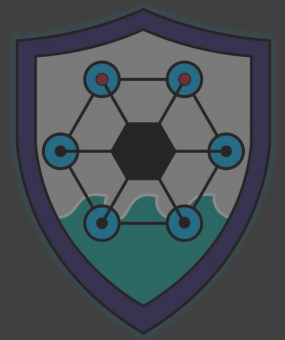
SeaShield

UCSB Computer Engineering

Capstone Project 2021

The Team

- Chris Scott:
  - Drone construction
  - Drone control using dronekit
- Eric Kim:
  - Android application
  - App/Drone communication
- Andrew Cizas:
  - Image augmentation
  - Detection model training
  - Drone construction assistance
- Andrew Berry:
  - Android application
  - Video feed
  - Real time rust detection
- Derek Cheng:
  - Detection model research
  - Detection model training

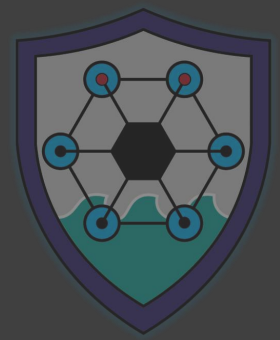


Rust and Corrosion on Naval Ships

- Oxidation rate dramatically increased by salt water
- Repair costs the Navy 3 billion dollars annually
  - https://www.popularmechanics.com/military/navy-ships/a30522792/navy-fighting-rust/

Problem: Rust and Corrosion

- **Salt water**
  - Conductive
  - Faster Oxidation
- **Naval Ships**
  - Steel hull
  - Weakened by rust/corrosion
  - May collapse under normal operation due to rust/corrosion



Rust Inhibiting Liquid Application

- Rinse salt water; slow down oxidation
- Cover rust; protect steel from oxygen
- Solution: Apply using drone with rust detection capability

Solution: Drone that Applies Rust Inhibiting Liquid

Key Components

Drone Body

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Video Feed +
Rust Detection

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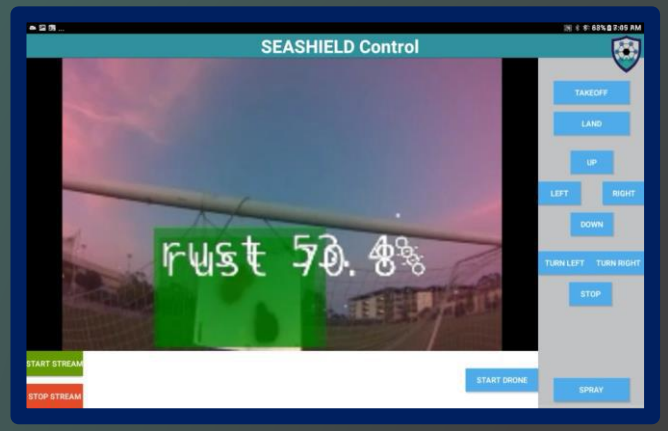
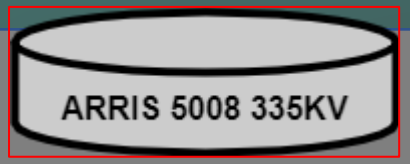
App Control

