

Executive Summary

This project presents the design and analysis of an autonomous micromouse robot developed for controlled motion, efficient power management, and precise environmental sensing. The system integrates dual DC geared motors, a microcontroller-based control unit, and multiple Time-of-Flight sensors to enable accurate wall detection and navigation. Mechanical and electrical analyses were conducted to validate torque, speed, and power requirements, resulting in an estimated power consumption of 6.589 W and a runtime of approximately 57 minutes. A maze-solving algorithm is implemented to allow efficient exploration and shortest-path determination. The final design demonstrates a compact, energy-efficient platform capable of stable motion and reliable real-time sensing.

Background

- The first known maze-solving machine was created by Claude Shannon in 1950, called the **Theseus Mouse**. The modern concept of the micro mouse emerged in 1977, when the *Institute of Electrical and Electronics Engineers (IEEE)* and *Science Museum of London* announced the first Micromouse Competition. Micro mouse competitions are now held globally, serving as both educational challenges and platforms for innovation in robotics and embedded systems.
- Contemporary micro mouse designs integrate:
 - Compact microcontrollers** with real-time processing and sensor fusion capabilities (e.g., STM32 or ESP32)
 - Time-of-Flight (ToF) sensors** for high-precision distance measurement
 - Lightweight LiPo batteries** for high discharge rates and power density
 - PID-based motor control and path-planning algorithms** for smooth, optimized motion

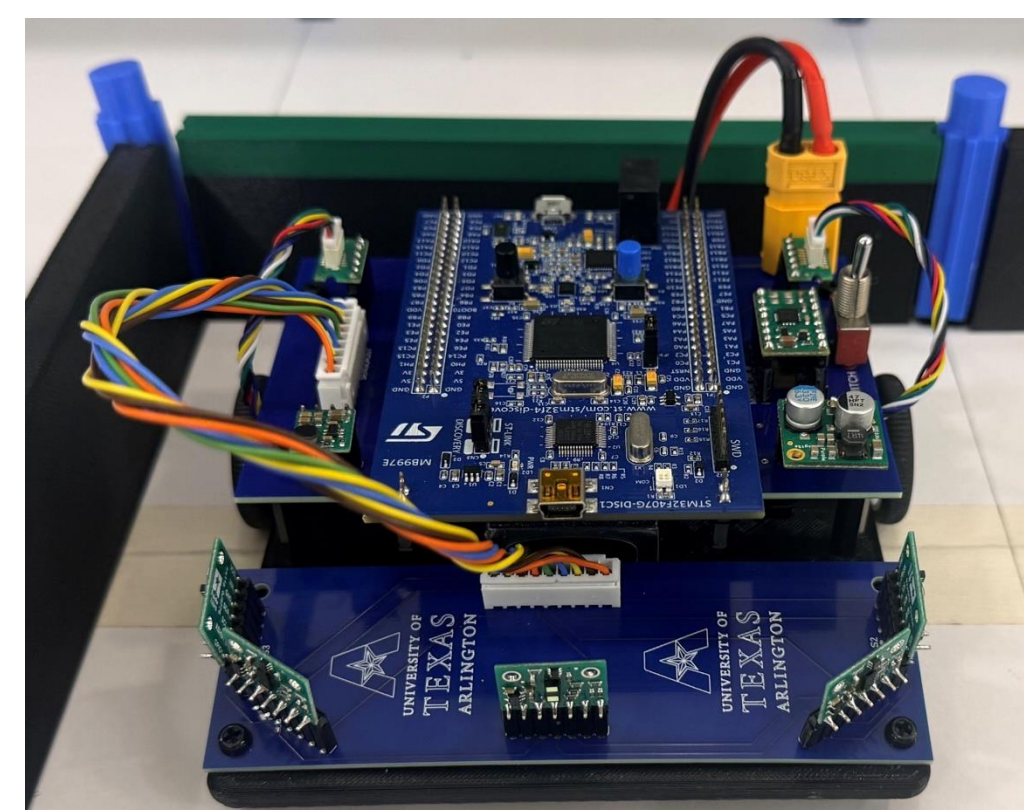
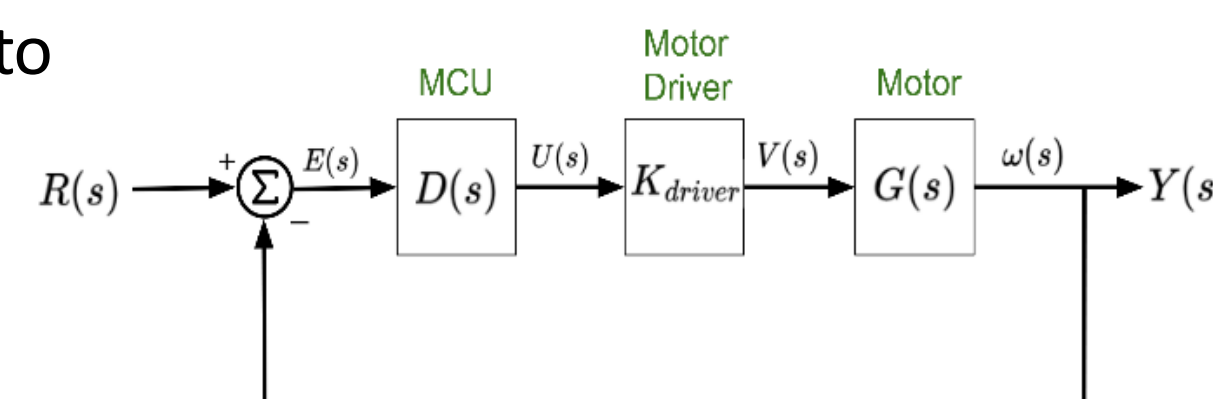


