LINE MAZE FOLLOWER ROBOT

TECHNICAL REPORT

PROJECT TEAM

Team Name: amiarinjaysarkar

Institution: Jadavpur University

Arinjay Sarkar — Team Leader
+91 7003828489

Arnab Bid
+91 9641565123

Saptarshi Nanda
+91 8617471550

Table of Contents

1. Team Details

Team Name	amiarinjaysarkar
College / Institute	Jadavpur University

Team Members

Name	Role	Contact
Arinjay Sarkar	Team Leader	+91 7003828489
Arnab Bid	Member	+91 9641565123
Saptarshi Nanda	Member	+91 8617471550

2. Abstract

This technical report presents the design, development, and optimization of an autonomous Line Maze Follower Robot engineered to navigate complex mazes consisting of black line tracks on a white surface. The robot utilizes a multi-sensor IR array, differential drive mechanism, and Arduino-based logic to identify paths, navigate intersections, and reach the final goal efficiently.

The system emphasizes high detection accuracy, mechanical stability, real-time correction algorithms, and compliance with competition constraints. The integration of robust sensing, optimized routing logic, and precise motor control allows the robot to navigate turns, T-junctions, X-junctions, loops, and dead ends while maintaining speed and stability. This design aligns with the specifications of the **Pravega XII Line Maze Follower Competition**.

The robot has been successfully built and tested. Future development will focus on PID parameter optimization, junction detection improvements, and speed enhancement for competitive performance.

3. Design Concept

3.1 Mechanical Design

The robot is built on a lightweight acrylic chassis designed for strength, stability, and modularity. It features a two-wheel differential drive using BO motors with high-friction rubber wheels for stable traction. A rear castor wheel ensures balance while minimizing drag. The motors are placed symmetrically to ensure straight-line stability.

Component Placement: The Arduino Uno and L298N Motor Driver are mounted centrally for equal weight distribution. The battery holder is placed at the bottom to lower the center of gravity, enhancing stability during sharp turns. The 5-sensor IR array is mounted at the front with optimal ground clearance (~10 mm).

3.2 Electronics Used

- **Arduino Uno R3:** Central microcontroller for sensing and motor control logic.
- **L298N Motor Driver:** Controls motor direction and speed via PWM signals.
- **IR Sensor Modules (×5):** Detects lines, turn points, and intersections with high accuracy.
- **BO Motors:** 100-300 RPM motors configured for differential drive system.
- **Power Source:** 11.1V Li-ion Battery Pack (3× 18650 cells) for extended operation.

3.3 System Architecture

The system follows a linear processing pipeline: **Inputs (IR Sensors)** → **Processing (Arduino Logic)** → **Outputs (Motor Driver** → **Motors)**. This modular architecture simplifies debugging and allows for flexible programming adjustments.

4. Working Principle

4.1 Line Detection & Logic

The IR array differentiates between the white surface (High Reflection) and the black line (Low Reflection). The microcontroller continuously samples these values to determine the robot's position relative to the line.

Navigation Logic:

- **Straight:** Center sensor detects black; side sensors detect white.
- **Turn Left/Right:** Line shifts to side sensors; motor speeds adjust to correct heading.
- **Intersections (T/X):** Multiple sensors active; robot pauses briefly to decide path based on maze-solving algorithm.
- **Dead Ends:** All sensors detect white; robot reverses and re-routes.

4.2 Motor Control

The Arduino sends PWM signals to the L298N driver to control speed and direction. Differential steering allows for precise turns.

MOVEMENT	LEFT MOTOR	RIGHT MOTOR
Forward	ON	ON
Slight Left	LOW PWM	HIGH PWM
Slight Right	HIGH PWM	LOW PWM
Sharp Turn	OFF / REVERSE	ON
Stop	OFF	OFF

5. Innovation & Special Features

Adaptive PID Control

Implements dynamic error correction to smooth oscillations on straight paths and curves.

Maze Memory System

Stores visited junctions to prevent looping and optimize the return path.