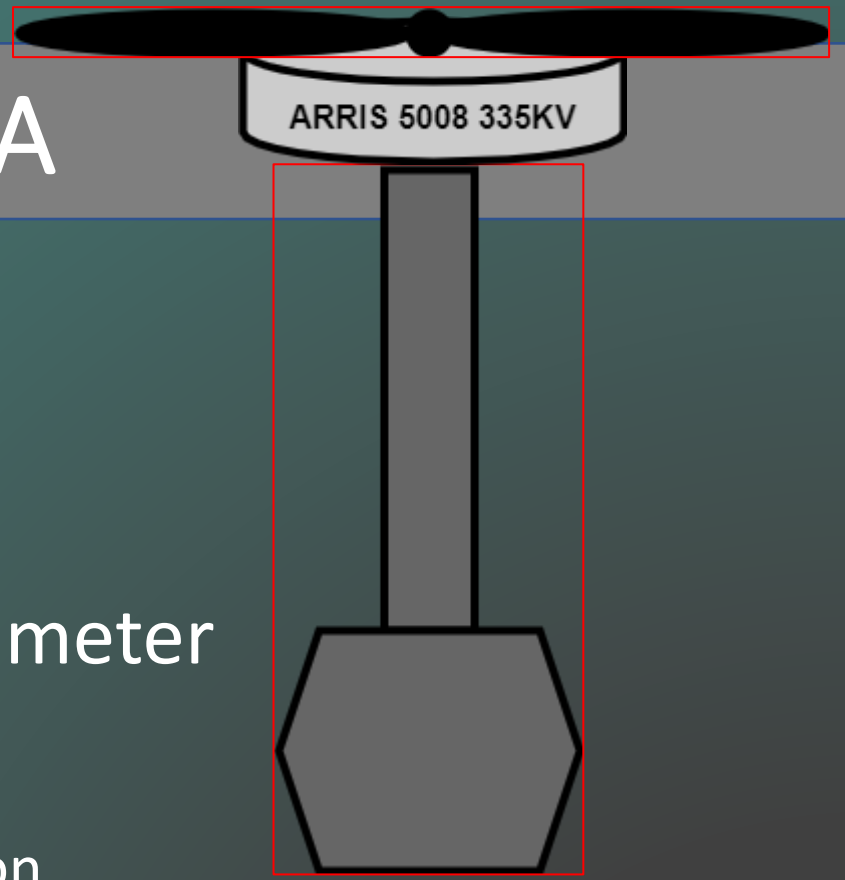


Brushless Motors



- Maximum 3300 g (7.3 lbs) thrust per motor
- 19,800 g (43.65 lbs) maximum drone thrust
- 21.8 lbs maximum drone gross weight
- 10 Amp draw per motor at 20lbs with 18-inch propellors

