E1.09 - Project M.A.R.U

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Meet the Team

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Project Overview

M.A.R.U is an autonomous Robo-Car that is designed to detect objects and boundaries, then maneuver accordingly. This is achieved by using infrared (IR) sensors to detect the boundaries and ultrasonic sensors to determine where objects are. The navigation subsystem receives information from the boundary and object detection subsystems and outputs decisions to the motor control subsystem. The interface amongst all subsystems is used to direct the Robo-Car via the use of sensors, a microcontroller and a motor driver via two direct current (DC) motors.
Robotics is a branch of engineering that combines aspects such as hardware, sensors, and programming which serves to further develop engineering and problem-solving skills.

Project Requirements

Robo-Car size
- Height: Unlimited
- Width: ≤ 17 cm
- Length: ≤ 24 cm
- Weight: ≤ 2000 g

Robo-Car features:
- Behavior must be non-offensive, non-destructive, and non-harmful.
- Must be battery powered and last the duration of Senior Design Day.
- It must operate autonomously, without human intervention.
- A "start" button is required. Robo-Car will move 5 seconds after being pressed.
- Must operate on a smooth surface.

Robo-Car Competitions
- Course Traverse

- The Robo-Car will travel 20-30 feet down an Ingram Hall hallway, turn and return to the starting point. The turnaround point is marked by a black line of width < 6" and the same length as the hall.
- No cameras will be used.

- Block Push

- It will push a random placed block out of the ring.
- The block will be 140 mm x 140 mm x 115 mm, weighing less than 1000g.

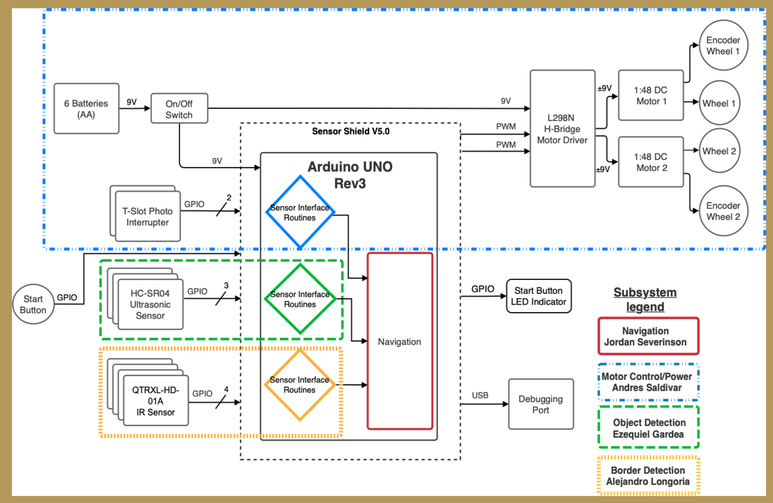
- Tournament

- Round robin tournament, with the 3 other Robo-Car teams.
- Force the body of the opposing Robo-Car to fall out of the sumo ring.

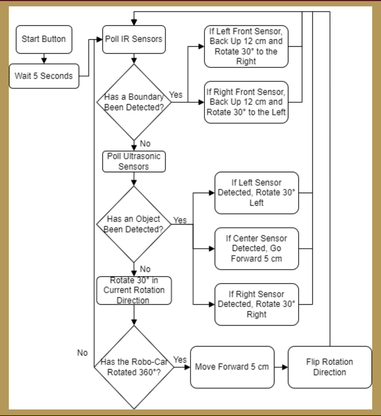
Acknowledgements

We would like to give a special thanks to our faculty advisor, Mr. Lee Hinkle, for assisting us and guiding us throughout our design. We would also like to thank Jeff Stevens for constant support and for always guiding us in the right direction.
A big shoutout to our D2 mentors, team 2.08 for always answering our questions and being our backbone throughout this whole semester. We couldn't have done it without you all. Thank you.

