



Dwight Look College of  
**ENGINEERING**  
TEXAS A&M UNIVERSITY

# Ember Bot:

## A Fire Fighting Robotic Vehicle

**Team 30:**  
Jonathan Chen  
Kevin Rivera  
Nancy Ramirez Castillo  
Yuwen Zheng  
**Sponsor:** Zian Wang

# Project Overview

## Problem Statement:

Traditional firefighting methods rely on human intervention, exposing personnel to extreme hazards such as heat, toxic smoke, and structural collapse. These settings can pose safety risks and potential response delays, especially in hard-to-reach areas.



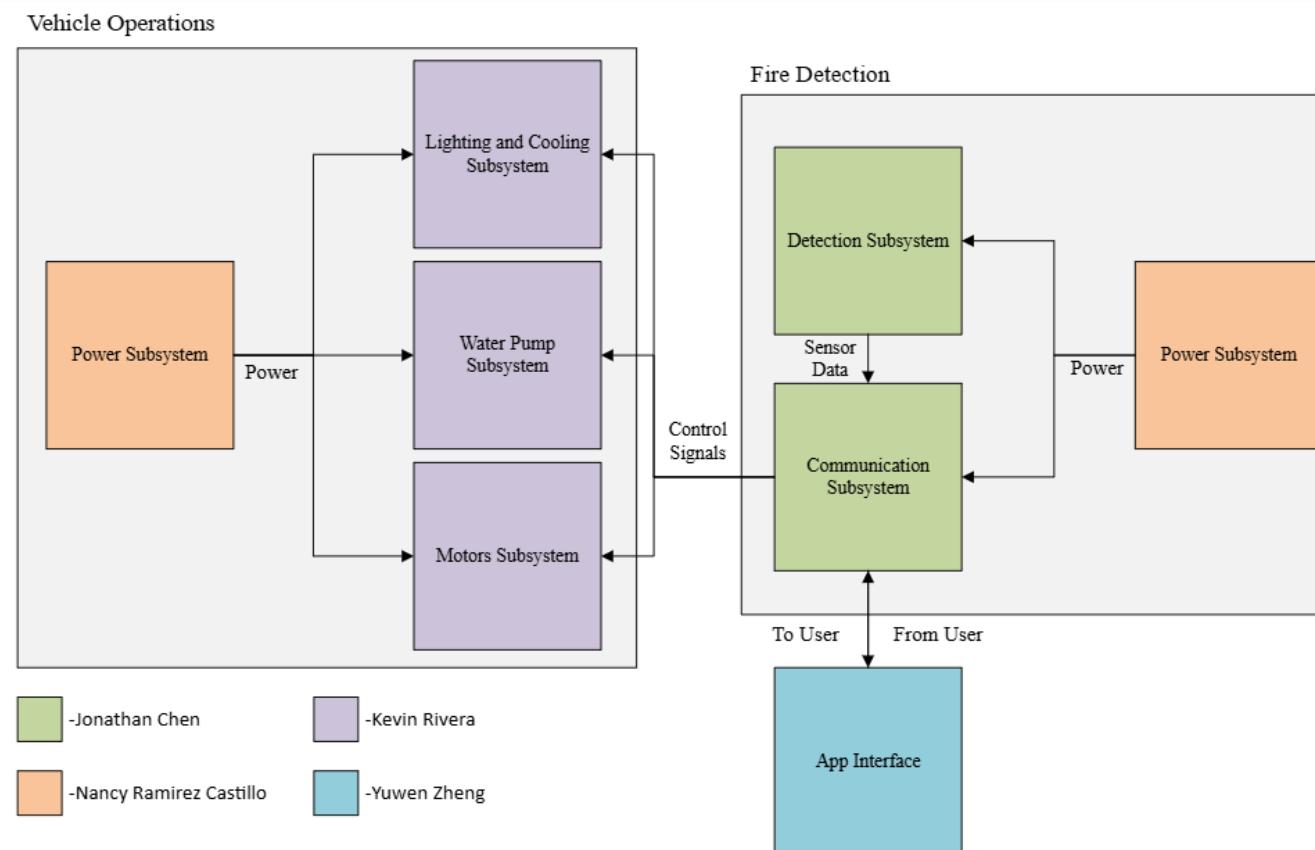
# Project Overview

## Solution proposal:

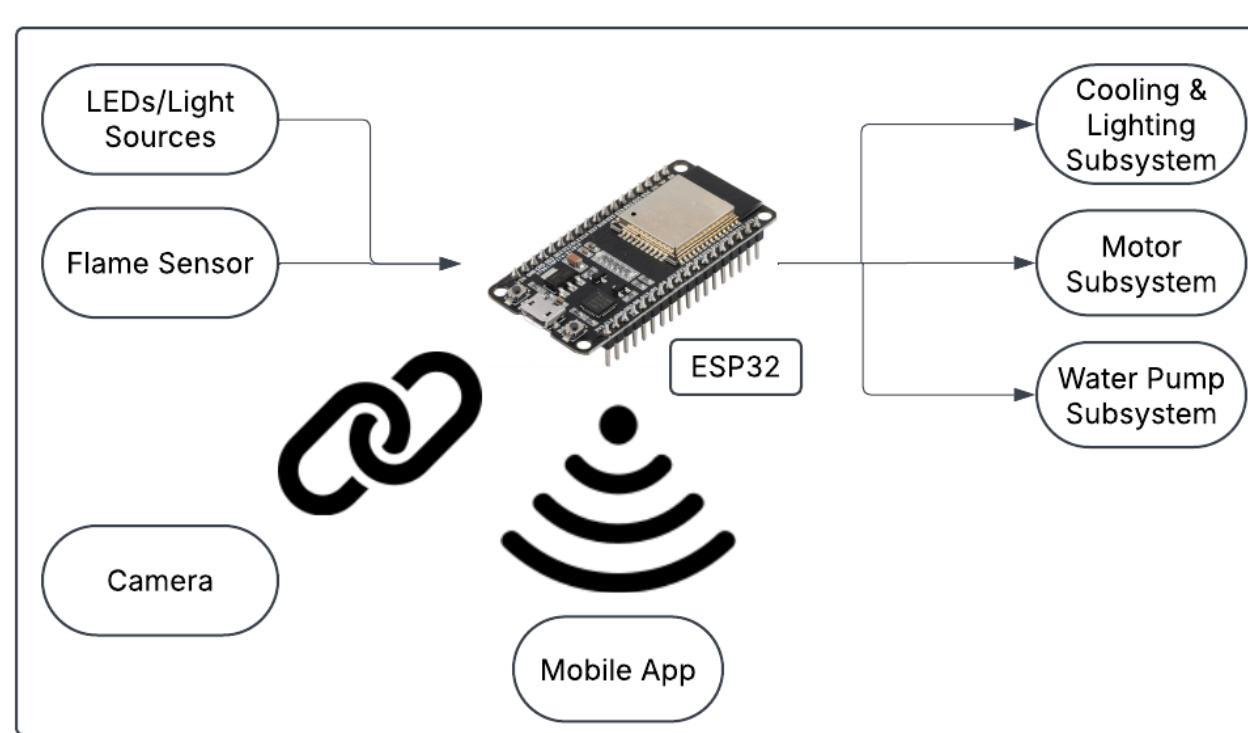
Ember Bot is a fire-fighting robotic vehicle designed to detect and extinguish small fires in high-risk areas through a mobile app. Equipped with IR sensors and a camera, firefighters will be able to control Ember Bot in areas deemed unsafe for humans.



