Dwight Look College of
ENGINEERING
TEXAS A&M UNIVERSITY

Team 30: Ember Bot
Bi-Weekly Update 4

Jonathan Chen, Kevin Rivera,
Nancy Ramirez Castillo, Yuwen Zheng
TA: Roman Venegas

Project Summary

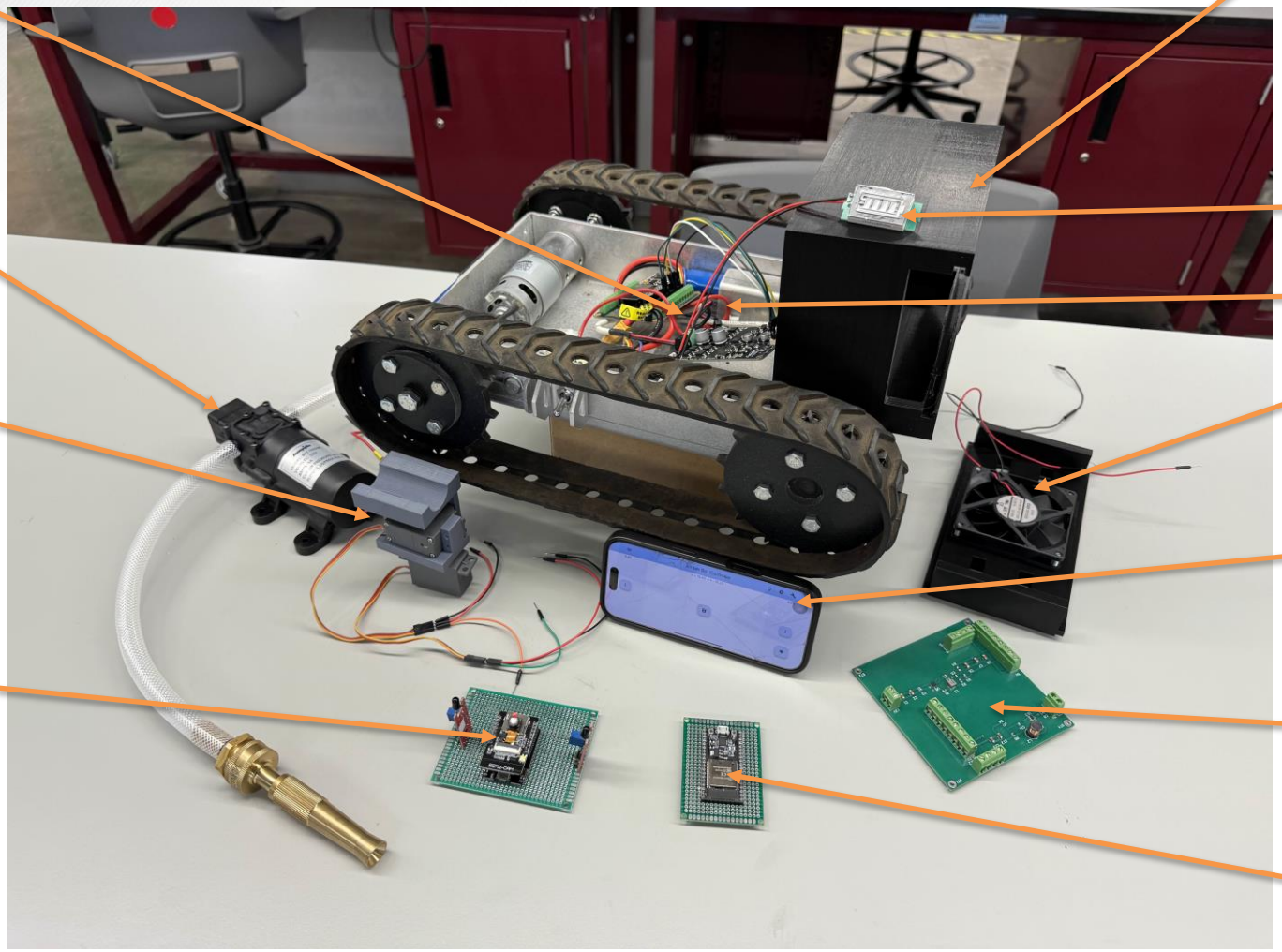
Problem Statement:

Traditional firefighting methods place firefighters in direct danger, exposing them to conditions that significantly threaten their safety and livelihood.

