Autonomous Mobile Robot Challenge

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Introduction

This project focuses on the design and implementation of an autonomous mobile car that can navigate a multi-zone track without human intervention. The robot is built using a PIC16F877A microcontroller and uses several sensors to follow a line, detect a tunnel, avoid obstacles, handle a bump, and park at the end of the track. By combining embedded software with real hardware components, the system operates as a self-contained embedded platform capable of making decisions in real time.

Design

The system design combines electrical connections and software logic to control sensing and movement. The hardware schematic, shown in Figure 1, shows how the microcontroller interfaces with the sensors and motors, The flow diagram, , shown in Figure 2, summarizes the decision-making process used during navigation.

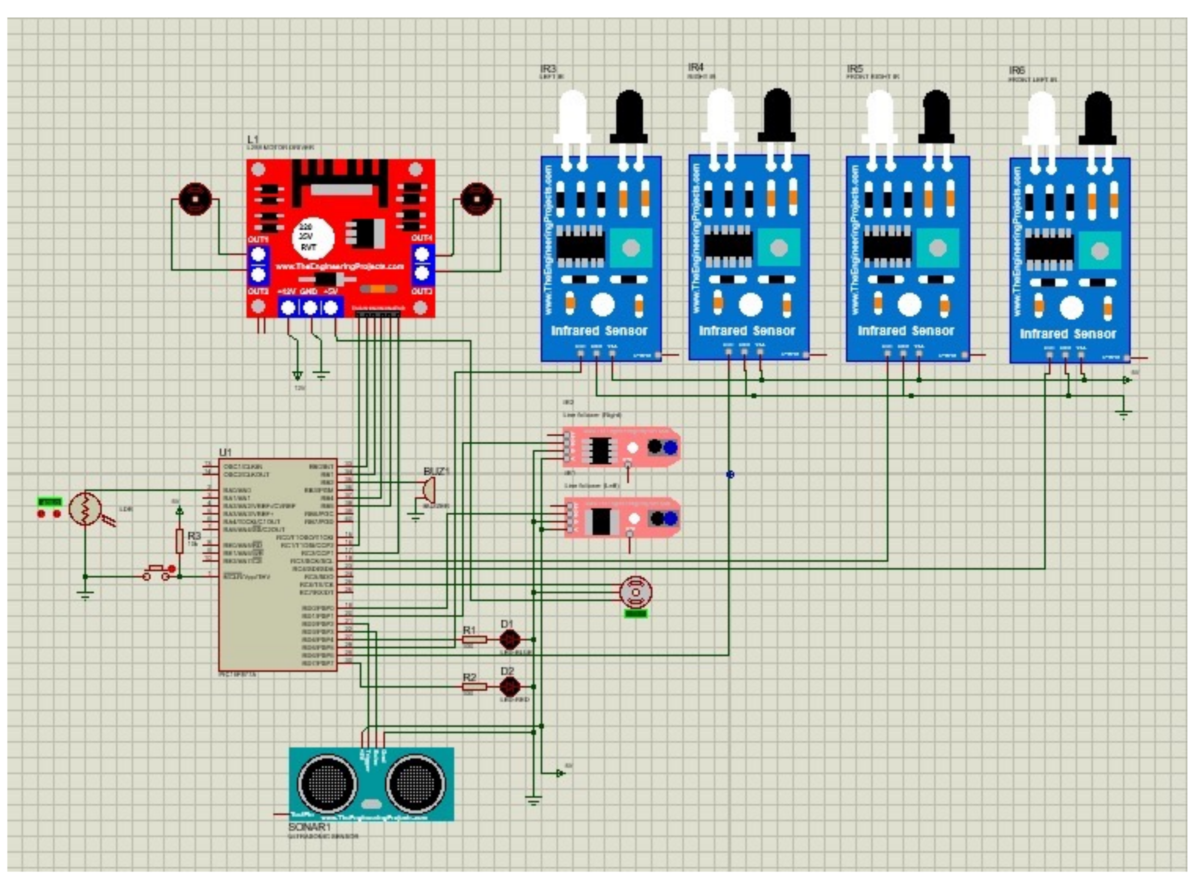

Figure 1: Hardware Schematic

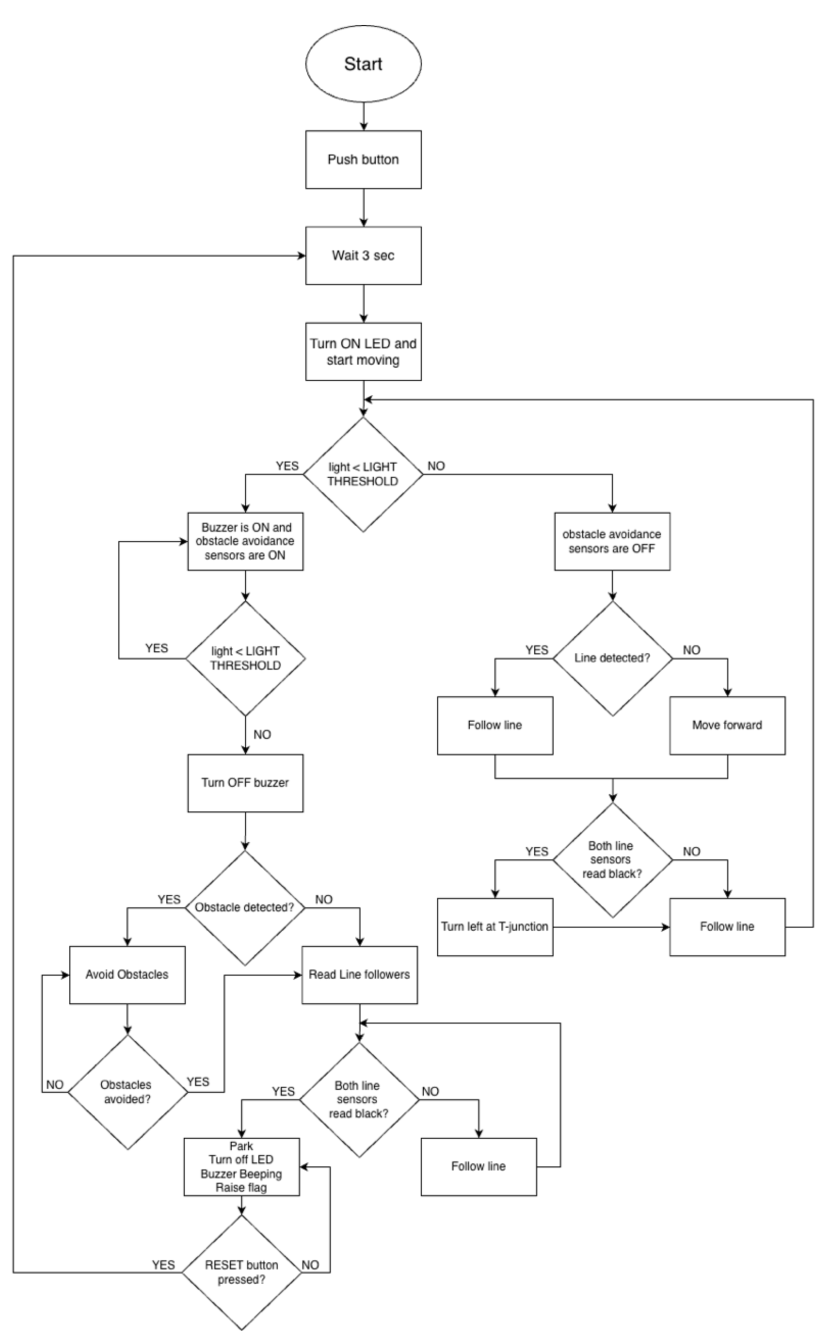

Figure 2: Hardware Schematic

Results

The final prototype successfully demonstrated autonomous operation across all sections of the track. After calibration and tuning, the robot was able to follow the line, detect and pass through the tunnel, avoid obstacles, climb the bump, and park at the final zone without human assistance. Multiple test runs were performed to ensure stable behavior and smooth transitions between operating modes. The system's performance depended on sensor calibration and battery condition, which were adjusted before each run. The Figures below show the final robot prototype, sensor placement, and key stages of operation. These results confirm effective integration between hardware and embedded software in a real-world autonomous system.