# System Overview

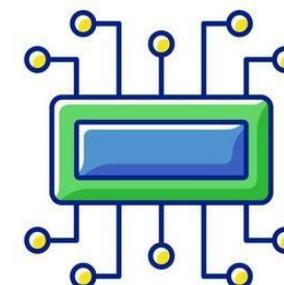


# Microcontroller Subsystem



## Subsystem Deliverables:

- Fire Detection
- Camera Live Streaming
- LED Source
- ESP32 Wi-Fi Access Point



Accomplishments since the last presentation

- Fire Detection Completed (KY-026)
- Camera Live Streaming (ESP32-CAM)
- Code Base & IDE-Set Up (ESP-IDF & Arduino IDE)



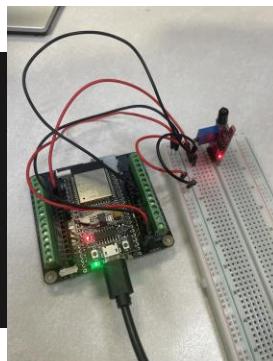
Ongoing progress/problems and plans until the next presentation

- Ongoing Progress:
- Wi-Fi Access Point
  - Lighting System
  - Demo/System Integration

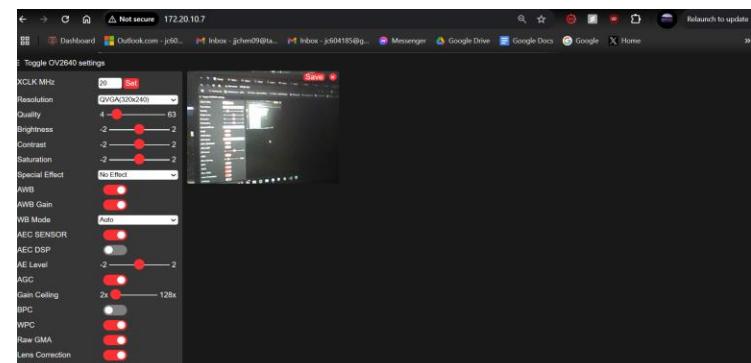
Problems:

- Fire Detection Range
- Unstable Camera Feed

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Iteration #26: Analog = 3067, Threshold = No Flame
Iteration #27: Analog = 3447, Threshold = No Flame
Iteration #28: Analog = 2028, Threshold = No Flame
Iteration #29: Analog = 27, Threshold = Flame Detected
Iteration #30: Analog = 64, Threshold = Flame Detected
Iteration #31: Analog = 21, Threshold = Flame Detected
Iteration #32: Analog = 31, Threshold = Flame Detected
Iteration #33: Analog = 70, Threshold = Flame Detected
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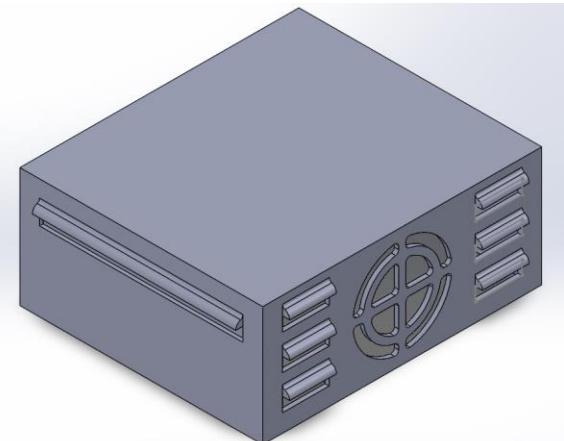
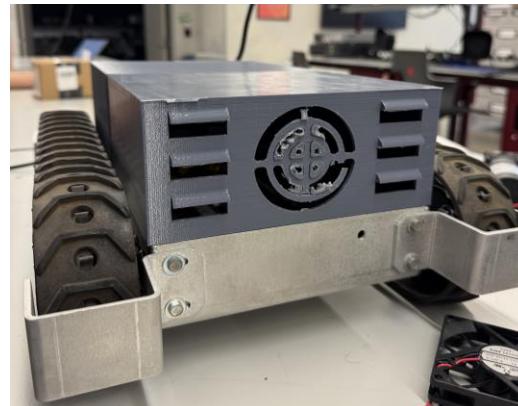
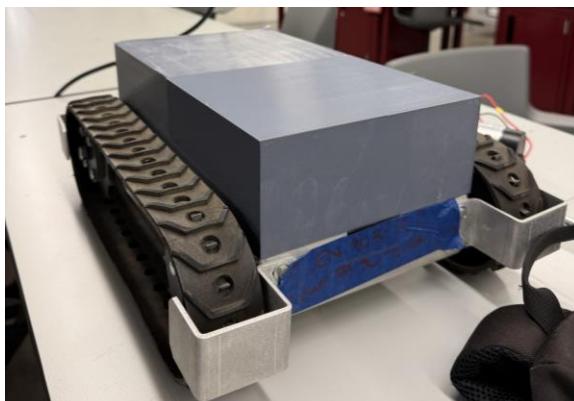