Figure 1. Shows the proposed platform for micromouse design.

Experimental Setup

- Motor & Motion Testing:** Evaluated motor response, speed, and torque under load to verify performance against design specifications.
- Sensor Validation:** Tested distance measurements for accuracy and consistency across varying ranges and surface conditions.
- Power Analysis:** Measured total system power consumption and verified voltage regulation under operational load.
- Integration Testing:** Confirmed seamless communication between microcontroller, sensors, and actuators.
- Algorithm Testing:** Simulated and validated the maze-solving algorithm (flood-fill) prior to full hardware implementation.
- System Verification:** Conducted preliminary full-system tests to ensure stable motion, reliable sensing, and correct control behavior.

Component	Competition Micro Mouse	Commercial Micro mouse	Proposed Platform
Motors	Brushless DC, 3000-5000 RPM	Brushed DC, 1000-1500 RPM	Brushed DC, 2000 RPM
Encoders	Optical	None	Magnetic
Sensors	6-8 IR/ToF	3-4 IR	5 ToF
Processor	STM32/ESP32/TIMSP430	Arduino	STM32
Search Algorithm	Flood Fill, A*, PID Trajectory	Wall-Follow	Flood Fill + PID
Speed (m/s)	2.5-3.5	0.5-1	2
Size (cm)	12x12	Varies	12.5x12.5