Solution Proposal:

Ember Bot introduces a remotely operated robotic vehicle that allows firefighters to combat fires from a safe distance.

Integrated System Diagram



Project Timeline

Subsystem Designs and Testing (completed 9/11)	Integration of motor subsystem and MCU (completed 9/17)	Integration of Wi-Fi and iPhone App (to complete by 9/28)	Individual Subsystem Power Test (to complete by 10/15)	Frame Placement Integration (to complete by 11/2)	Full Integration Validation (to complete by 11/26)	Demo and Report (to complete by 12/5)

System Integration led by Jonathan Chen (Microcontroller)

Accomplishments since last update 18 hrs of effort	Ongoing progress/problems and plans until the next presentation
• Verified communication between mobile app commands and motor response are correctly synchronized. • Validated error handling for communication dropouts and motor command conflicts during extended runtime	• On-going adjusting real-time nozzle system alongside video stream feedback for coordinated point and shoot. • Conducting extended range and latency tests for various microcontroller communication protocols under varying signal conditions. • Preparing full-field validation of system range, control precision, and streaming reliability with designated PCB.

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Microcontroller System Integration

Jonathan Chen

```
Received JSON:
{"left_position":-4.3333282470703125,"mid_x":0.0,"mid_y":0.0,"right_position":0.0}
Parsed coords: leftMotor=-4, rightMotor = 0, NozzleX=0, NozzleY=0
Received JSON:
{"left_position":-7.0,"mid_x":0.0,"mid_y":0.0,"right_position":0.0}
Parsed coords: leftMotor=-7, rightMotor = 0, NozzleX=0, NozzleY=0
Received JSON:
{"left_position":-5.666656494140625,"mid_x":0.0,"mid_y":0.0,"right_position":0.0}
Parsed coords: leftMotor=-6, rightMotor = 0, NozzleX=0, NozzleY=0
Received JSON:
{"left_position":-52.0,"mid_x":0.0,"mid_y":0.0,"right_position":0.0}
Parsed coords: leftMotor=-52, rightMotor = 0, NozzleX=0, NozzleY=0
Received JSON:
{"left_position":-46.33332824707031,"mid_x":0.0,"mid_y":0.0,"right_position":0.0}
Parsed coords: leftMotor=-46, rightMotor = 0, NozzleX=0, NozzleY=0
Current coords: leftMotor=-46, rightMotor = 0, NozzleX=0, NozzleY=0
No input received for 1 second. Resetting all values to 0.
Current coords: leftMotor=0, rightMotor = 0, NozzleX=0, NozzleY=0
```

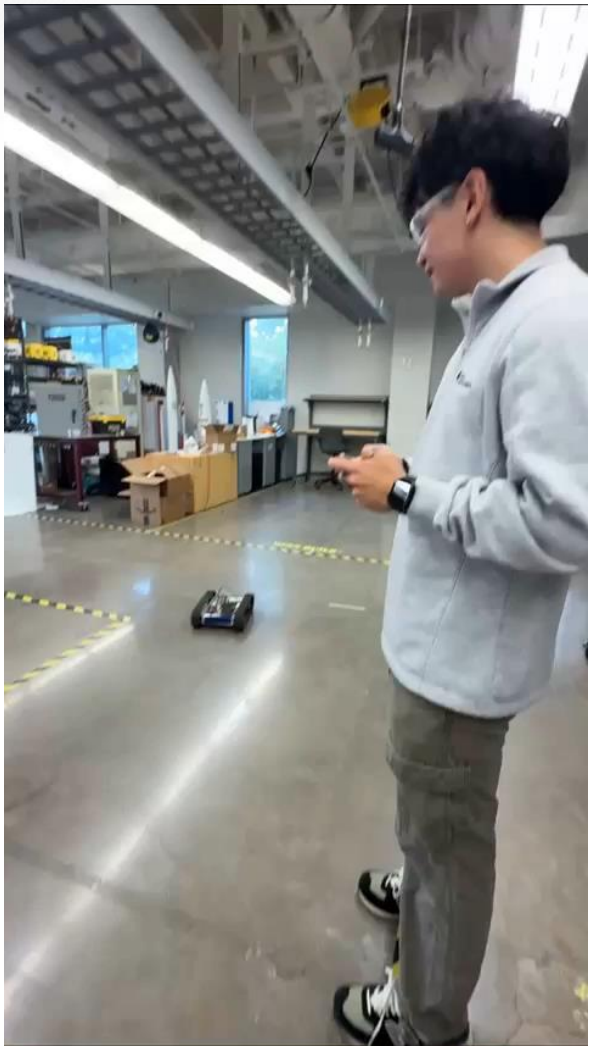
Coordinates Communication Verified and Tested

