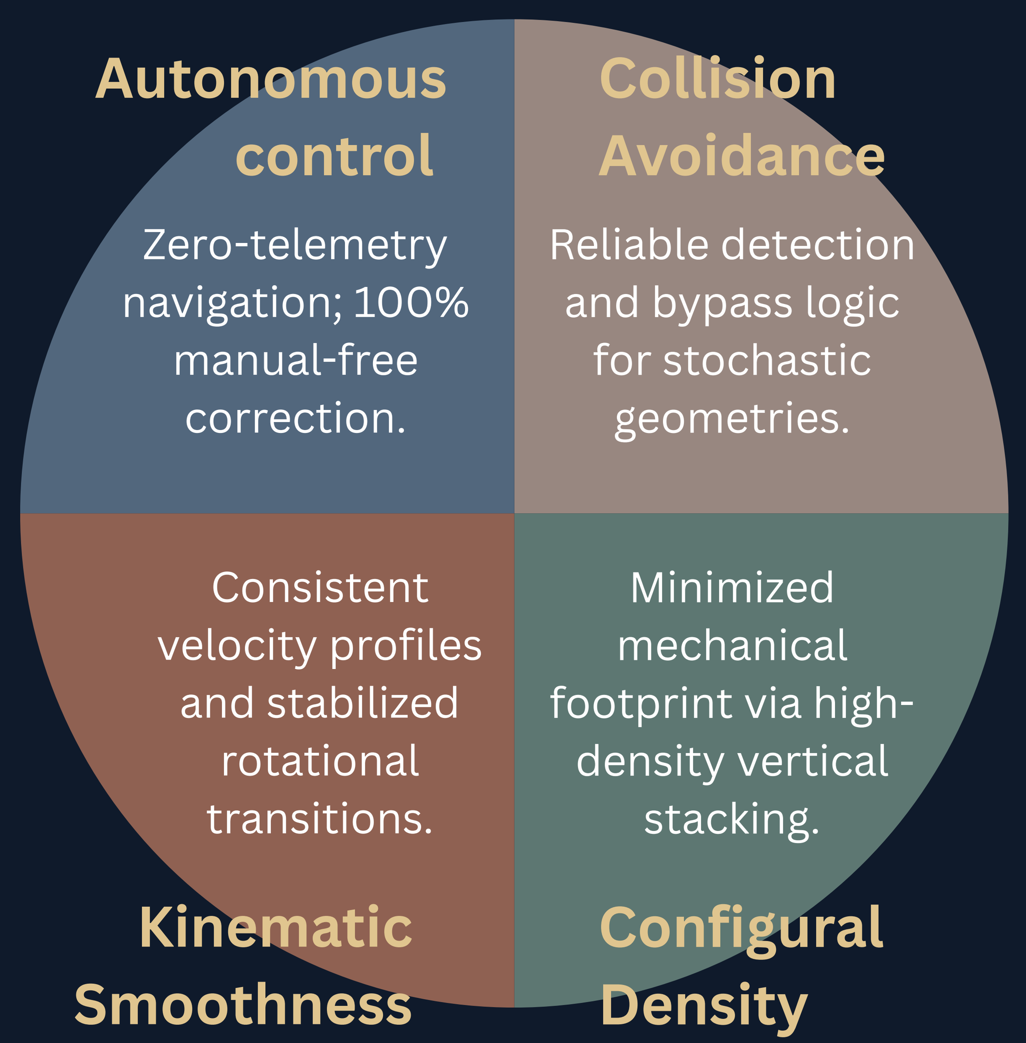
YILDIZ TECHNICAL UNIVERSITY DEPARTMENT OF MECHATRONICS ENGINEERING 2025 FALL SEMESTER INTRODUCTION TO MECHATRONICS ENGINEERING (MKT 1821)

OBSTACLE AVOIDING CAR

Project Objectives & Design Constraints

The main objective was the development of a fully autonomous mechatronic system intended to move through an arena of 1.5m x 1.5m with stochastic (randomly distributed) obstacles. The development was constrained by four main engineering requirements:



Components
Logic Level Converter 4 Kanal
MX1508 DC Motor Driver
HC-SR04 Ultrasonic sensor
N20- 6V 12mm with RPM/min:
7x9cm Double Sided Perfboard
Mini ball caster for Smart Car
1x40 15 mm 180 Degree Male
Supex 18650 3.7V 2500mAh Li-
Single Battery Holder for 18650
Mini Adjustable 3A Step-Down
180° SG90 RC Mini Servo
IC205 180 Degree Slide Switch

I. Autonomous Control Logic

- Information Processing: The system employs an ultrasonic sensor to monitor the navigational path. A detection threshold of 10cm is programmed to trigger the avoidance sequence.
- "Scan & Pivot" Algorithm: Upon obstacle detection, the vehicle executes a physical rotation to sample the surrounding environment. This software-driven approach compensates for single-sensor hardware constraints by sampling data across a 180-degree arc.
- Decision Matrix: The ESP32 compares lateral clearance values and selects the vector with maximum distance. A heading-correction sequence follows to realign the vehicle with its primary navigational objective.