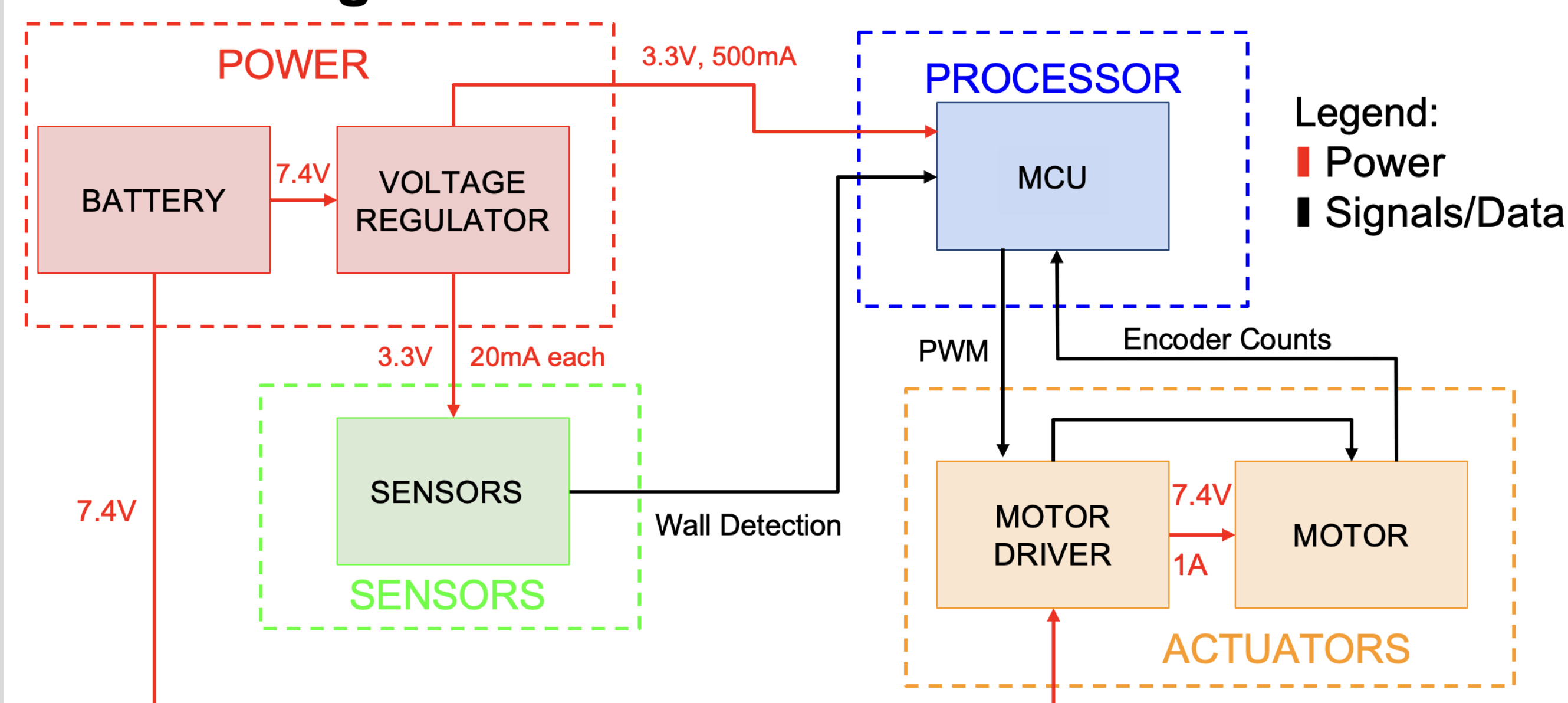
Experimental Test Plan

The objective of this project was to design and develop an autonomous robot capable of navigating a standard 16×16 maze efficiently and accurately.

System Design Approach:

- Mechanical System:** Selection of DC motors to meet speed (~2 m/s) and torque requirements
- Electrical System:** Design of a custom PCB and power regulation system (7.4 V LiPo → 3.3 V)
- Sensing System:** Integration of Time-of-Flight sensors for real-time wall detection
- Control System:** Implementation of motion control and path-planning algorithms

Block Diagram



Experimental Results

The system components were successfully designed, tested, and integrated into a functional prototype.

Hardware Implementation:

- All electronic components verified individually and in integrated operation
- Custom PCBs fully designed using Fusion 360 and submitted for professional manufacturing
- Power system validated to support stable operation of motors and control electronics

Performance Metrics:

- Estimated speed: up to 2 m/s
- Total power consumption: ~6.589 W
- Estimated runtime: ~57 minutes

Algorithm Development:

- Maze-solving algorithm (flood-fill) is near completion
- Initial testing demonstrates correct path computation and mapping logic
- System Status:
 - Seamless subsystem integration achieved
 - Maze construction in progress for full-system validation

Conclusions

The development of the Micro Mouse Maze Solver represents a successful integration of mechanical, electrical, and computational design principles into a compact and efficient autonomous system. Through detailed analysis and component selection, the team has achieved a design for a balanced platform capable of delivering reliable motion control, precise sensing, and efficient power management.