JSON Error and Invalid Catches Set-Up

```
// Keep only the most recent JSON
int lastBrace = json.lastIndexOf('{');
if (lastBrace > 0) json = json.substring(lastBrace);

// Validate JSON structure
if (!json.startsWith("{") || !json.endsWith("}")) {
  Serial.println("[WARN] Ignored malformed JSON packet.");
  server.send(400, "application/json", "{\"error\":\"Corrupted packet ignored\"}");
  // Flush any junk leftover
  while (client.available()) client.read();
  return;
}
```

Microcontroller System Integration



System Integration led by Kevin Rivera (Vehicle Operations & Water Pump)

Accomplishments since last update 21 hrs of effort	Ongoing progress/problems and plans until the next presentation
• Validated PWM speed control and direction signal code for DC motors through ESP32 and mobile app • Tested top speed, turn radius, and terrain capabilities through mobile app control	• Place new water tank on robot • Mounting electronics into frames such as motor drive, PCBs, sensors, and camera. • Ongoing adjustments to servo and camera integration

User Maneuverability

Distance (ft)	Time (s)	Speed (ft/s)
8	3.2	2.5
8	3.21	2.49
8	3.1	2.58

Average Speed (ft/s)	Average Speed (mph)
2.52	1.72

Max Turn Radius (in)
4

Tread Height: 4.8 in

Obstacle 1 Height: 1.9 in

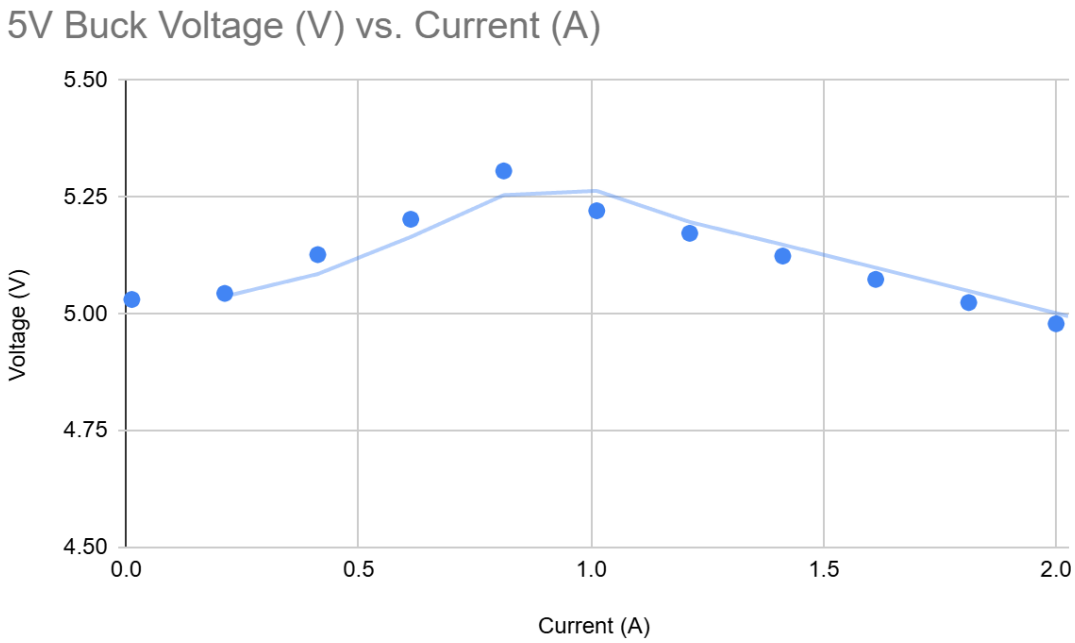
Obstacle 2 Height: 1.5 in

System Integration led by Nancy Ramirez Castillo (Power)