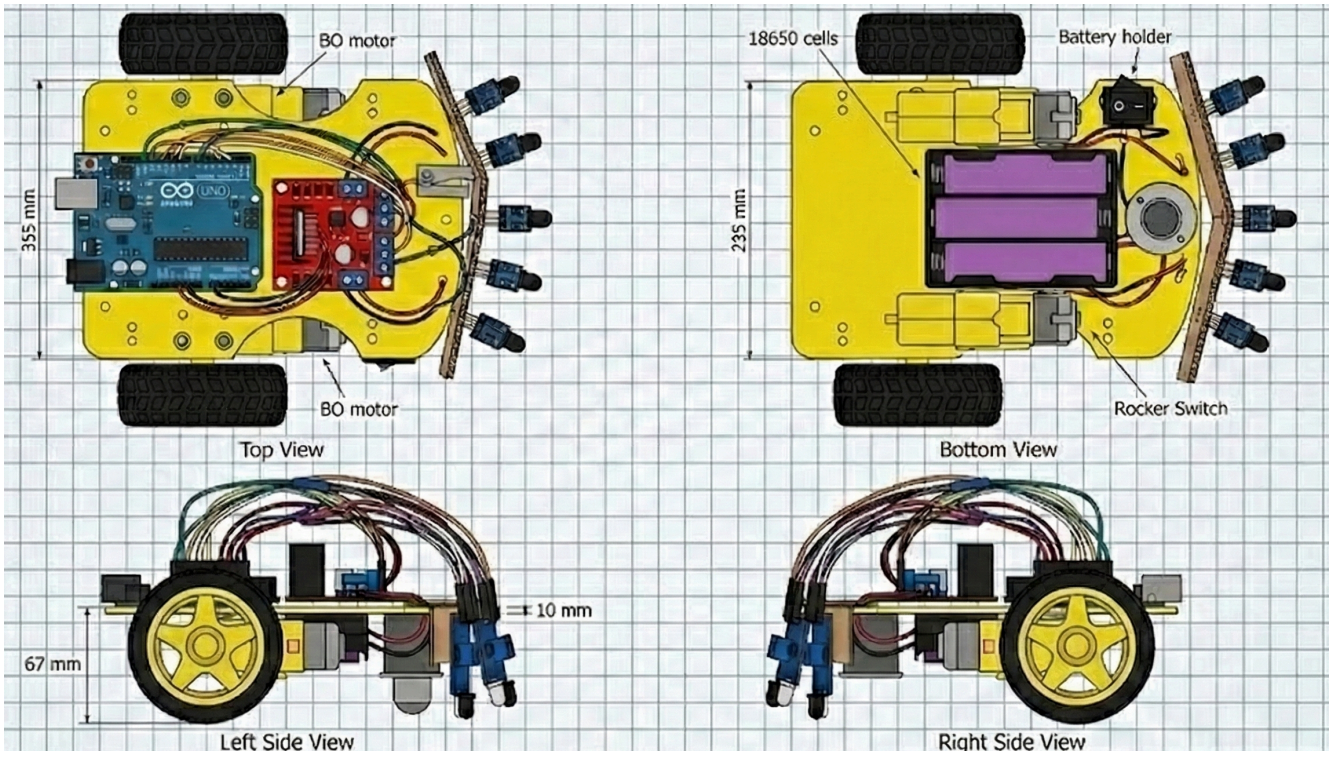
Modular Chassis

Designed for quick repairs; components easily accessible and replaceable.

Noise Filtering

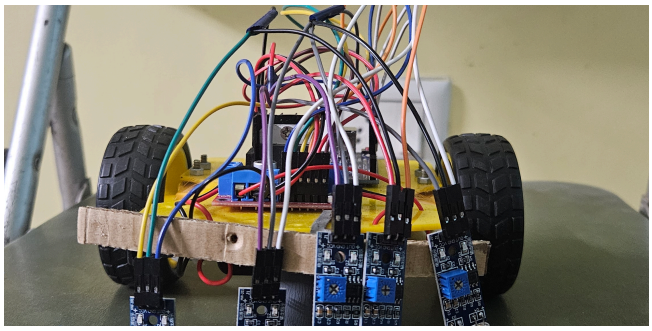
Software debouncing prevents erroneous readings from ambient light.