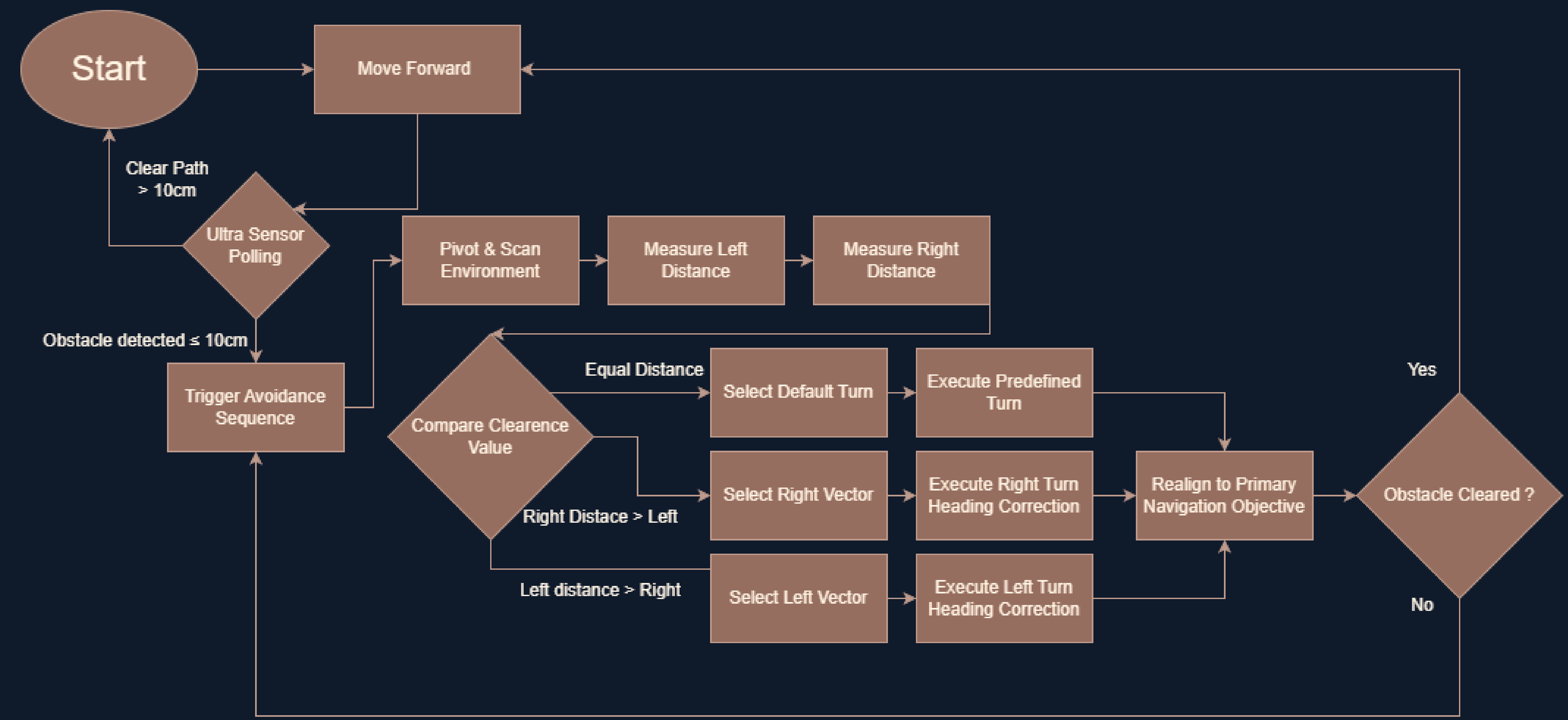
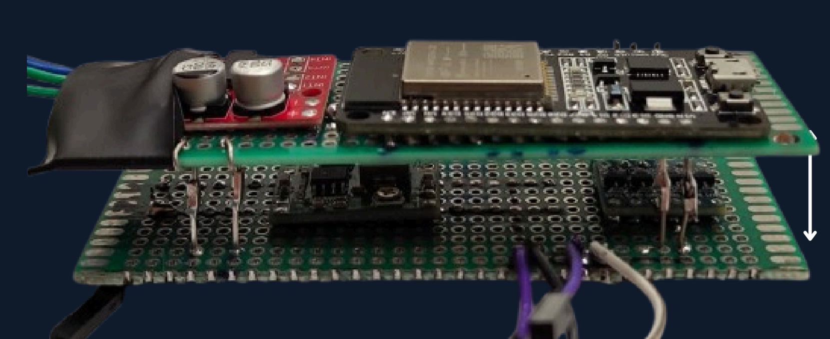