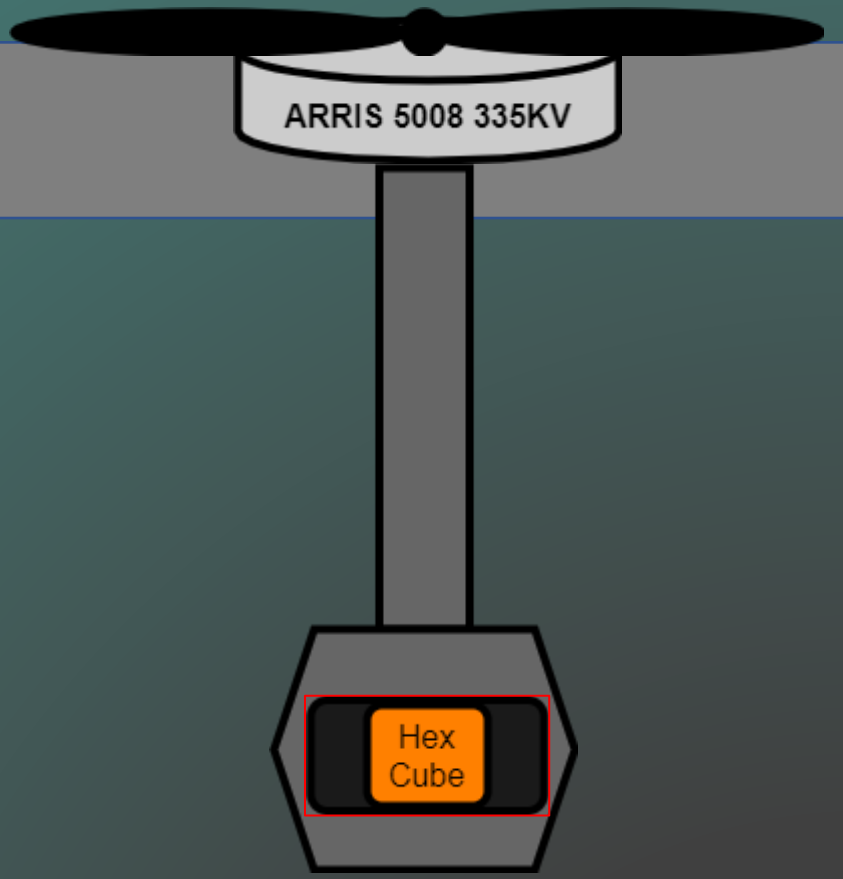
Tarot Carbon Fiber Frame TL960A



- 1050 grams (2.3 lbs)
- 960 mm (37.8 inch) diameter
  - Allows 18in propellers
    - More thrust per RPM
    - Less power consumption

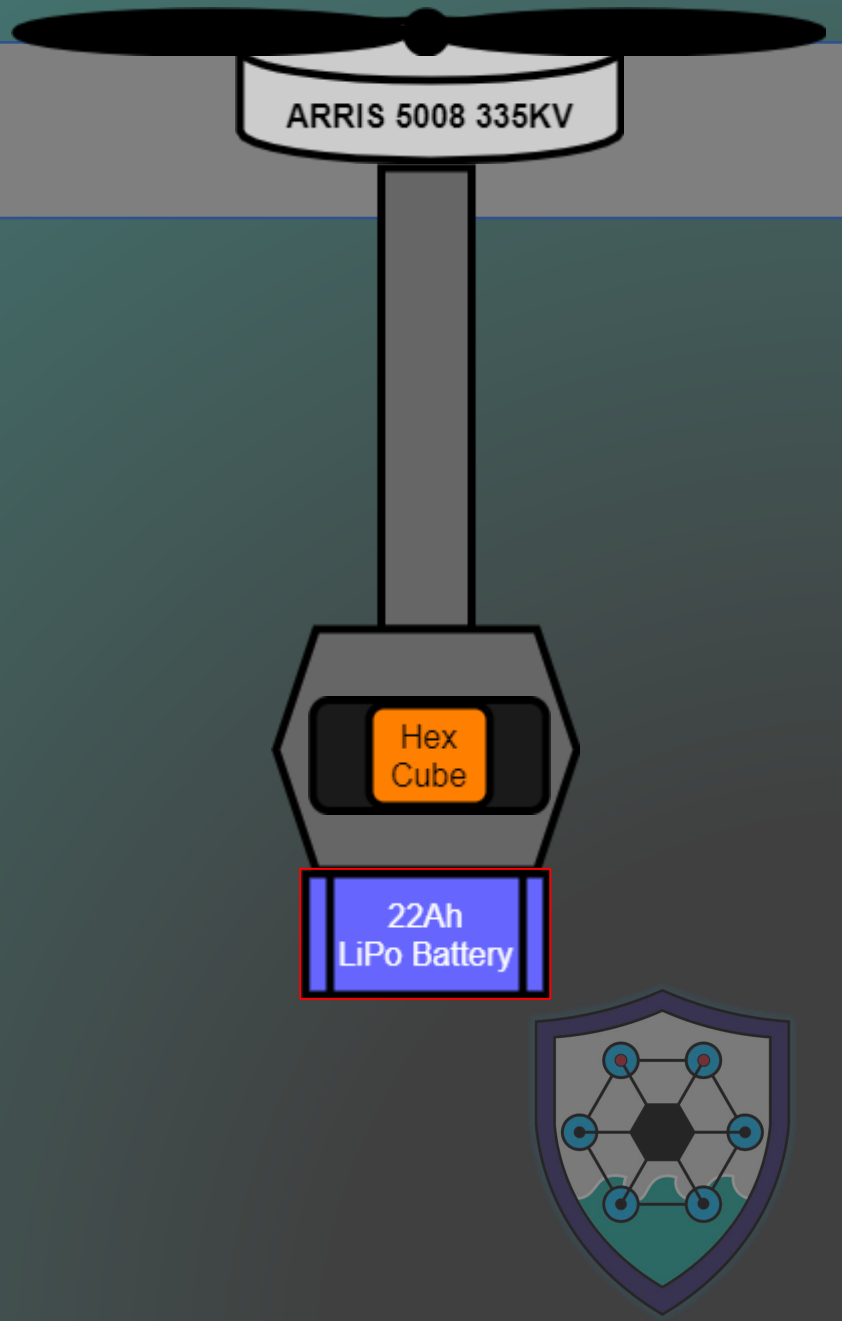
Flight Controller

- HEX Cube Orange
- Triple redundant IMUs
- 2 IMUs vibration isolated
- Temperature controlled
- Ardupilot Firmware installed



