E2.07 – Eggsplorer

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TEXAS STATE INGRAM SCHOOL OF ENGINEERING

Team

Nick
-Boundary Detection
-Power System
-Motor Control

Jodie
- Gripper
-User Interface

Bryce
-Object Detection

Christian
-Navigation

Project Overview

Designing and building an autonomous robot that, once parameters are selected, identifies, collects from the playing field, and returns colored eggs to a red origin square, without further human intervention.

Objectives

Single Egg Fetch:

Retrieve a single colored egg from the playing field and return it to the origin.

Multiple Egg Fetch:

Retrieve multiple eggs of the same color from the playing field and return them to the origin.

Requirements

Requirement	Measured Result	Outcome
Budget ($40)	$38.28	PASS
Maximum Weight (600g)	975.22 grams (Approved)	PASS
Maximum Robot Dimensions 20 cm(W), 20 cm(H), 30 cm(L)	Measured: 16.75 cm (W), 17 cm(H), 29.5 cm(L)	PASS
Single Egg Retrieval	7/8 Blue, 8/8 Green, 6/8 Yellow, 8/8 Purple	PASS
Multiple Egg Retrieval	4/4 Blue, 3/4 Green, 3/4 Yellow, 4/4 Purple	PASS

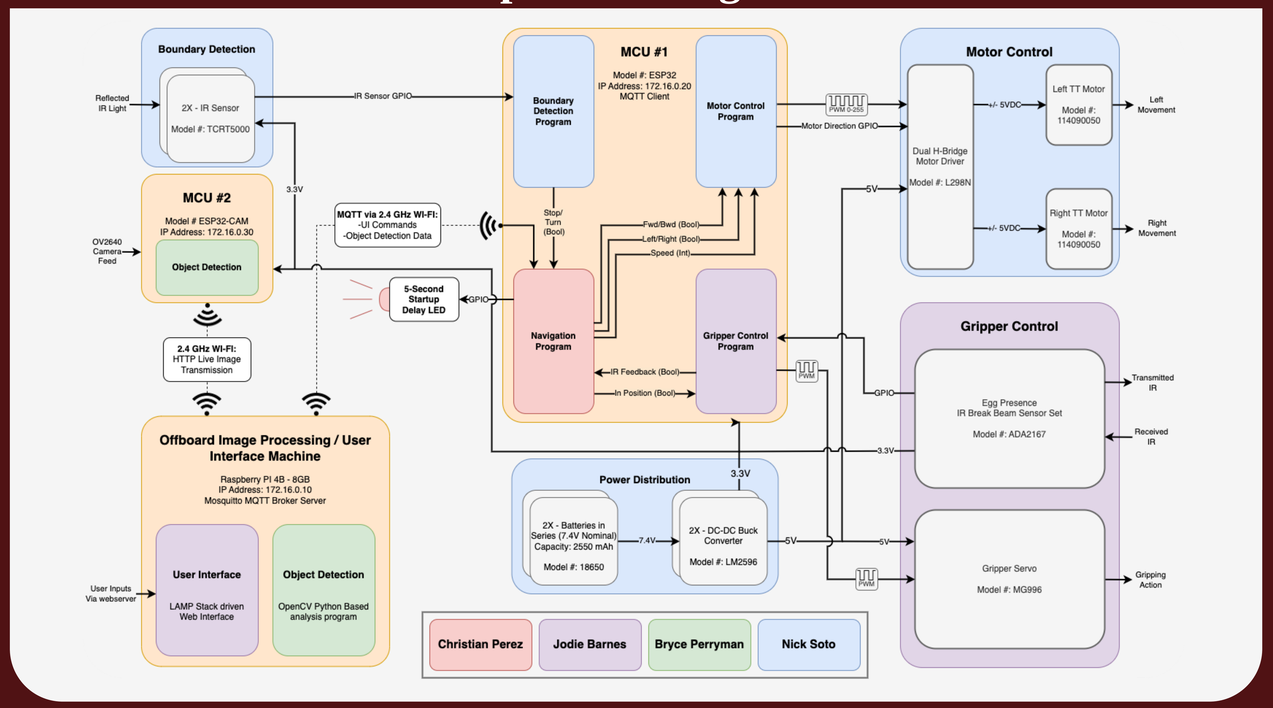
Major Changes

- Implemented Raspberry Pi 4 Model B in place of the laptop for image processing and UI
- Removed rear boundary IR sensor
- Replaced provided gripper with custom 3D printed gripper
- Implemented more durable metal gear TT motors over the plastic gear motors

