Princess Sumaya University for Technology
جامعة الأميرة سميّة للتكنولوجيا

Autonomous Mobile Robot

M. Al-hamdan, M. Hasan, and S. Al-bazlamet
Supervisor: Dr. Belal Sababha
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King Abdullah II School of Engineering
Princess Sumaya University for Technology

Introduction

The field of robotics comes hand in hand with the embedded systems field, the advancement of embedded systems over the years enabled machines to perceive and navigate complex environments with minimal interventions from humans, from automation to self-driving cars, for the robot to be able to switch between different moving styles like follow a line, then notice that it is in a tunnel then move freely without a line, this in itself is a significant requirement for modern autonomous systems. This project focuses on designing an Autonomous Mobile Robot, developed in way that enables it to participate in a multi-stage navigational challenge.

Design

To tackle these challenges, our team designed an integrated system that focuses on mechanical stability, electrical efficiency, and intelligent software logic, our approach utilizes the PIC 16F877A microcontroller as the central processing unit, interfacing with a number of sensors and drivers.

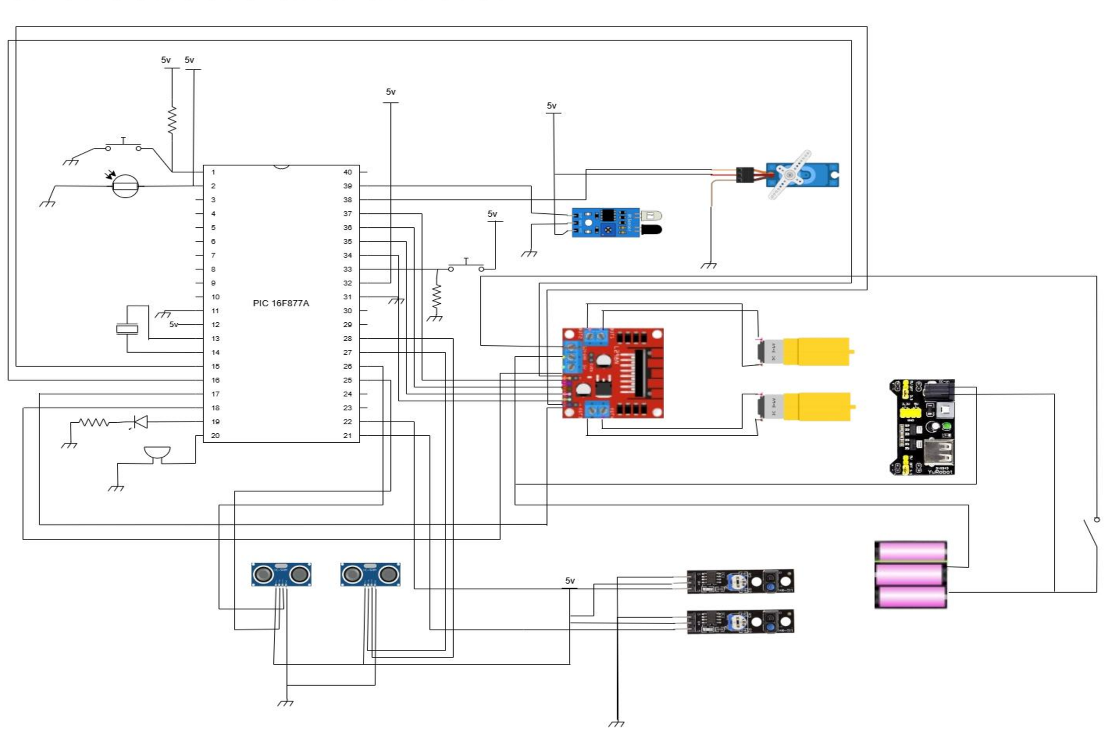

Figure 1: Electrical Design

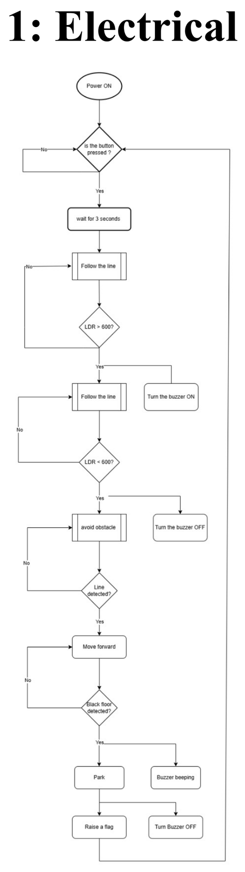

Figure 2 Software Design.

The software approach was to build a finite-state machine, so the robot can switch between these states after detecting specific environmental triggers, this report showcases the engineering decisions, hardware integration, and algorithmic logic that define our robot's performance in the competition.

