TEXAS STATE
INGRAM SCHOOL OF ENGINEERING

E2.06 - NaviBot

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Overview

NaviBots are fully autonomous battery-powered robots capable of navigating a maze and utilizing solution algorithms to complete the maze in the shortest time possible.

Requirements

- Autonomously navigate an unknown maze environment
- Start command
- Size and weight restrictions
- Battery life > 40 minutes
- Budget < $40
- A functional PCB based design
- Map the maze in under 5 minutes
- Complete speed run

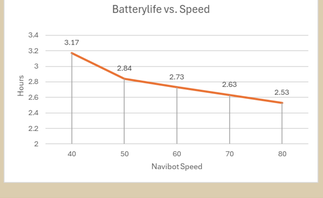
D2 Changes

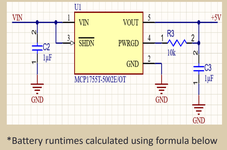
- IR-based time-of-flight sensors
- PCB-based chassis
- Condensed motor circuitry
- ATmega329p → ESP32
- Mapping and A* implementation

Power

Current Consumption of NaviBot V2					
Motor Speed	Arduino Nano Esp32	Motor Control Subsystem	Wall Detection Subsystem	Mapping Subsystem	Total Consumption
40	77.1mA	136mA	66.4mA	20mA	267.5mA
50	77.1mA	150mA	66.4mA	20mA	293.5mA
60	77.1mA	160mA	66.4mA	20mA	303.5mA
70	77.1mA	170mA	66.4mA	20mA	313.5mA
80	77.1mA	180mA	66.4mA	20mA	323.5mA

NaviBot V2 set to PWM of 60





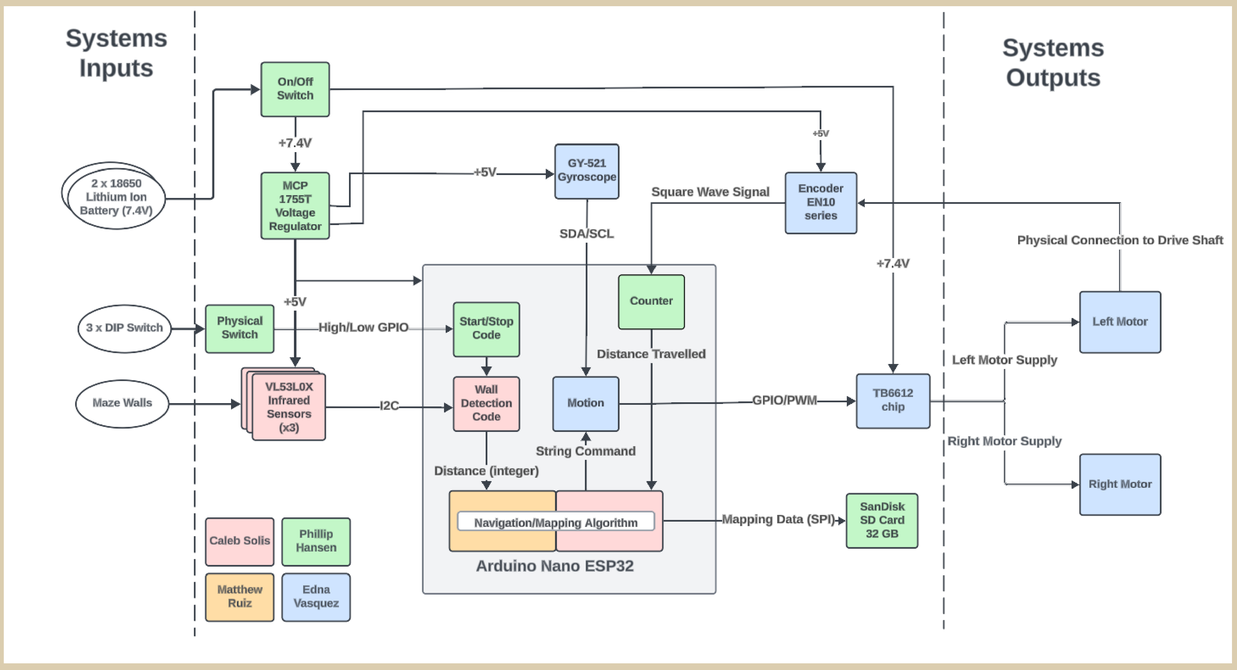
*Battery runtimes calculated using formula below

$$\frac{2600mAh}{Total\ Output\ Current^{k}} = Hours\ of\ Runtime$$

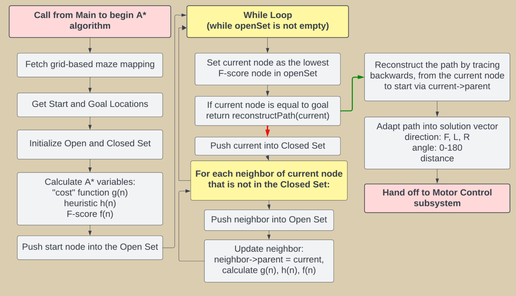
Acknowledgements

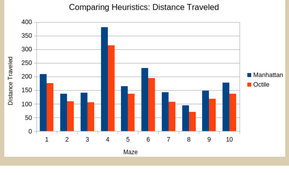
Sponsor: Mr. Liam Quinn
Faculty Advisor: Mr. Mark Welker