Fire Detection



Camera Streaming

Accomplishments since the last presentation	Ongoing progress/problems and plans until the next presentation
<ul style="list-style-type: none"><li>First version of frame printed</li></ul>	<ul style="list-style-type: none"><li>Design is too big to be printed as a single piece</li><li>Designing second layer containing water tank</li><li>Old motor driver did not work, new one coming in this week</li></ul>

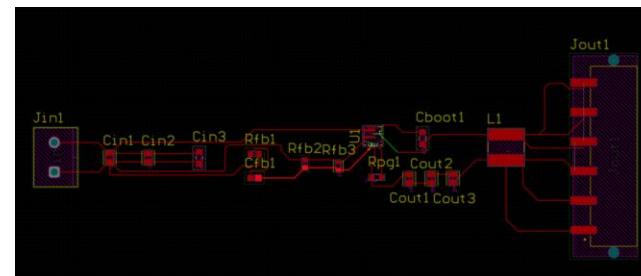
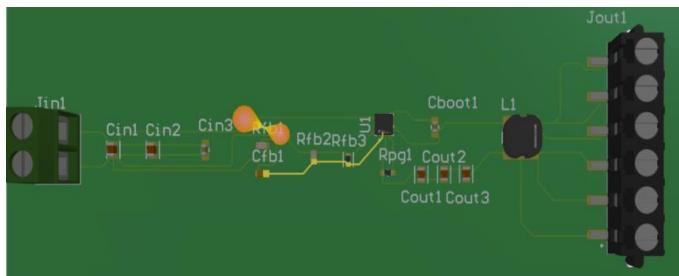
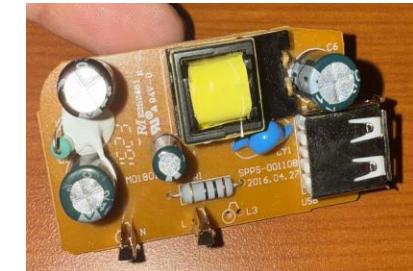
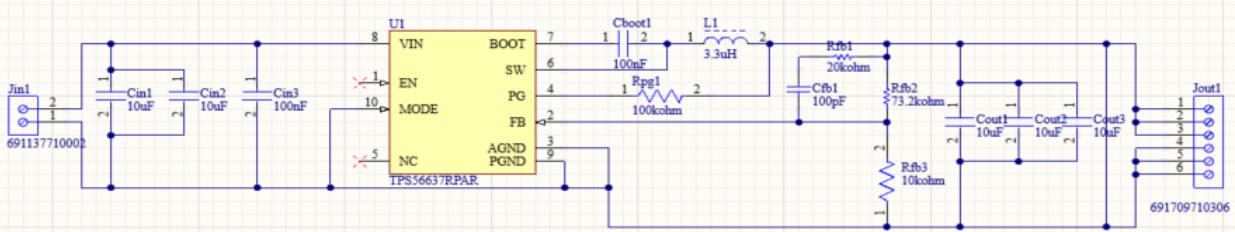