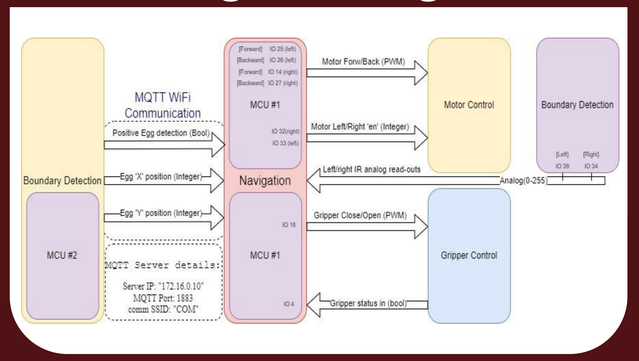
Acknowledgements

Sponsor: Mr. Liam Quinn
Faculty Advisor: Mr. Jeff Stevens

Top Level Diagram



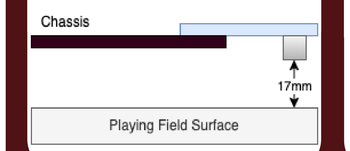
Navigation Diagram



Boundary Detection Test Results

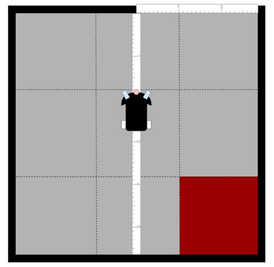
Test	Measured Results	
Detection Test	•0° - 20/20 •60° - 20/20 •120° - 20/20 •180° - 20/20	•30° - 20/20 •90° - 20/20 •150° - 20/20
Minimum Size Detection Test	36 mm²: 20/20 64 mm²: 20/20 100 mm²: 0/20 144 mm²: 0/20	
Ambient Light Sensitivity	100%: 20/20 50%: 20/20 0%: 20/20	

IR Sensor Placement



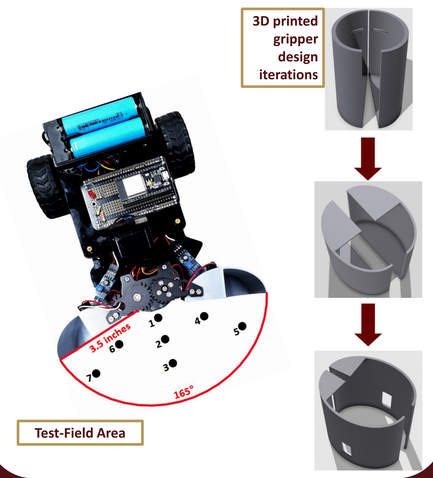
Motor Control Test Results

Test	Measured Results
Straight Travel Deviation	20/20 trials at 255 PWM 2 ft = 0.0 in 4 ft = 0.1 in 6 ft = 0.15 in
Advanced Movements	10/10 trials Average distance = 1.25 in
Motors Performance	10/10 trials Left Motor = 38.47 RPM Right Motor = 38.44 RPM



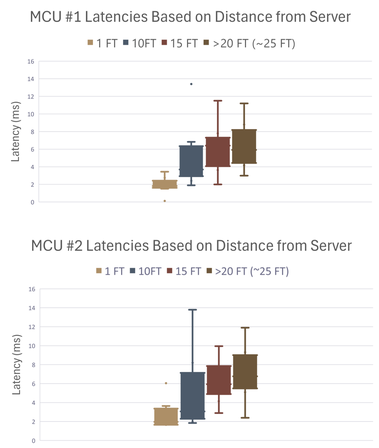
Gripper Test Results

Requirements	Test Description	Measured Results	Outcome
Field of Grasp Measurement	Measure field of grasp of gripper.	165° field of view, 3.5 inches from servo	N/A
Gripping Reliability	Run 70 egg fetches (10 at each test point). Ensures gripper reliably grabs each color of egg within the predetermined region.	70/70 successful attempts	PASS
Sensor Reliability	Detect egg 70 times while performing an egg fetch. Ensures the break-beam sensor accuracy and consistency with egg detection feedback.	70/70 successful attempts	PASS



User Interface Test Results

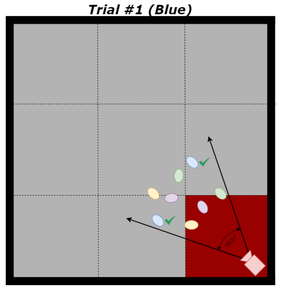
Requirements	Test Description	Measured Results	Outcome
Command button function accuracy	Test all available button inputs for respective functionality.	All button inputs performed their respective tasks.	PASS
Lowest possible latency from UI input selection button to beginning of robot task	Test latency of button inputs (from the Raspberry Pi to the beginning of selected action); Ideal latency per MCU is <20 ms per function.	Latency on all button input functions was <20 ms.	PASS
Useability	Peer review of correct functionality and aesthetic design	20 peers polled: Aesthetics: 19/20 Approved Functionality: 20/20 Affirmed	PASS



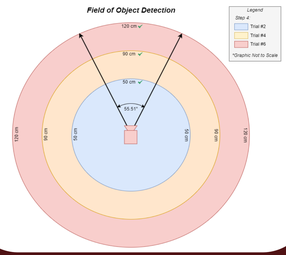
Object Detection Test Results

Test	Measured Results
Field of Detection – Horizontal angle and maximum distance	Average HFOV: 55.51° Maximum Distance: 120 cm
Object Detection by color	18/18 – Blue 17/18 – Green 16/18 – Yellow 18/18 - Purple
Origin Square Detection	7/8 Successful trials from each of the 8 gray tiles. Furthest corner did not detect

Trial #1 (Blue)



Field of Object Detection



Power Test Results

Power Budget	
	Power (W)
TCRT5000 IR Sensor	0.1004
ADA2167 BB Sensor	0.025
ESP32	0.919
ESP32 CAM	0.873
H Bridge Board	1.796
Servo Motor	1.41
Total	4.58

Total Battery Life	
Rated Battery Capacity	5.1 Ah
Discharge Rate	0.579 A
Peukert's Number	1.1
Expected Battery Life	9.3 Hours
50% Discharge Time	4.652 Hours
Tested Battery Life	4.3 Hours