Figure 1: Autonomous Control Logic Flowchart illustrating the 'Scan & Pivot' decision-making cycle for obstacle discrimination and heading correction.

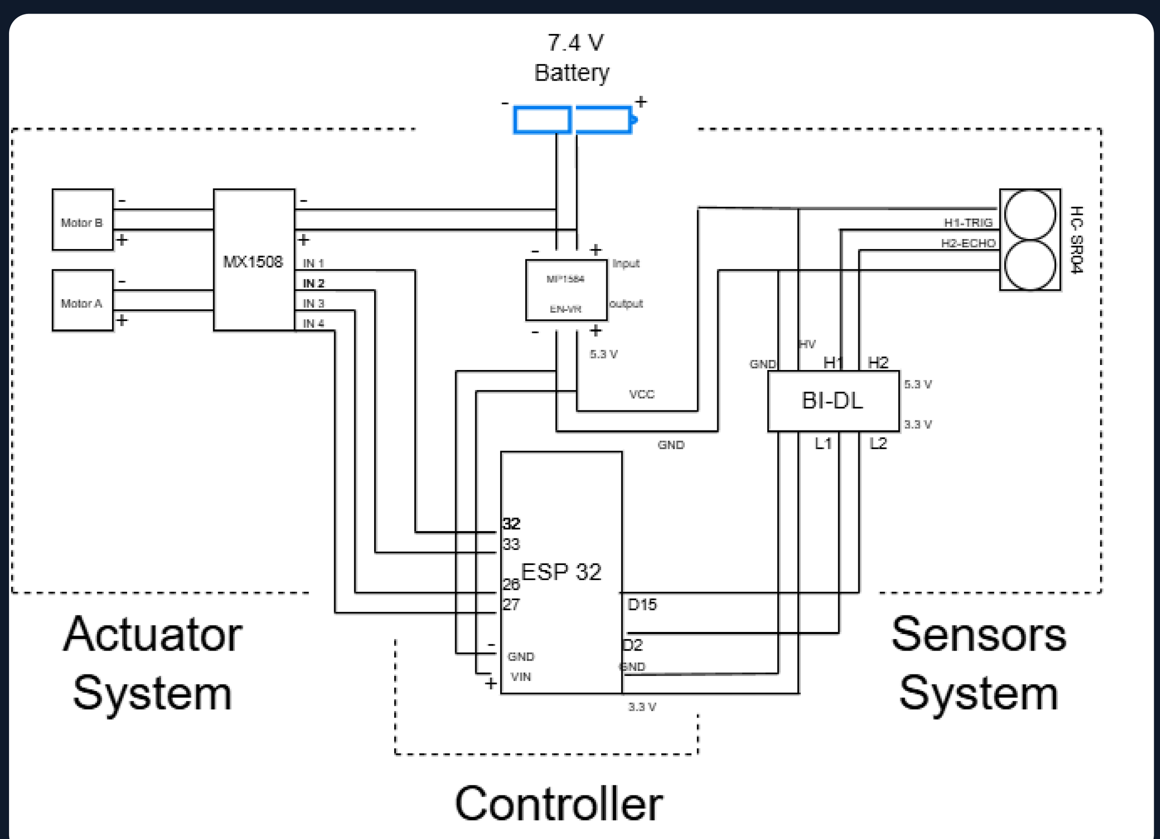
II. Circuit Architecture & Electronic Integration