Lithium Polymer Battery

- High Amp discharge rate
  - 220 to 440 Amp instantaneous
- 22 Ah / 60 A * 60 min/H
  = 22 min flight time.

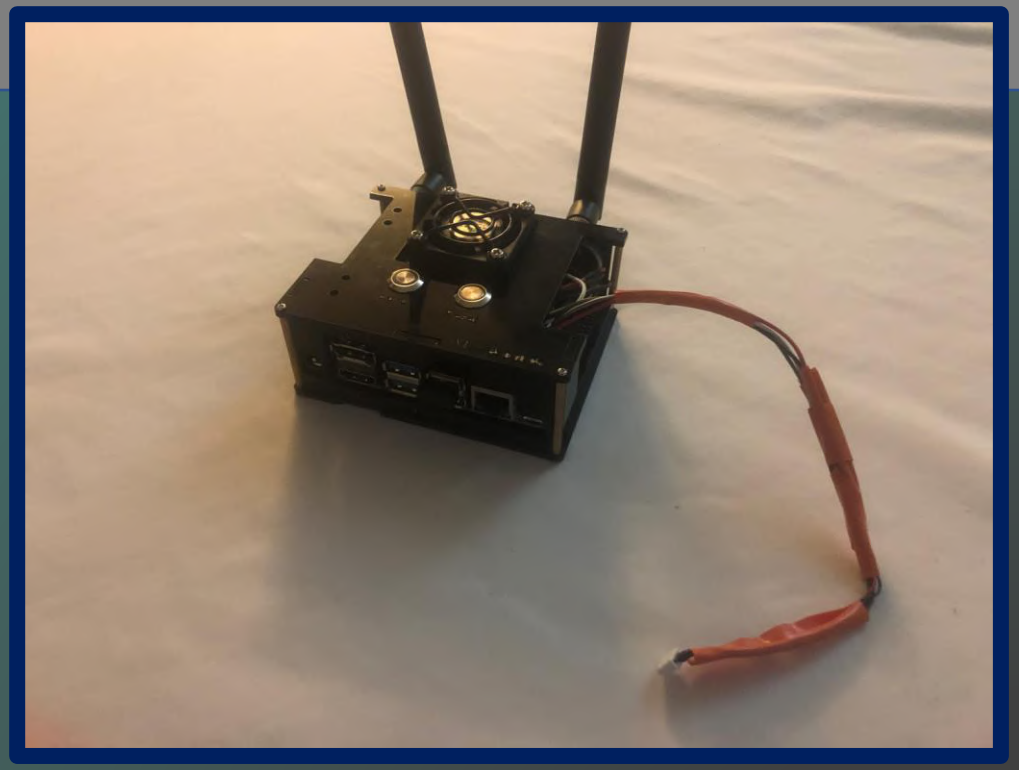


12V DC Water Pump

- 1.2 Gallons per minute
- 110 PSI automatic cut-off switch