Accomplishments since the last presentation	Ongoing progress/problems and plans until the next presentation
<ul style="list-style-type: none"><li>Verified water pump max range of 7-8ft</li><li>Began testing nozzle movement system</li></ul>	<ul style="list-style-type: none"><li>Water pump is a little loud</li><li>Design a holder for the water nozzle</li></ul>

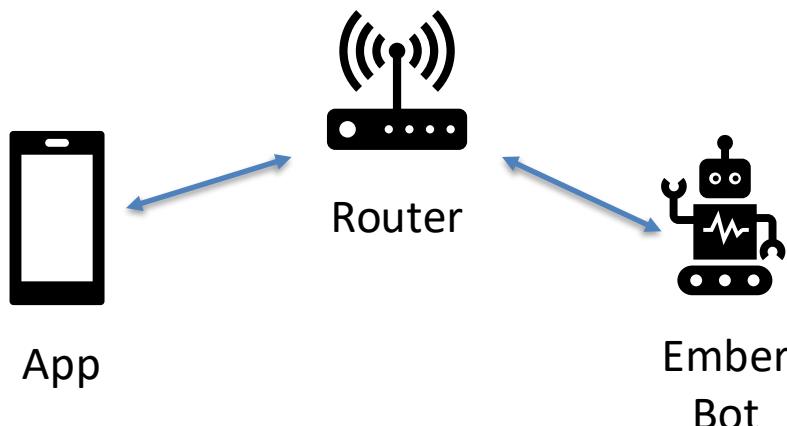


Accomplishments since the last presentation	Ongoing progress/problems and plans until the next presentation
<ul style="list-style-type: none"> <li>Ran simulations to ensure correct output voltage/current for power converters</li> <li>PCBs are ordered and waiting for delivery</li> </ul>	<ul style="list-style-type: none"> <li>Practice soldering during lab</li> <li>AC/DC Converter 3D printed case</li> <li>Arrangement for optimal cooling</li> </ul>