Results

The results of the project confirmed the successful integration of the PIC16F877A microcontroller with the robot's sensory and drive systems to achieve autonomous navigation. Through precise calibration, the robot attained a stable straight-line trajectory by maintaining a balanced power differential between the two motors. The navigation system effectively utilized a combination of IR reflective sensors for accurate line tracking and an LDR for reliable tunnel entry detection. Furthermore, the implementation of a dual-ultrasonic sensor configuration utilizing both front and side-mounted HC-SR04 units enabled the robot to execute a consistent wall-following strategy for obstacle avoidance. Finally, the power management system, supported by a 3S Battery Management System (BMS) and a dual-rail power supply, provided the necessary electrical stability to power the motors and sensors simultaneously without logic resets.

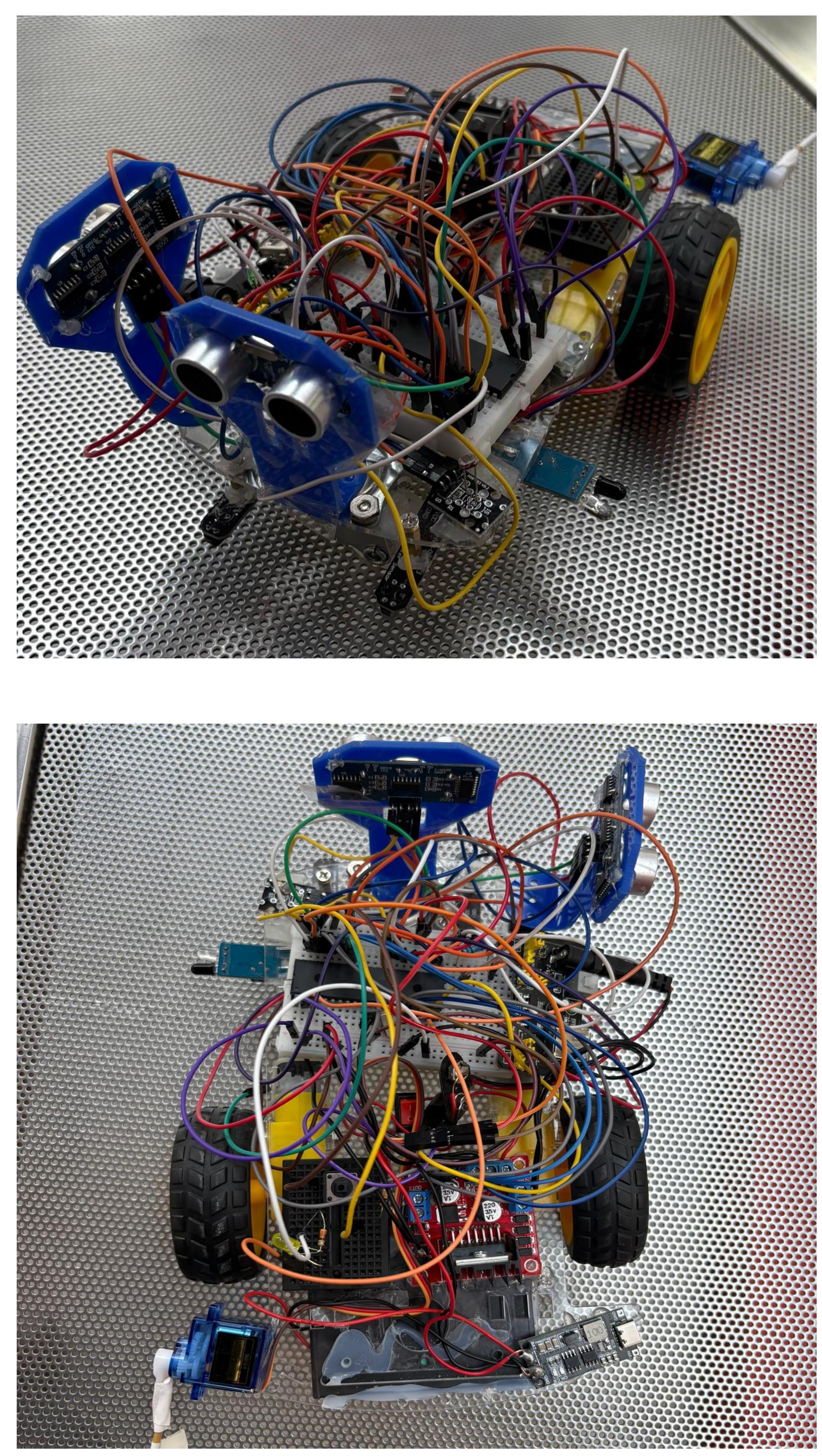

Figure 3: Final implementation

Conclusion

The Autonomous Mobile Robot challenge successfully demonstrated the integration of mechanical design, electrical engineering, and software logic to navigate a complex, multi-stage environment. By utilizing a PIC16F877A microcontroller and a finite-state machine architecture, the robot was able to autonomously transition between distinct operational modes, including line following, tunnel navigation, and obstacle avoidance.

Ultimately, the project underscored that while theoretical design is foundational, real-world calibration and trial-and-error are essential for building a reliable autonomous system capable of perceiving and reacting to its environment.