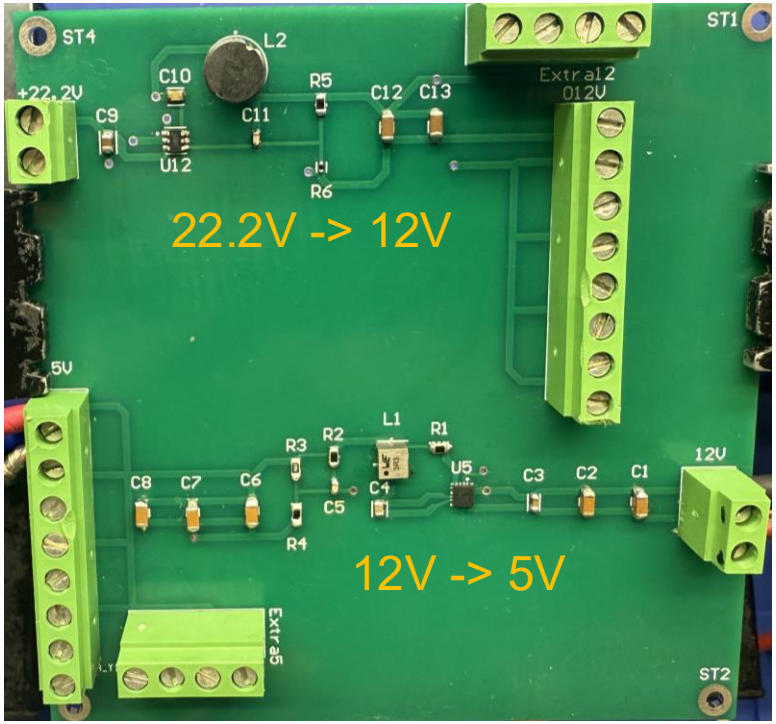
Accomplishments since last update 22 hrs of effort	Ongoing progress/problems and plans until the next presentation
• Successful 5V Buck E-load Test • First Integration Load Test with 5V Rail – **Failed**	• Ongoing12V Rail circuit debugging • Ongoing 5V Rail circuit debugging

Power E-Load Test

Current (A)	Voltage (V)
0.0121	5.0309
0.212	5.0439
0.412	5.1269
0.612	5.2026
0.812	5.3061
1.012	5.2209
1.212	5.1726
1.412	5.1239
1.612	5.0739
1.812	5.0243
2	4.9789