12V to 5V Buck



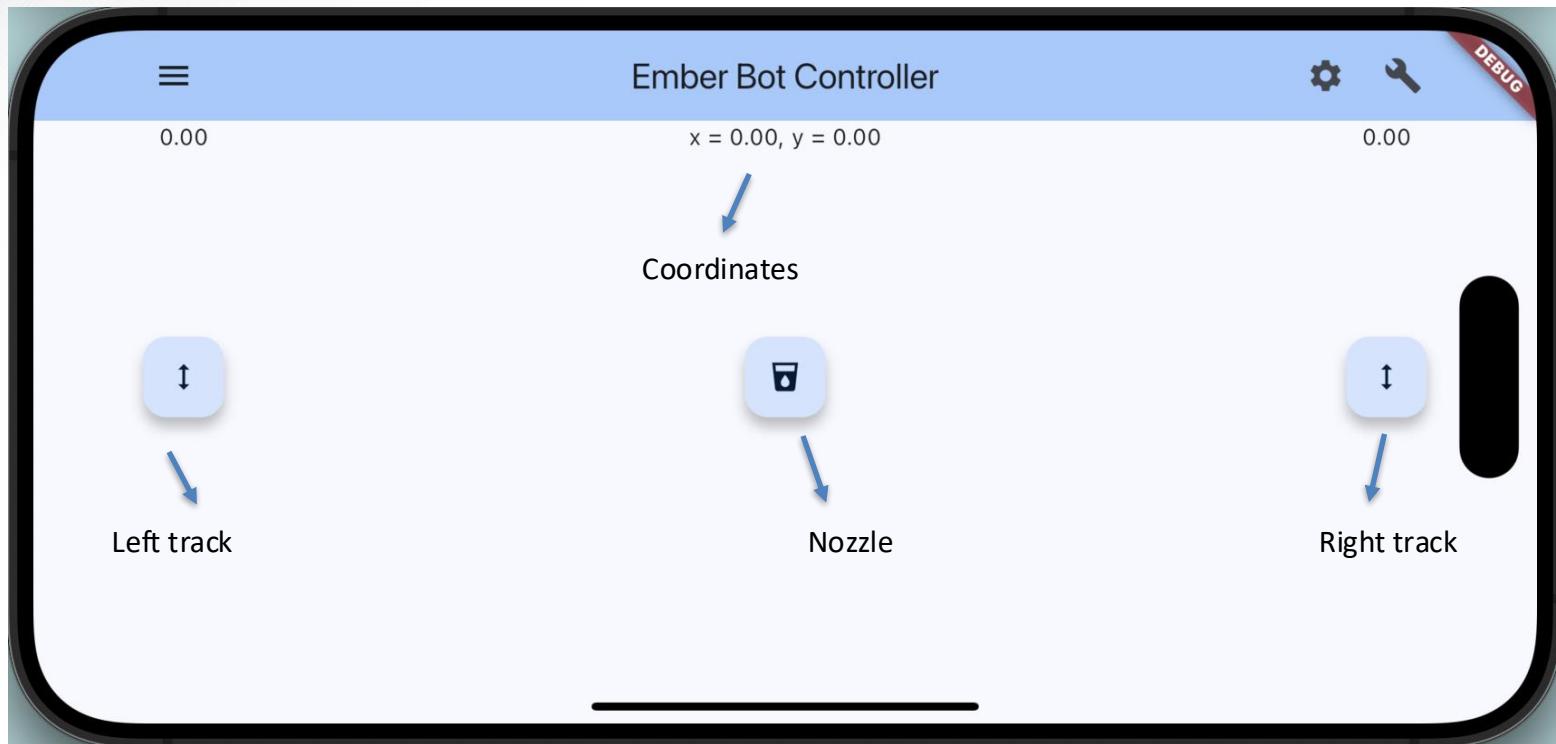
Accomplishments since the last presentation	Ongoing progress/problems and plans until the next presentation
<ul style="list-style-type: none"> <li>• App running on emulator</li> <li>• Buttons added for controlling right &amp; left tracks</li> <li>• User manual page &amp; settings page added</li> <li>• Able to record button coordinates data for future nozzle updates</li> <li>• Wi-Fi functionality tested</li> </ul>	<ul style="list-style-type: none"> <li>• Bind Wi-Fi functionality to buttons</li> <li>• Add live video stream to the app</li> <li>• Building testbenches for video streaming validation</li> <li>• Optimize the app for better user experience</li> </ul>



```

flutter: Nozzle moving: 551.00 175.00
flutter: Nozzle moving: 557.67 175.00
flutter: Nozzle moving: 561.67 175.00
flutter: Nozzle moving: 564.00 175.67
flutter: Nozzle moving: 564.67 176.67
flutter: Nozzle moving: 565.33 177.67
  
