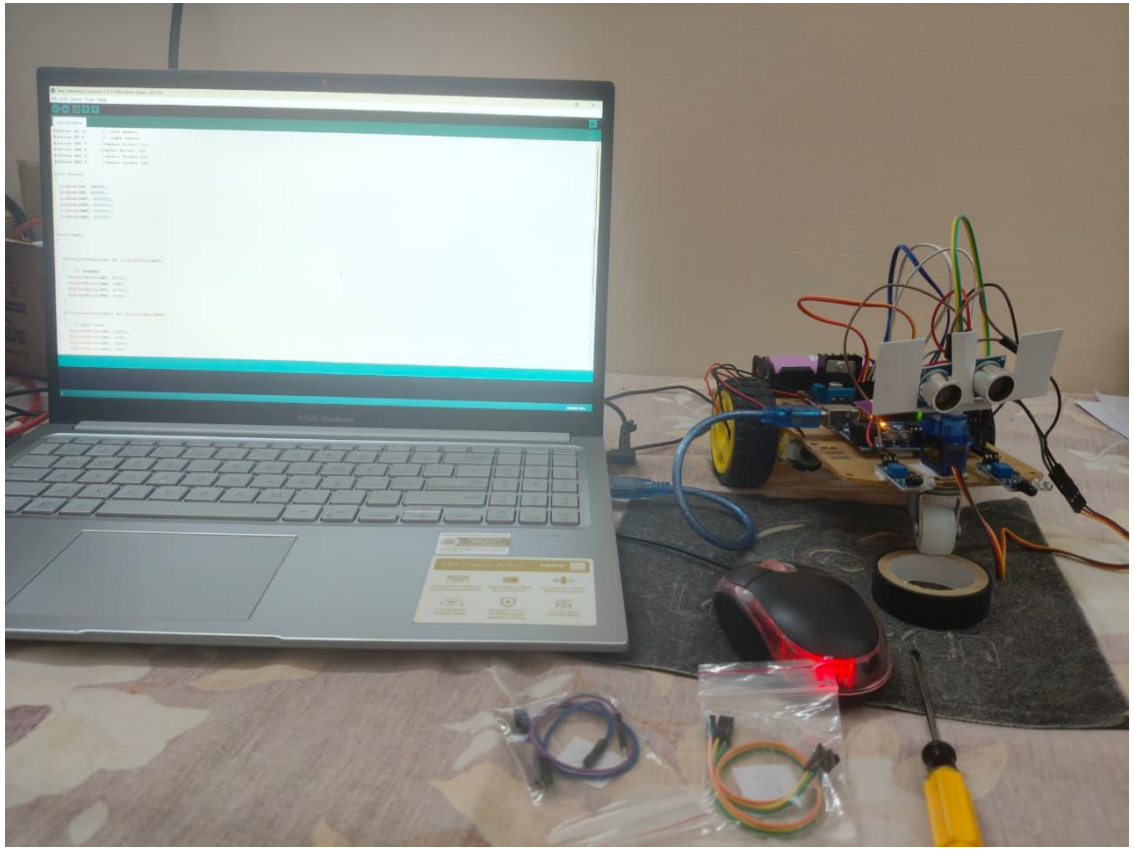
PREVIOUS MODEL-



CURRENT STATUS OF THE MODEL–

- Currently, we are prepared with a proper working model of line following with also the obstacle detection feature which is working and we are also trying to improvise the functionality such as the decision-making process of the robot while the obstacle detection also improvising the deviation from the line following.
- We have also assembled the Bluetooth module and are currently working on its Arduino code. We are trying to integrate it to our mobile using suitable app through which we will be able to give it voice command and control it using the app by giving the instructions such as stop, forward, backward, right etc.
- We are trying to improve the functionality by integrating all the things together and are working on the simultaneously functioning of each of the features i.e., line following, obstacle detection and avoidance and voice control (via Mobile app).

CURRENT MODEL-



CONCLUSION–

The robot is designed as a ***multi-functional autonomous system*** that integrates line following, obstacle detection & avoidance, and voice control. From its final performance, we can expect:

- **Autonomous Navigation** – The robot will follow a predefined path (line) accurately without human intervention.
- **Collision-Free Movement** – It will detect obstacles in its path and take corrective actions (stop, turn, reroute) to avoid crashes.
- **Human Interaction** – Through voice commands given via a mobile app, the robot can be directly controlled, adding flexibility and user-friendly operation.
- **Versatility** – It demonstrates the integration of ***sensor-based automation*** with ***manual voice-based control***, making it adaptable for real-life applications like smart delivery systems, guiding bots, or personal assistant robots.

In short: The final robot is expected to be ***intelligent, responsive, and interactive***, capable of moving safely along paths, avoiding obstacles, and responding to human voice commands for controlled operation.