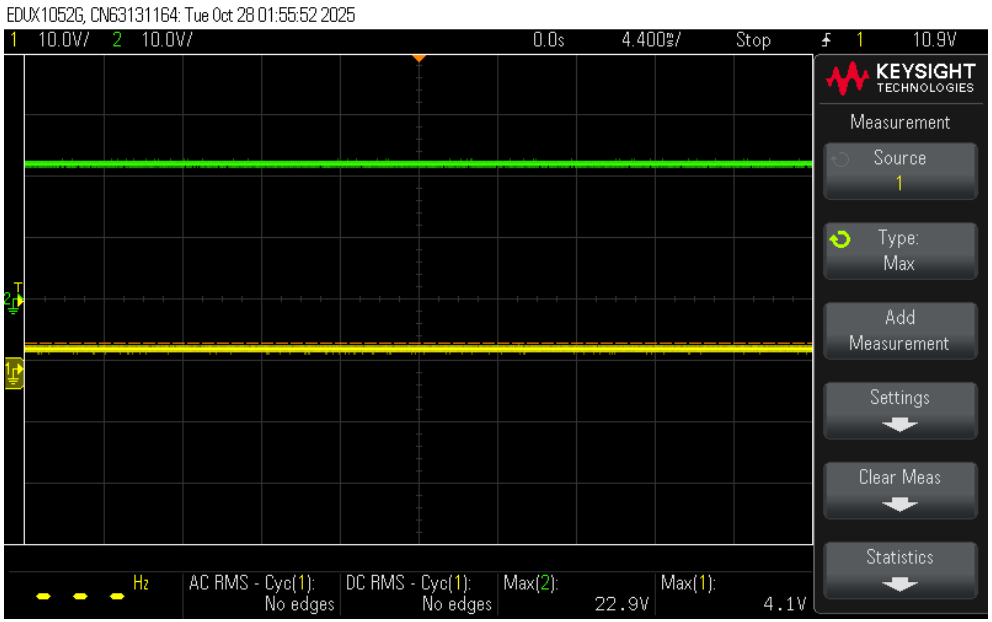
Power Debugging



Power Debugging

22.2V to 12V Converter

Measurements	Voltage (V)
Input	22.9
Output	4.1
Pin 2 - SW	12.9
Pin 3 – Vin	22.9
Pin 4 - Feedback	4.0
Pin 5 - Enable	4.8
Pin 6 - Boot	15.3
L_in	12.9
L_out	5.6



Green – Source Input
Yellow – Converter Output

Mobile App Integration
Yuwen Zheng

Accomplishments since last update 10 hrs of effort	Ongoing progress/problems and plans until the next presentation
• During testing, when we flick a button too fast, motor may crack due to race condition of control signals received by microcontroller • The race condition is due to random network delay that may cause control signals not arriving in the order they were sent by the app • Issue fixed by tagging control signals using a monotonically increasing counter, then the server can filter out control signals that arrive out of order	• Testing all functionalities of the app to determine other issues that may affect behavior • Testing the app on different devices(Both android and iPhone) • Testing the accuracy of mobile app control over nozzle and LED

App Control Over Motor Drive

```
LED_Control: 0.0 left: 0.0 mid_x: 0.0 mid_y: 0.0 right: 96.0 pump: 0.0
10.0.65.112 - - [26/Oct/2025 22:09:18] "POST / HTTP/1.1" 200 -
LED_Control: 0.0 left: 0.0 mid_x: 0.0 mid_y: 0.0 right: 82.33334350585938 pump: 0.0
10.0.65.112 - - [26/Oct/2025 22:09:18] "POST / HTTP/1.1" 200 -
LED_Control: 0.0 left: 0.0 mid_x: 0.0 mid_y: 0.0 right: 142.6666717529297 pump: 0.0
10.0.65.112 - - [26/Oct/2025 22:09:18] "POST / HTTP/1.1" 200 -
LED_Control: 0.0 left: 0.0 mid_x: 0.0 mid_y: 0.0 right: 151.0 pump: 0.0
10.0.65.112 - - [26/Oct/2025 22:09:18] "POST / HTTP/1.1" 200 -
LED_Control: 0.0 left: 0.0 mid_x: 0.0 mid_y: 0.0 right: 121.33334350585938 pump: 0.0
10.0.65.112 - - [26/Oct/2025 22:09:18] "POST / HTTP/1.1" 200 -
LED_Control: 0.0 left: 0.0 mid_x: 0.0 mid_y: 0.0 right: 158.33334350585938 pump: 0.0
10.0.65.112 - - [26/Oct/2025 22:09:18] "POST / HTTP/1.1" 200 -
LED_Control: 0.0 left: 0.0 mid_x: 0.0 mid_y: 0.0 right: 132.6666717529297 pump: 0.0
10.0.65.112 - - [26/Oct/2025 22:09:18] "POST / HTTP/1.1" 200 -
LED_Control: 0.0 left: 0.0 mid_x: 0.0 mid_y: 0.0 right: 164.33334350585938 pump: 0.0
10.0.65.112 - - [26/Oct/2025 22:09:18] "POST / HTTP/1.1" 200 -
LED_Control: 0.0 left: 0.0 mid_x: 0.0 mid_y: 0.0 right: 0.0 pump: 0.0
10.0.65.112 - - [26/Oct/2025 22:09:18] "POST / HTTP/1.1" 200 -
LED_Control: 0.0 left: 0.0 mid_x: 0.0 mid_y: 0.0 right: 176.33334350585938 pump: 0.0
10.0.65.112 - - [26/Oct/2025 22:09:18] "POST / HTTP/1.1" 200 -
LED_Control: 0.0 left: 0.0 mid_x: 0.0 mid_y: 0.0 right: 80.33334350585938 pump: 0.0
```