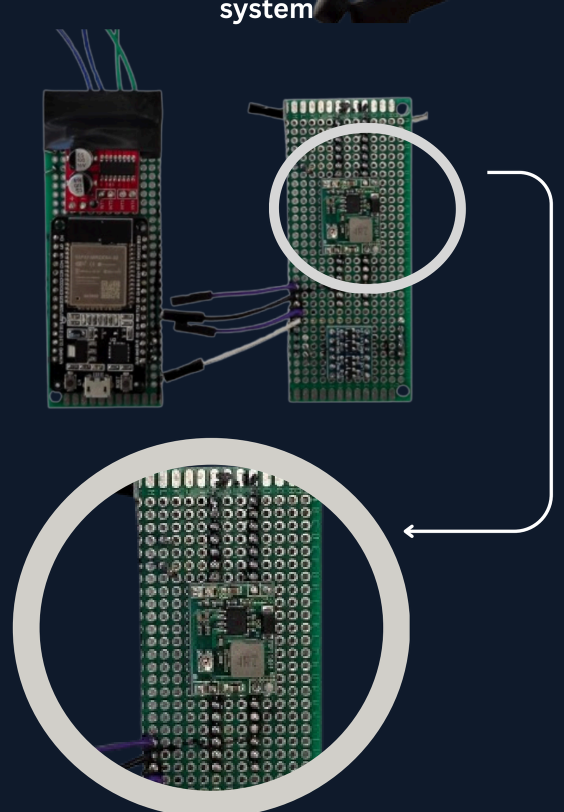
The electronic system was designed as a multi-layered mechatronic assembly, prioritizing spatial efficiency and signal reliability.

- Vertical Modular Stack: Dual-layer perfboard design for 40% higher volumetric density.
- Bus-Soldered Rails: Centralized power/ground distribution to eliminate "wire nesting" and EMI.
- Logic Level Conversion: 4-channel bridge (3.3V <-> 5V) for precise sensor/ESP32 communication.
- Power Stability: Dual 18650 Li-ion source with 3A step-down regulation to prevent "brown-outs".



Multi-layered mechatronic circuit system





High-Durability Bus Rails

III. Mechanical Architecture & Kinematics

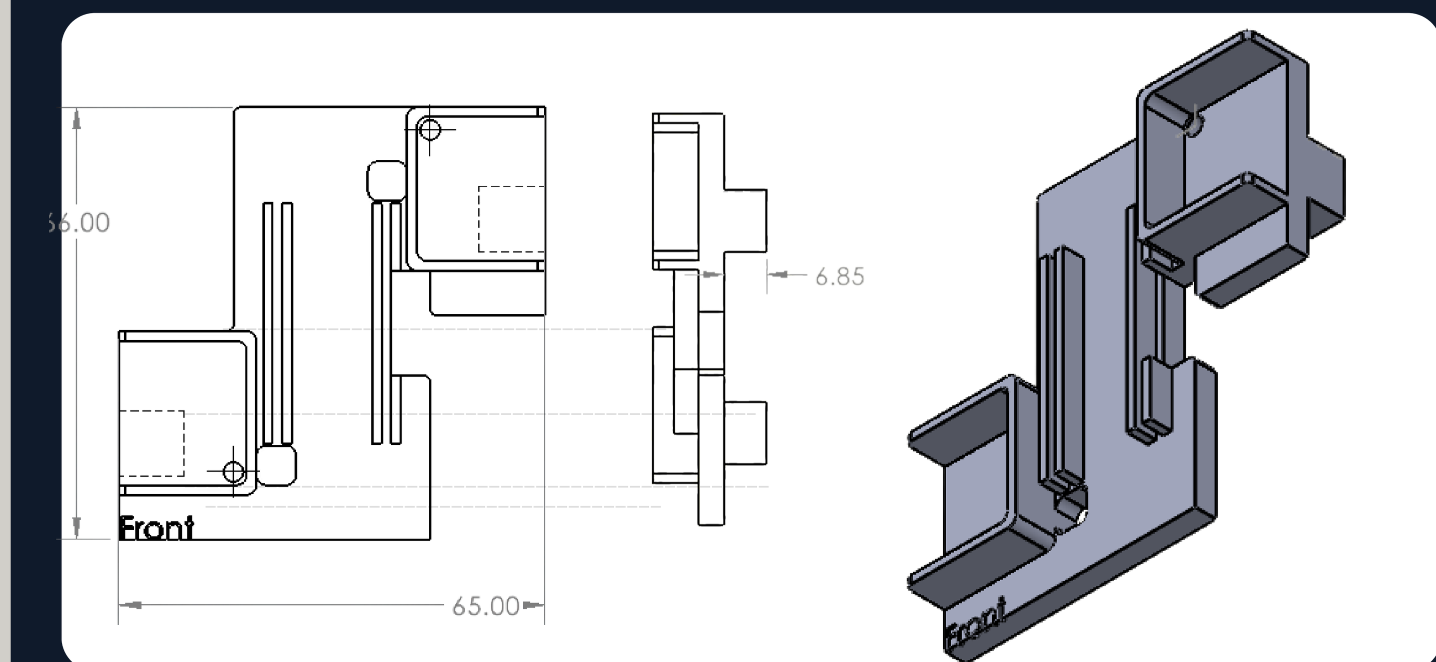


Figure 2: Chassis CAD. Technical drawings detailing the dimensional specifications of the mechanical assembly.