- 3.0 Amp draw

NVIDIA Jetson Nano

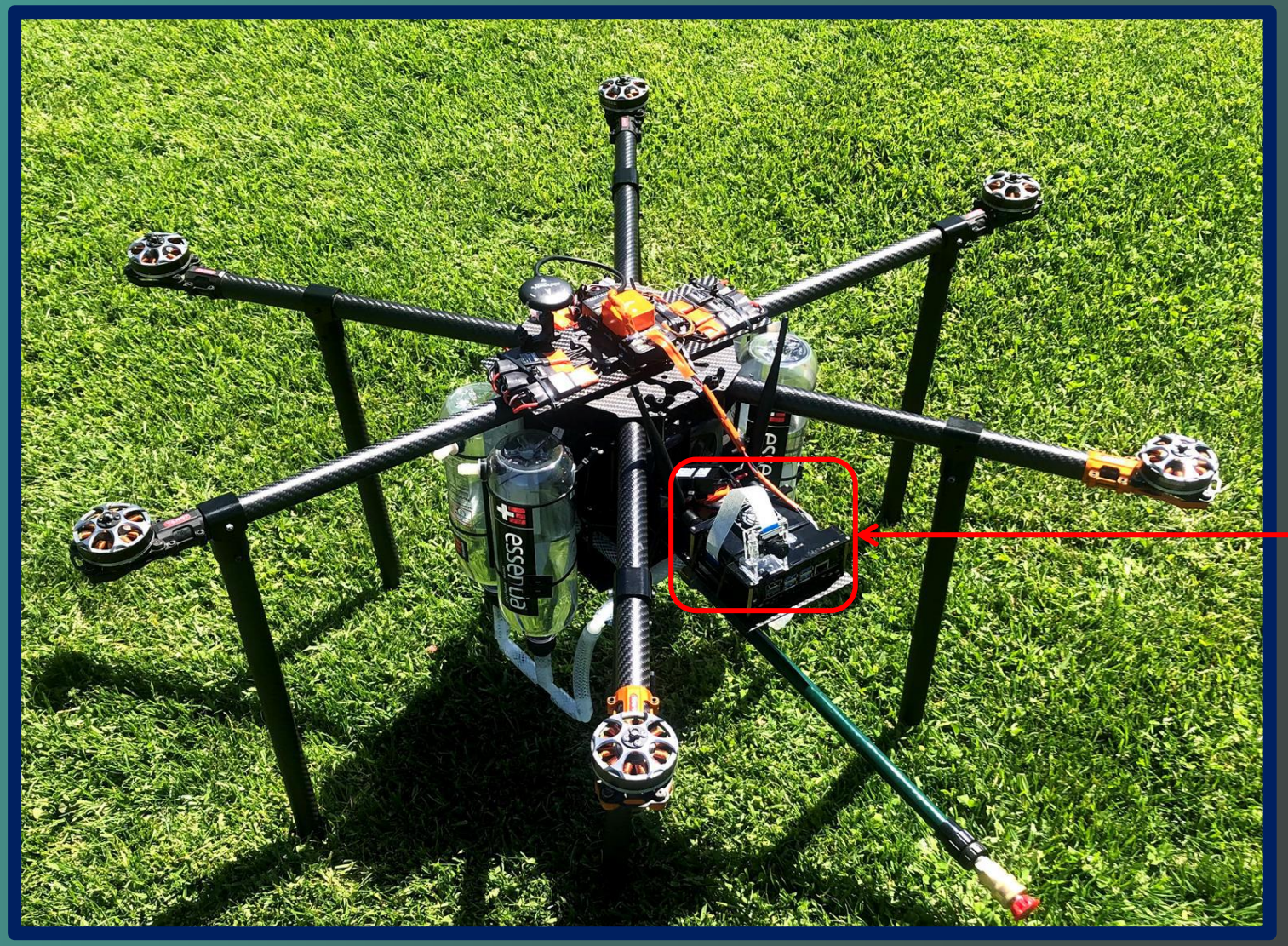
- Image processing
- Live video stream to App
- Rust detection on stream
- Drone control using Dronekit-Python
- Intel AC8265 Wireless NIC Module
  - WiFi Access Point for communication