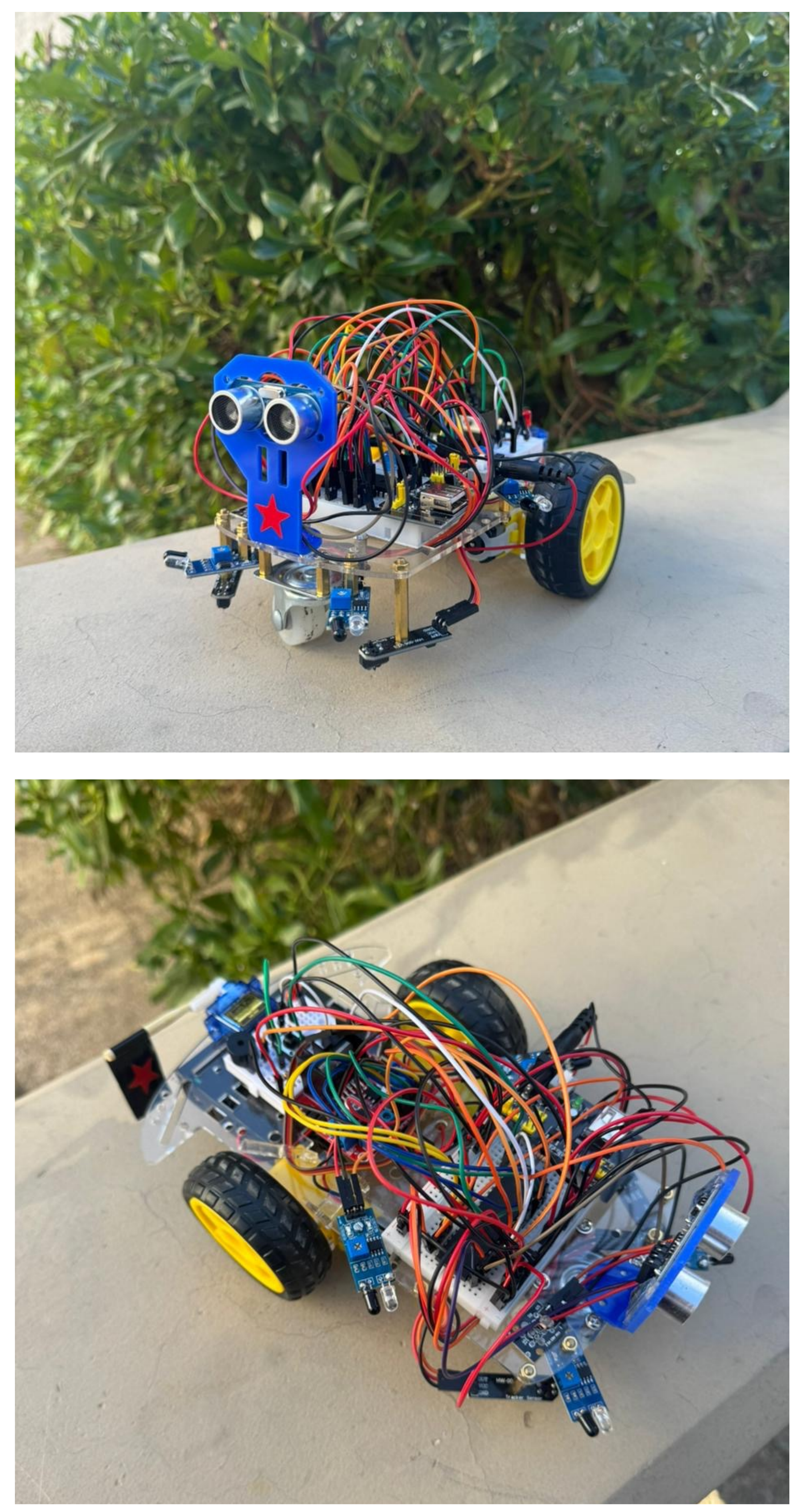

Figure 3: Final Implementation of the autonomous robot

Over all, the system showed consistent response timing and stable motor control during operation, indicating effective use of timers, PWM, and control logic within the microcontroller. Mode transitions, such as entering and exiting the tunnel or switching to obstacle avoidance, occurred without noticeable delays or erratic behavior. Minor performance variations were mainly linked to external factors, including ambient lighting and surface reflectivity, rather than software instability. Overall, the results demonstrate that the system architecture is robust and suitable for real-world autonomous navigation tasks.

Conclusion

This project demonstrates how an embedded system can interact with the physical world to make real-time decisions. By combining sensing, control, and software logic, the robot was able to operate autonomously on a structured track. The work highlights the importance of testing, calibration, and system integration when building reliable embedded and robotic systems.