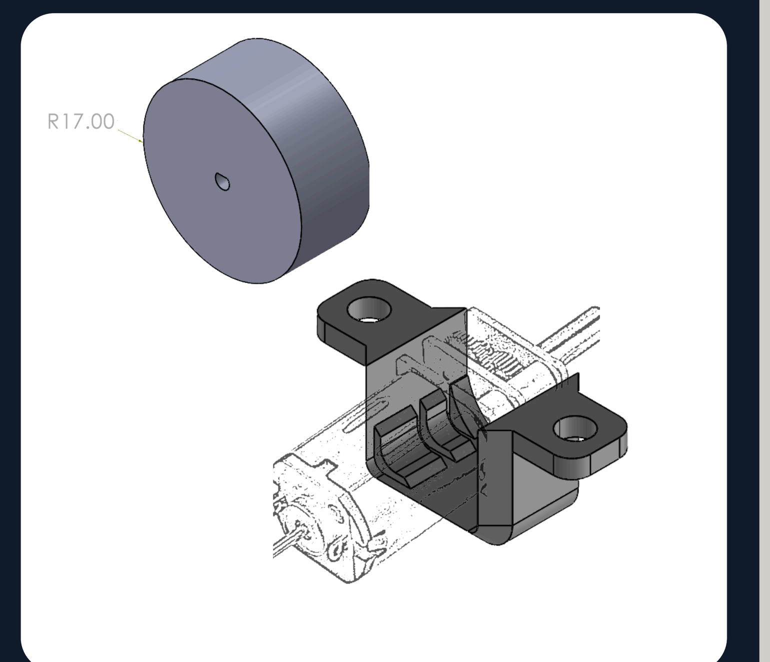
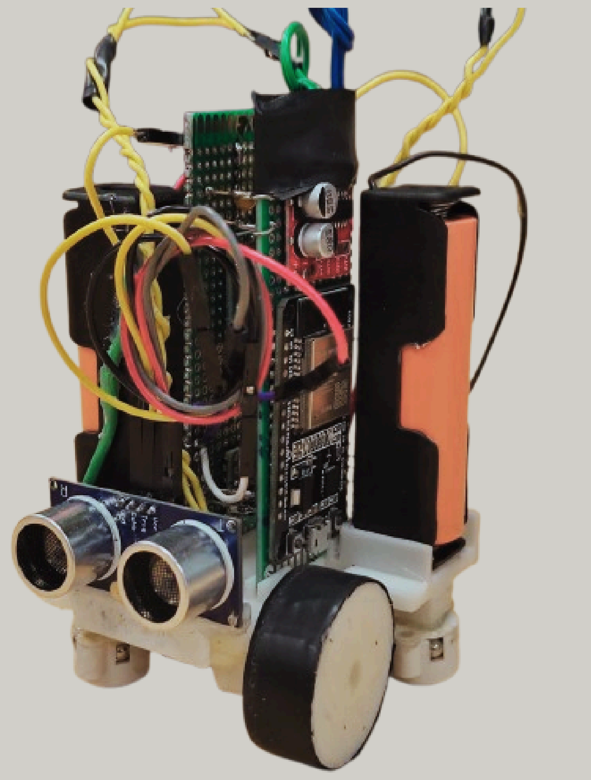


Figure 3: Custom Components. Isometric CAD views of the custom motor mounts and wheels.

- **Iterative Structural Refinement:** The project utilized a multi-stage prototyping process to eliminate Mechanical Asymmetry. Initial defects causing non-linear (arched) travel were corrected in the second iteration through precision alignment of the drive-axis and center of mass.
- **Traction Interface Engineering:** To resolve kinetic slippage and inconsistent turning radii, an analytical study of wheel-surface friction was conducted. Rubber bands were replaced with uniform adhesive layering (tape) to stabilize the coefficient of friction.
- **Chassis Configuration:** A two-wheel differential drive system with a rear ball-caster was implemented. This architecture optimized maneuverability in confined spaces and facilitated high-torque rotations for environmental scanning.



Workflow

- Requirements & Concepts
- System Design
- Detailed Design
- Implementation Prototyping
- Testing & Validation
- Final Assembly

GR/26: 2406A933 ISHRAQUE SARWAR SIAM- 25067915 AZZIKRI PUTRA MARESON-2506A905 TARTEEL ABDELMEGID Prof.Dr. HAYDAR LİVATYALI