```

# App UI Demo





# Execution Plan

Ember Bot Project Schedule																			
Deliverable/Task	Owner	Duration	Note	FEB				MARCH				APRIL				MAY			
				W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4
<strong>Overall Deliverables</strong>																			
ConOps	All	2w	Due 2/5	████	███														
FSR + ICD	All	2w	Due 2/20	████	███	██													
Validation Plan	All	2w	Due 2/20	████	███	██													
Milestone Plane	All	2w	Due 2/20	████	███	██													
Midterm Presentation	All	2w	Due 2/24	████	███	██													
Status Update Presentation	All	2w	Due 4/2	████	███	██													
Final Presentation	All	3w	Due 4/16					████	███	██									
Final Demo	All	3w	Due 4/21					████	███	██									
Final Report	All	3w	Due 4/27					████	███	██									
<strong>Microcontroller &amp; Fire Detection</strong>																			
ESP32 Installation + Start-Up	Jonathan	3w		████	███	██													
ESP32 Framework	Jonathan	3w		████	███	██													
Camera Module	Jonathan	2w		████	███	██													
IR Sensor Detector	Jonathan	2w		████	███	██													
Light Source	Jonathan	2w		████	███	██													
Microcontroller Connection w/ Systems	Jonathan	2w		████	███	██													
<strong>App Development</strong>																			
Create wireframe and overall structure	Yuwen	3w		████	███	██													
Create clickable prototype	Yuwen	2w		████	███	██													
Create User Interface Design	Yuwen	2w		████	███	██													
Test the app with basic functionality	Yuwen	2w		████	███	██													
Create User Manual within app	Yuwen	2w		████	███	██													
Create User Help page within app	Yuwen	2w		████	███	██													
Add WiFi Functionality	Yuwen	2w		████	███	██													
Add video streaming	Yuwen	2w		████	███	██													
Finalize App Design	Yuwen	2w		████	███	██													
<strong>Power System</strong>																			
Design circuit schematic	Nancy	2w		████	███	██													
Breadboard Assemble and Testing	Nancy	2w		████	███	██													
Power Efficiency and Load Testing	Nancy	1w		████	███	██													
PCB Design	Nancy	2w		████	███	██													
PCB Testing	Nancy	3w		████	███	██													
Thermal and Safety Analysis	Nancy	1w		████	███	██													
Validate Recharging	Nancy	1w		████	███	██													
<strong>Pump System + Car</strong>																			
Verify Vehicle Movement	Kevin	2w		████	███	██													
Set up Lighting and Cooling	Kevin	2w		████	███	██													
Servo System	Kevin	2w		████	███	██													
Water Pump System	Kevin	3w		████	███	██													
Creating Vehicle Frame	Kevin	2w		████	███	██													
<strong>Annotations:</strong>																			
				Critical	1	Completed													
				External dependency	2	Expected Completion													
				Postponed	3	In Progress													