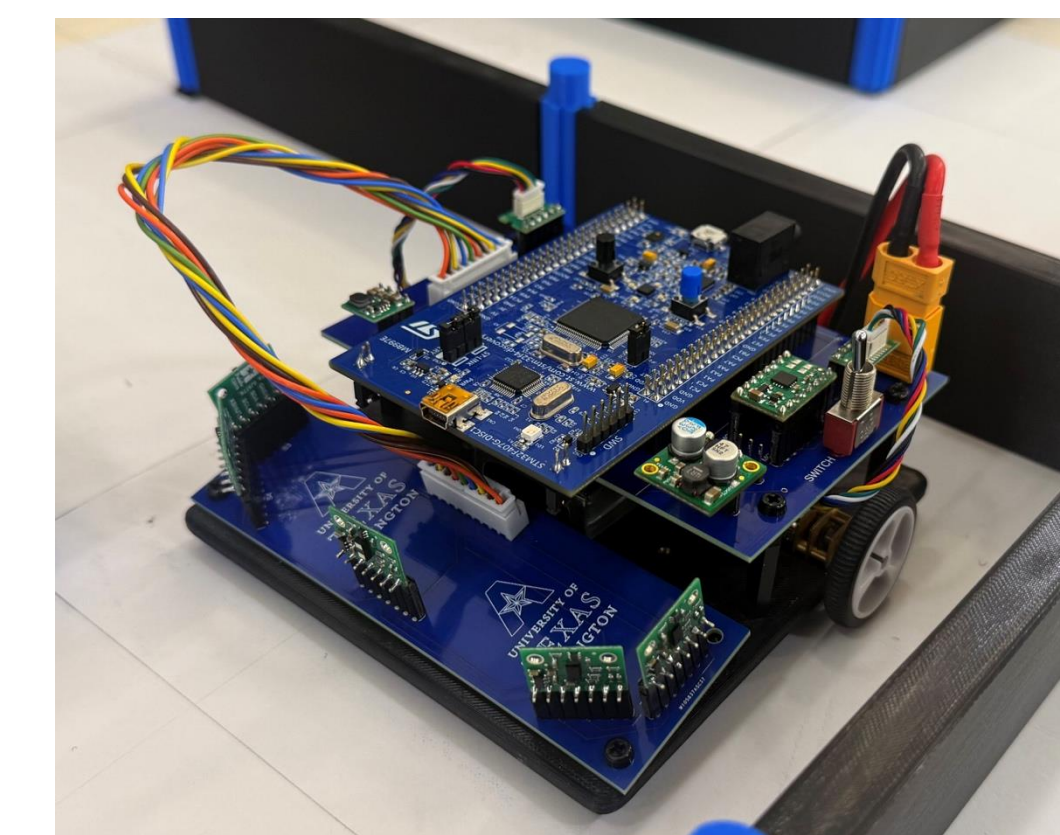
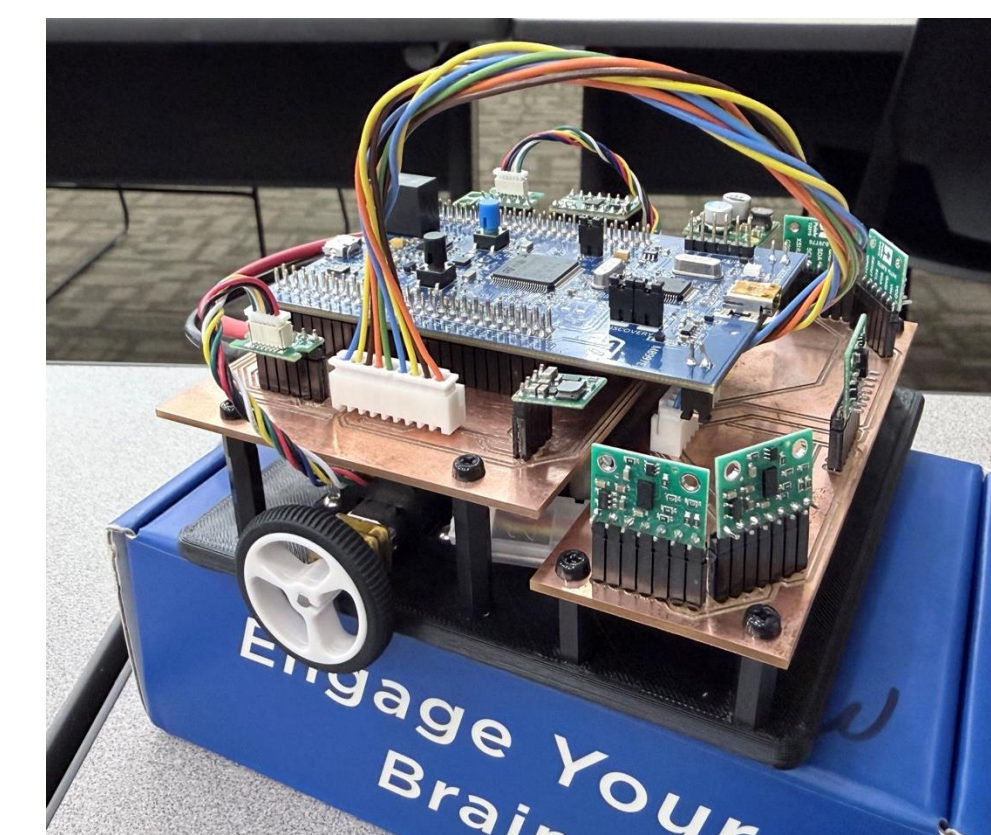


Figure 2,3. Show the original platform for micromouse design and the improved design.

References

References:

- Edwardo. (2019, April 04). Theseus. Retrieved from History of AI: <https://historyof.ai/shannon/>
- Tse, D. (2020, December 22). How Claude Shannon Invented the Future. Retrieved from Quanta Magazine: <https://www.quantamagazine.org/how-claude-shannons-information-theory-invented-the-future-20201222/>
- IEEE. (2025). Micromouse. Retrieved from IEEE and UCLA Project Docs: <https://projects.ieeebruins.com/micromouse/>