Right Button released
reset to 0

Random Control Signals
Shows up due to network
delay

App Control Over Motor Drive

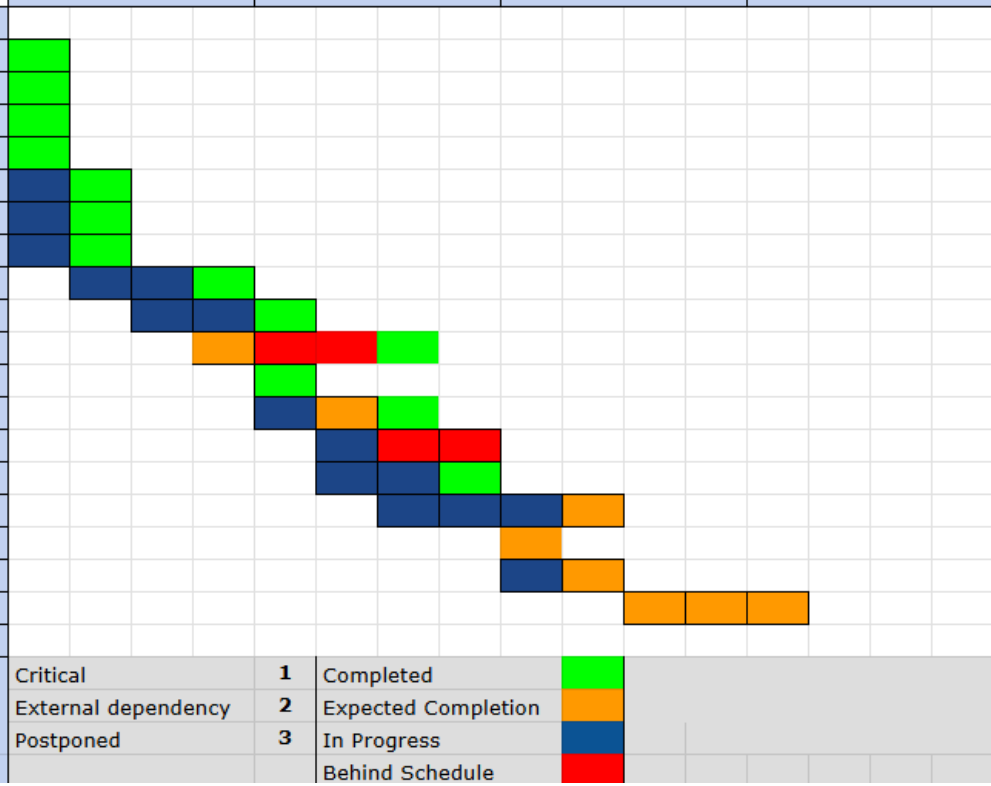
```
10.0.65.112 - - [26/Oct/2025 22:46:23] "POST / HTTP/1.1" 200 -
request_number 2213 LED_Control: 0.0 left: 164.33334350585938 mid_x: 0.0 mid_y: 0.0 right: 0.0 pump: 0.0
10.0.65.112 - - [26/Oct/2025 22:46:23] "POST / HTTP/1.1" 200 -
request_number 2214 LED_Control: 0.0 left: 185.0 mid_x: 0.0 mid_y: 0.0 right: 0.0 pump: 0.0
10.0.65.112 - - [26/Oct/2025 22:46:23] "POST / HTTP/1.1" 200 -
request_number 2215 LED_Control: 0.0 left: 202.33334350585938 mid_x: 0.0 mid_y: 0.0 right: 0.0 pump: 0.0
10.0.65.112 - - [26/Oct/2025 22:46:23] "POST / HTTP/1.1" 200 -
request_number 2216 LED_Control: 0.0 left: 211.6666717529297 mid_x: 0.0 mid_y: 0.0 right: 0.0 pump: 0.0
10.0.65.112 - - [26/Oct/2025 22:46:23] "POST / HTTP/1.1" 200 -
request_number 2217 LED_Control: 0.0 left: 215.0 mid_x: 0.0 mid_y: 0.0 right: 0.0 pump: 0.0
10.0.65.112 - - [26/Oct/2025 22:46:23] "POST / HTTP/1.1" 200 -
request_number 2218 LED_Control: 0.0 left: 0.0 mid_x: 0.0 mid_y: 0.0 right: 0.0 pump: 0.0
10.0.65.112 - - [26/Oct/2025 22:46:23] "POST / HTTP/1.1" 200 -
10.0.65.112 - - [26/Oct/2025 22:46:24] "POST / HTTP/1.1" 200 -
10.0.65.112 - - [26/Oct/2025 22:46:24] "POST / HTTP/1.1" 200 -
10.0.65.112 - - [26/Oct/2025 22:46:24] "POST / HTTP/1.1" 200 -
10.0.65.112 - - [26/Oct/2025 22:46:24] "POST / HTTP/1.1" 200 -
10.0.65.112 - - [26/Oct/2025 22:46:24] "POST / HTTP/1.1" 200 -
10.0.65.112 - - [26/Oct/2025 22:46:24] "POST / HTTP/1.1" 200 -
```