# Validation Plan

Test Name	Success Criteria	Methodology	Status	Engineer(s) Responsible
Fire Detection	Flame Sensor delivers correct output resulting from Flame/IR	Measure Sensor Output with IR Source at Varying Distances	TESTED	Jonathan Chen
Camera Streaming	Steady Visual Output from Camera Stream	Set up ESP32-CAM to transmit live video. Evaluate frame rate, transmission stability, and stream quality	TESTED	Jonathan Chen
ESP32 WiFi Access Point	System connects with Microcontroller Remotely	ESP32-CAM and Cellular Device are able to connect to ESP32 via WiFi. Measure functionality at Distance	UNTESTED	Jonathan Chen
LED Output	LED functions as directed	Light Source tested at OFF/ON State	UNTESTED	Jonathan Chen
Communication Range	All subsystem components can be remotely accessed across the room	System Communication Test is tested across the FEDC room, performed at 5 Feet Intervals till no response	UNTESTED	Jonathan Chen
Vehicle Movement	Both motors can be controlled independently via the motor driver	Input control signals can control each motor independently to go forward, backwards, turn left, turn right, and turn 180 degrees.	UNTESTED	Kevin Rivera
Electronics Isolation	There is no risk of water damaging the PCB, motors, and other electronics in the bottom layer of the robot	Seal and connect the two pieces of the bottom 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	UNTESTED	Kevin Rivera
Vehicle Chassis	Vehicle frames can hold all electronics and water tank safely	Place the bottom level of the frame with the water tank attached on top to ensure even weight distribution while moving	UNTESTED	Kevin Rivera
Servo Movements	Servos can successfully move and point to a certain point	Attach 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	TESTED	Kevin Rivera
Maximum Water Range	Check the maximum range of the water pump system	Turn on the water pump with the nozzle on and measure the distance in which the flow of water goes before beginning to drop	TESTED	Kevin Rivera
Water Nozzle Movement	Water pump system successfully attached to the servo system	Connect the servos with the water nozzle and verify that the range fits with the coordinate system verified in the servos movement test	UNTESTED	Kevin Rivera
App Launch on emulator	The app can run and tested on emulator	The app can obtain all the function designed on emulator	TESTED	Yuwen Zheng
App Launch on mobile device	The app can be installed on mobile device and can be opened	The app is able to function on both emulator and a physical mobile device	UNTESTED	Yuwen Zheng
Left/Right wheel button	Both button can be dragged vertically, show the axis position on screen	Drag each button on screen and drag both button at the same time	TESTED	Yuwen Zheng
Nozzle Button	The button can be dragged both vertically & Horizontally	drag nozzle button on screen	TESTED	Yuwen Zheng
User Manual Page Button	The button can direct the user to a new page with user manual	click on the button and check if the user is direct to a new page with user manual	TESTED	Yuwen Zheng
Help page Button	The button can direct the user to a new page with help guide on Ember Bot	click on the button and check if the user is direct to a new page with help page	TESTED	Yuwen Zheng
Wifi Functionality	The app is able to establish communication with ESP32 through wifi connection	Write a test application running on a laptop that listens for incoming packets. let the app send control signals to laptop's IP	UNTESTED	Yuwen Zheng
Video Streaming	The app is able to receive and display video signal in the mobile app	Test if the video can be received and displayed on the screen of the mobile device	UNTESTED	Yuwen Zheng
1.1 Buck (24V-12V) Simulation	Steady state waveform and outputting a max of 12.6V	Using LTSpice/Altium to select components and verify power rail. Using a higher voltage to compensate for real world applications which will decrease the output voltage	TESTED	Nancy Ramirez Castillo
1.2 Buck (24V-12V)	Keeps operating under high temperature and running time	Use the DC Power Supply to provide 24V and measure the output voltage using the Oscilloscope ensuring it runs smoothly for 15 minute without overheating	UNTESTED	Nancy Ramirez Castillo
1.3 Buck (24V-12V)	Smooth step-down voltage from boost converter	Test the flow of power, voltage, and current with the boost and buck converter connected. Outputs at both converters should be minimal compared to when running alone	UNTESTED	Nancy Ramirez Castillo
2.1 Buck (12V-5V) Simulation	Steady state waveform and outputting a max of 5.5V	Using LTSpice/Altium to select components and verify power rail. Using a higher voltage to compensate for real world applications which will decrease the output voltage	TESTED	Nancy Ramirez Castillo
2.2 Buck (12V-5V)	Low voltage output and current of min. 1.5A	Use the DC Power Supply to provide 12V and measure the output with Oscilloscope ensuring minimal ripple and runs for 15 minutes without overheating	UNTESTED	Nancy Ramirez Castillo
2.3 Buck (12V-5V)	Smooth step-down voltage from first buck converter	Test the flow of power, voltage, and current with both buck converters connected. Outputs at both converters should be minimal compared to when running alone	UNTESTED	Nancy Ramirez Castillo
3.1 Boost (22.2V-24V)	Outputs 23.5V-24.5V and 2.2A current with minimal voltage ripple	Use the DC Power Supply to provide the 22.2V that will be provided by the Li-Po batteries and measure the output voltage using the Oscilloscope ensuring it runs smoothly for 5 mins	UNTESTED	Nancy Ramirez Castillo
4.1 AC/DC Charger Simulation	Simulation shows use of all 120VAC to output 12.6VDC	Using LTSpice/Altium to select components and verify power rail. Using a full-wave rectifier to use all alternative power to help cut down recharging time	TESTED	Nancy Ramirez Castillo
4.2 AC/DC Charger	Steady DC output from wall outlet	Keeps a steady 12.6V/2.2Ah to charge one Li-Po battery and indicating when battery is full with LED lights	UNTESTED	Nancy Ramirez Castillo
Full System Load	No overheating under max. load conditions	Power the entire system and let it run under full operation for 15 minutes. Monitor every converter's output with a load connected to simulate next semester integration	UNTESTED	Nancy Ramirez Castillo