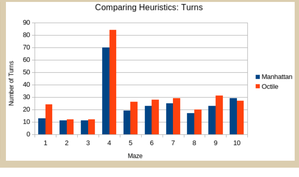
Top Level Block Diagram



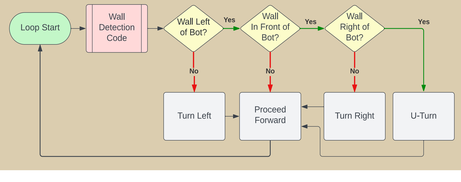
A* Algorithm







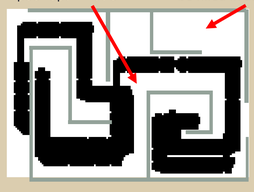
Wall-Following Algorithm



Mapping Test Results

Filtering can result in poor optimization

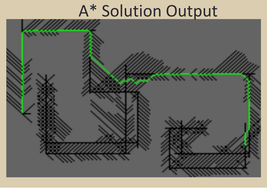
Unsearched paths will be filled in as walls



All real explored walls are shown in the map (15/15)

1min 40s mapping time

A* Solution Output

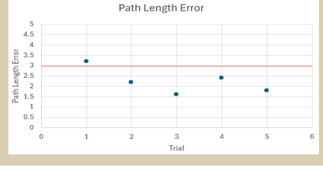


Store peripheral data to the SD card during initial trial

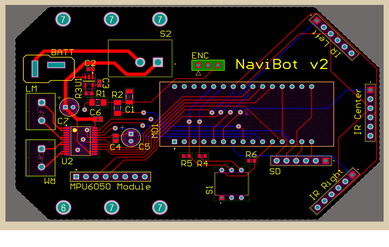
Upon reconfiguration, create a 400x400 BIN file filled with ones (wall). Make the starting cell zero (no wall) .

Usng stored data points, populate the BIN map with known maze information and update cell values

Apply processing filters to account for sampling frequency



PCB

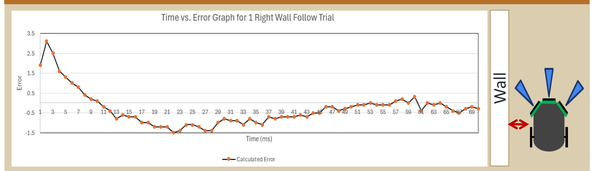


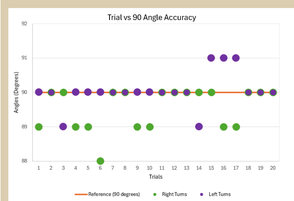
- Thick motor power traces
- Bypass capacitors near protected IC
- Motor mounting holes
- 58mm x 94mm
- Top and bottom copper pours for power distribution and heat sink
- Module headers for sensors and microprocessor for easy maintenance

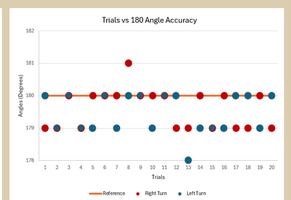
Meet the Team

Matthew Ruiz | Caleb Solis | Phillip Hansen | Edna Vasquez

Motor Test Results



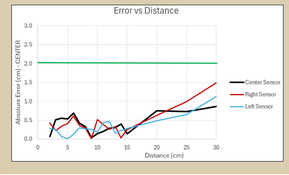




Wall Detection Test Results

Material Dependence		
Material	Poster	Glass
Average(cm)	2.93	27.97
Difference (cm)	0.00	25.26
Percent Difference	0.0%	-932.6%

Color Dependency			
Color	White	Grey	Black
Average(cm)	5.88	5.58	5.27
Difference(cm)	0.00	-0.30	-0.61
Percent Difference	0.00%	-5.18%	-10.45%



Incidence Angle Dependence			
Incidence Angle (degrees)	0	45	75
Average(cm)	10.25	10.13	10.17
Difference (cm)	0.00	-0.12	-0.08
Percent Difference	0.00%	-1.19%	-0.76%

Overall Results

Requirement	Measured Results	Outcome
BOM Does Not Exceed $40	BOM = $30.67	PASS
Weight <= 600 g	238.6 g	PASS
15cm x 15cm x 15cm	11cm x 10cm 12cm	PASS
40-minute runtime	60min	PASS
PCB Chassis	Completed and functional	PASS
Map the maze in under 5 minutes	1min 40sec	PASS
Optimized Run	Solution: Crop file size or hold A* storage externally	FAIL