No extra signals generated
Out-of-order Signals are received but ignored

Execution Plan

Ember Bot Project Schedule

Deliverable/Task	Owner	Duration
Engineering Milestones		
Add IP Address Page	Jonathan	1 Week
Implement Video Streaming code	Yuwen	1 Week
Real Flame Testing	Jonathan	1 Week
Buck Converters Re-design	Nancy	1 Week
Integrate Video Streaming with ESP32	Jonathan	2 Weeks
Frame Re-design	Kevin	2 Weeks
Nozzle Calibration	Kevin	2 Weeks
ESP32 PCB Design	Nancy	2 Weeks
Motor Control via App	Kevin	2 Weeks
Order & Solder PCB	Nancy	2 Weeks
Implement LED Button	Yuwen	1 Week
Fine Tune Buttons of UI	Yuwen	2 Weeks
Frame Installation with Water Tank Filled	Kevin	1 Week
Bind Mobile App with ESP32	Jonathan	2 Weeks
Power Integration	Nancy	4 Weeks
Implement App User Guide	Yuwen	1 Week
Test Mobile App on Different Devices	Yuwen	2 Weeks
Final Integration and Testing	All	3 Weeks
Annotations:		



Validation Plan

Test Name	Success Criteria	Methodology	Identifier	Status
Optimizing WiFi Connection	Connect via Wi-Fi Access Point 50-100 Feet Away	Attempt connecting to the ESP-32 Wi-Fi access point at varying distances and with/without obstacles inbetween.	ICD 6.1	Tested
Frame Installation	Frame does not dislodge from 10 minutes of use	Once installed, the robot will be moved via the motors and the frame must stay in place without dislodging for 10 minutes	ICD 3.2.3	Untested
Water Holding	Water Tank Does Not Leak	With the designed and printed water tank, it will be filled with water away from all electronics and be observed for any areas of leaks	ICD 3.2.3	Untested
Thermal Management	Thermal Management	Testing will be done in ambient room temperature (77 F) and recorded with an infrared temperature gun. Place all electronics in the frame and have them run at nominal operating states with the fan on. Temperature of each board will be tracked and recorded every 30 seconds for a total of 5 minutes. Ensure that no devices go past the maximum of 120 F	ICD 4	Untested
Movement Speed With Weight	Ember Bot is able to move at 4mph with the estimated full weight of system	The equivalent of the total weight of all electronics/components will be placed on the robot. Verify that the motors are capable of moving the weighted robot at our desired speed by recording the total displacement in 10 seconds.	FSR 3.2.1	Tested
Water Nozzle Aim Calibration	Water Nozzle points to +-10 degrees of user input	Sketching a x-y plane at the recommended distance of 6ft and measuring the accuracy of this distance.	FSR 3.2.1	Untested
Video Streaming	Mobile app can receive and display video signals from ESP32	The mobile app will able to display video streaming from the camera on Ember Bot	ICD 6.3	Tested
Video Distance & Frame Test	Video Stream doesn't lose frames or quality as distance increase up 50 Feet	Test the independent mobile integration with the camera at varying distances, aiming for 5 feet intervals until 50 feet or the distance of entire room	ICD 4	Tested
Microcontroller & App Connection	Values sent for Ember Bot control are sent from the app and received correctly through the ESP32	Using user inputs on the mobile app, ensure that multiple inputs are able to be recived and sent to the respective vehicles components. This includes the DC motors, servos, and LED strip. ESP32 send back packets confirming communication.	ICD 6.2	Tested