Robot Structure Overview

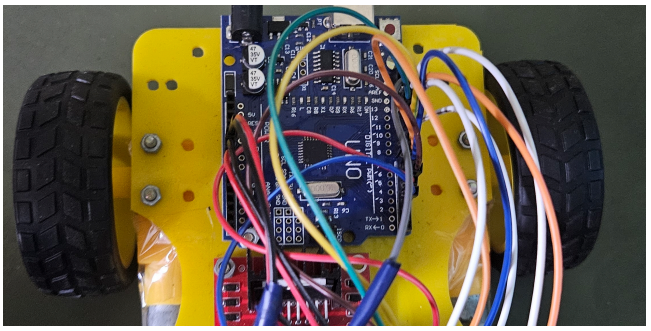


6. Robot Views Gallery

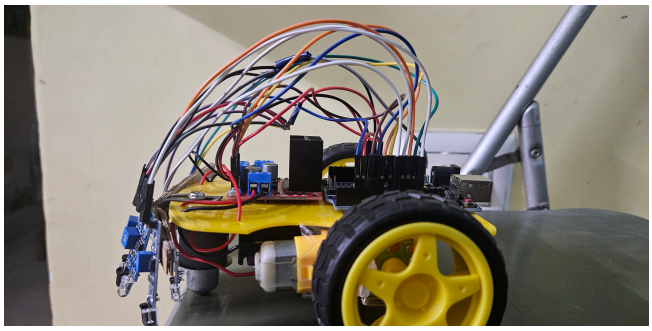
The following images showcase all perspectives of the Line Maze Follower Robot, demonstrating the mechanical design, component placement, and overall build quality.



Front View



Top View

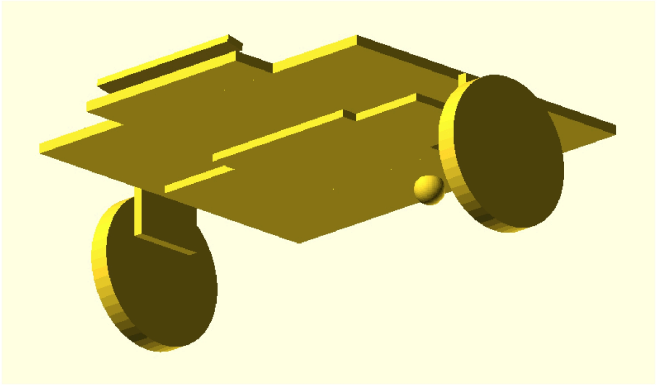


Side View

Back View

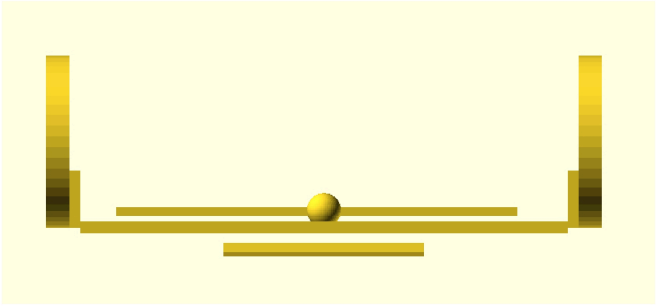
7. CAD Model Documentation

The following CAD drawings illustrate the mechanical design, ensuring compliance with the dimension constraints (≤ 25 cm × 25 cm × 20 cm).

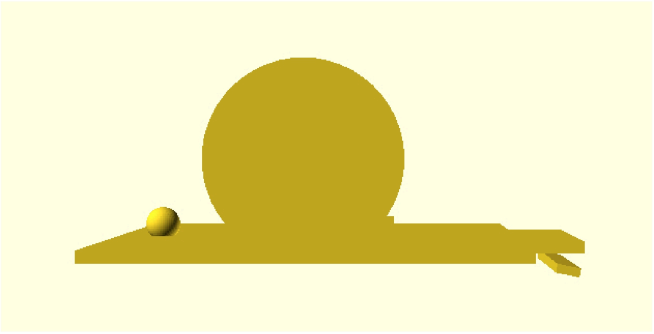


CAD SHEET 1

CAD SHEET 2



CAD SHEET 3



CAD SHEET 4

8. Video Demonstration

A video demonstration of the Line Maze Follower Robot in action is available. The video showcases the robot's line-following capabilities and navigation through test tracks.

Robot Demo Video

View the robot in action:

https://drive.google.com/file/d/1D31dKCN1ZP2V_7VuUAQvFr9G8Lg_ef9O/view

9. References

- Pravega XII Line Maze Follower Competition Rulebook
- Arduino Uno R3 Technical Documentation
- L298N Dual H-Bridge Motor Driver Datasheet
- Standard IR Sensor Module Specifications
- Jadavpur University Robotics Club Resources