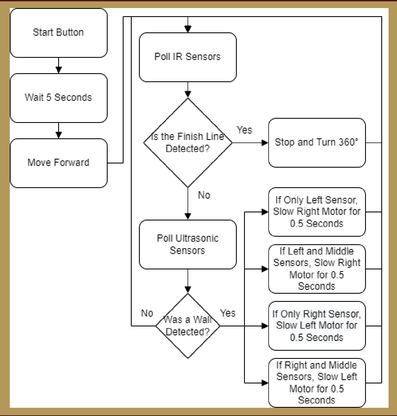
Functional Block Diagram



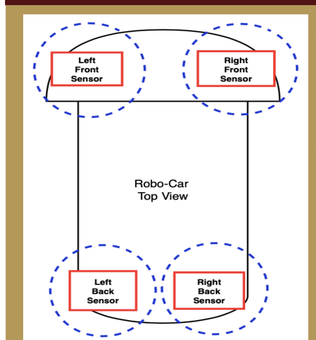
Block Push Flowchart



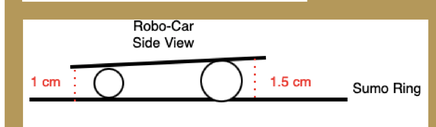
Traversal Flowchart



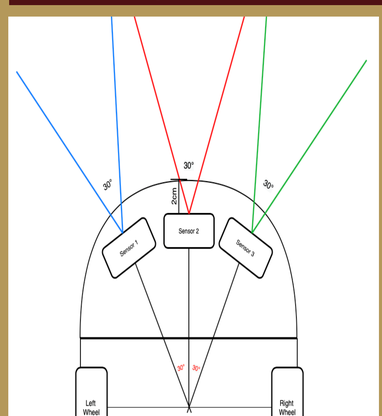
Boundary Detection Design



- IR sensors have an optimal range of 2 cm and a max range of 8 cm
- The closer the IR Sensor are to the ring, the higher the contrast is between the light and dark readings



Object Detection Design



- 3 front facing sensors
- Placed 2 cm behind chassis edge on Robo-Car
- Angle of 30° relative to sensor 2
- Minimal overlap
- Increased field of vision
- Correlates angle of direction to turning radius of Robo-Car

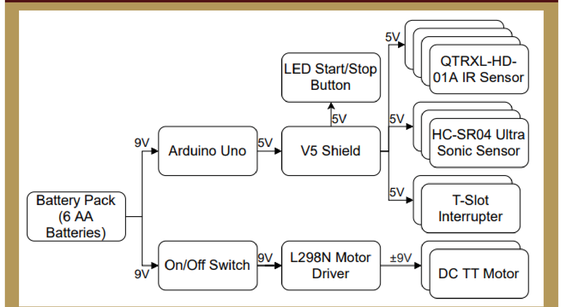
Test Cases

Description	Criteria
Verify a minimum battery life of 3 hours	Pass: If the Robo-Car still functions as intended after 3 hours in worst case conditions
Verify that the Robo-Car can stay in the sumo ring	Pass: If the Robo-Car can stay in bounds for 5 minutes while alone in the sumo ring while running the sumo code
Verify that the Robo-Car can detect a block that is 140 mm x 140 mm	Pass: If the Robo-Car can make contact with the block inside the ring within 40 seconds 5 times in a row
Verify the latency threshold of the IR sensors at varying motor PWM	Pass: Latency must be less than required stopping time

Power Dissipation

Component	Voltage (V)	Current (A)	Power (W)
AA battery Pack (6)	6.48	0.500	3.24
Arduino Uno	4.79	0.165	0.790
V5 Shield	4.79	0.165	0.790
L298N Motor Driver	6.69	0.583	3.90
DC TT Motor(left)	4.46	0.361	1.61
DC TT Motor(right)	4.56	0.335	1.52
QTRXL-HD-01A (VCC)	4.95	0.0311	0.153
QTRXL-HD-01A (Brightness)	4.95	0.0212	0.104
HC-SR04	4.95	0.00242	0.0119

Power Block Diagram



D2 Plans

- Order and test alternate power supplies
- Order and test an alternate microcontroller with less latency
- Design and code the sumo competition algorithm
- Optimize code to reduce latency