App User Guide	App user page can be viewed on different mobile app devices	After the Ember Bot is fully integrated and tested, determine specific instructions to set up and control Ember Bot. Let other group members walk through the user guide to check if it provides a clear instructions to users	FSR 3.2.4	Untested
Mobile App on Different Devices	The mobile app can be loaded on to at least 5 other devices(Both iphones and android)	Load mobile app on other group member's devices to test if the app can function as expected on different devices. Devices include iPhone16 pro. iPhone 15 pro Max, and Pixel 9.	FSR 4.1.1	Untested
Power Boards Testing	Able to supply power under max load	Using different combinations of loads, two buck converters should keep a consistent output for all components needed	FSR 3.2.3	Untested
Battery Endurance Testing	Ember Bot can operate for an hour under continuous use and indicate when battery is low	Starting with full batteries, Ember Bot will run all different components for an hour and then will log how much battery power was used.	ICD 4.1	Untested
Motor and nozzle user test	Control the motors and nozzle movements with no more than a 2 second delay via the mobile app	After connection between the ESP32 and our mobile app is made, have a user send inputs from the app to control the motors and servo motors. Track how long it takes for these actions to take place.	FSR 3.2.1	Untested
Electonics Isolation	There is no risk of water damaging the PCB, motors, and other electronics in the bottom layer of the robot	Connect the pieces of the frame and pour 1 gallon of water over it for a short time and once done check below the frame to see if water leaked	FSR 3.2.3	Tested
Servo Movements	Servos can successfuly move and point to a certain point	Attatch a laser on the end of the servo configuration to point to a x-y grid. Input x and y coordinates and verify that the laser is pointing to the correct point. The laser must be 1 inch within the desired location	FSR 3.2.1	Tested
Water Nozzle Movement	Nozzle from water pump system securely attached to servos.	Connect the servos with the water nozzle and verify that the range fits with the coordinate system verified in the servos movement test. Sweep servos across the grid in a square and X pattern 3 times to validate that nozzle is securely placed.	FSR 3.2.1	Tested
Vehicle Movement	Both DC motors can be controlled independetly via the motor driver	Input control signals can control each motor independetly to go forward, backwards, turn left, turn right, and turn 180 degrees. Expected max speed of 2mph. Input signals must have a delay of less than two seconds from microcontroller.	FSR 3.2.2	Tested
E-Load Testing	Maintains a steady 12V ± 5% and 5V ± 5% output under varying load conditions up to 2A.	Using an E-load in constant current mode and vary the load from 0A to 2A, monitor the output voltage and ripple using an oscilloscope to ensure stable operation at full load.	FSR 3.2.3	Partial Tested
Sudden Input Testing	Motors and Nozzle properly register JSON files as a FIFO order.	Testing the motors and nozzles with the app controls in a jitter method as well as a sudden input method, such as flicking. Ensure that there is no stutter nor stuck commands so that the robot can function as intended without getting caught in motion.	ICD 6.2	Untested

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Questions?

Thank You!
Ember Bot

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