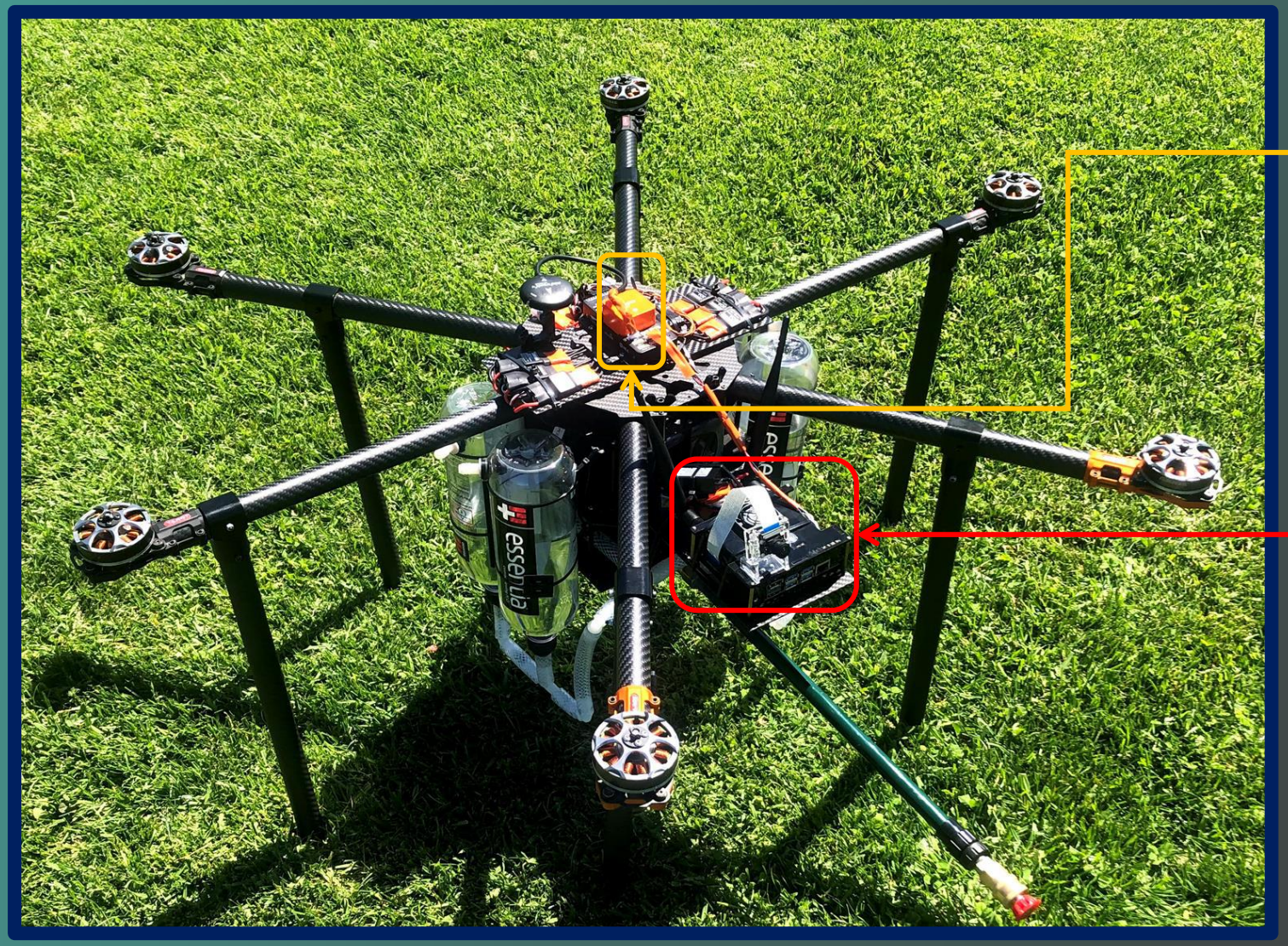
Drone Construction Initial

Drone Construction Final

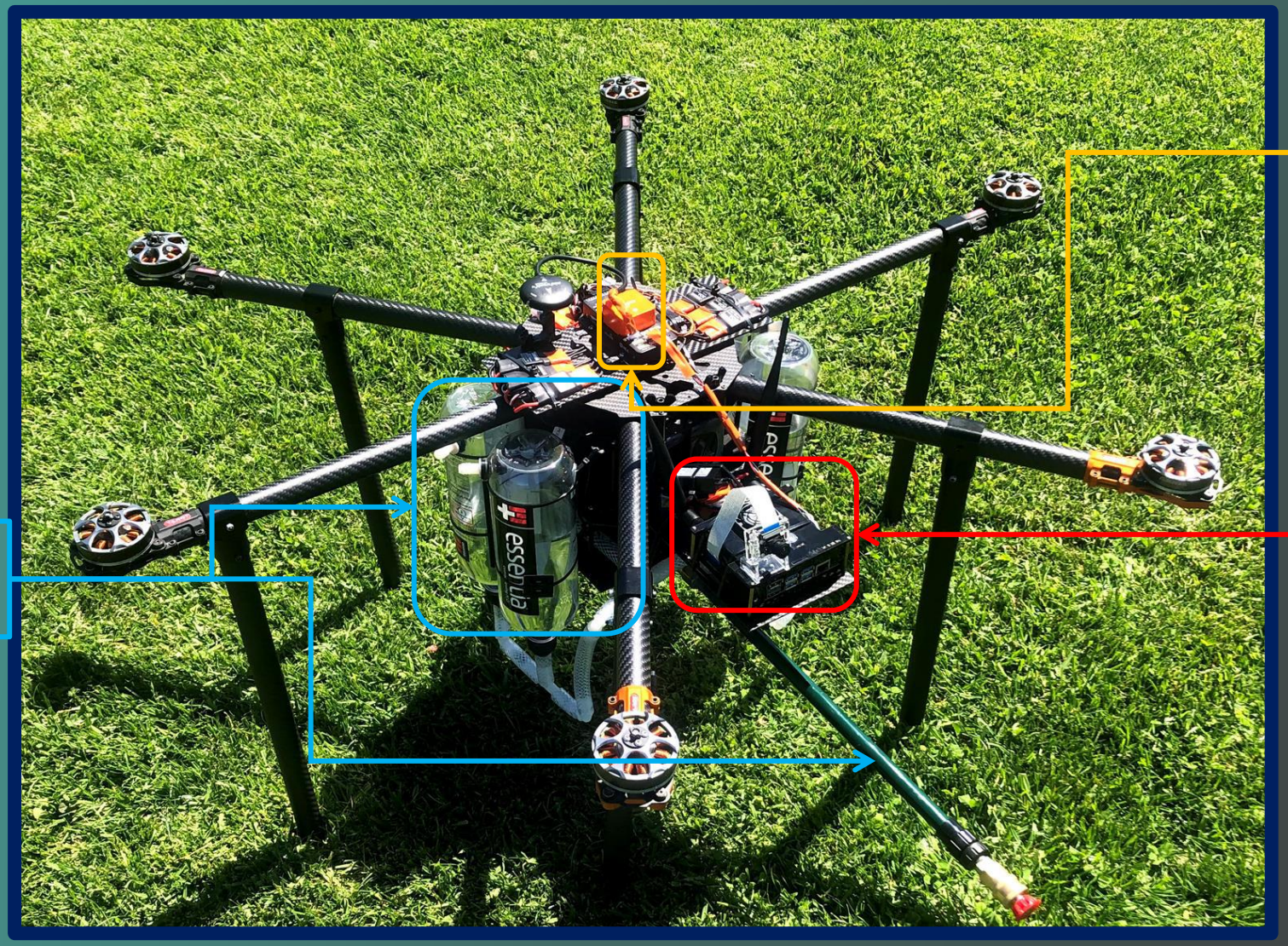
Drone Construction Final



Drone Construction Final



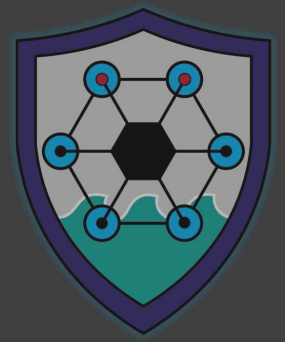
Drone Construction Final

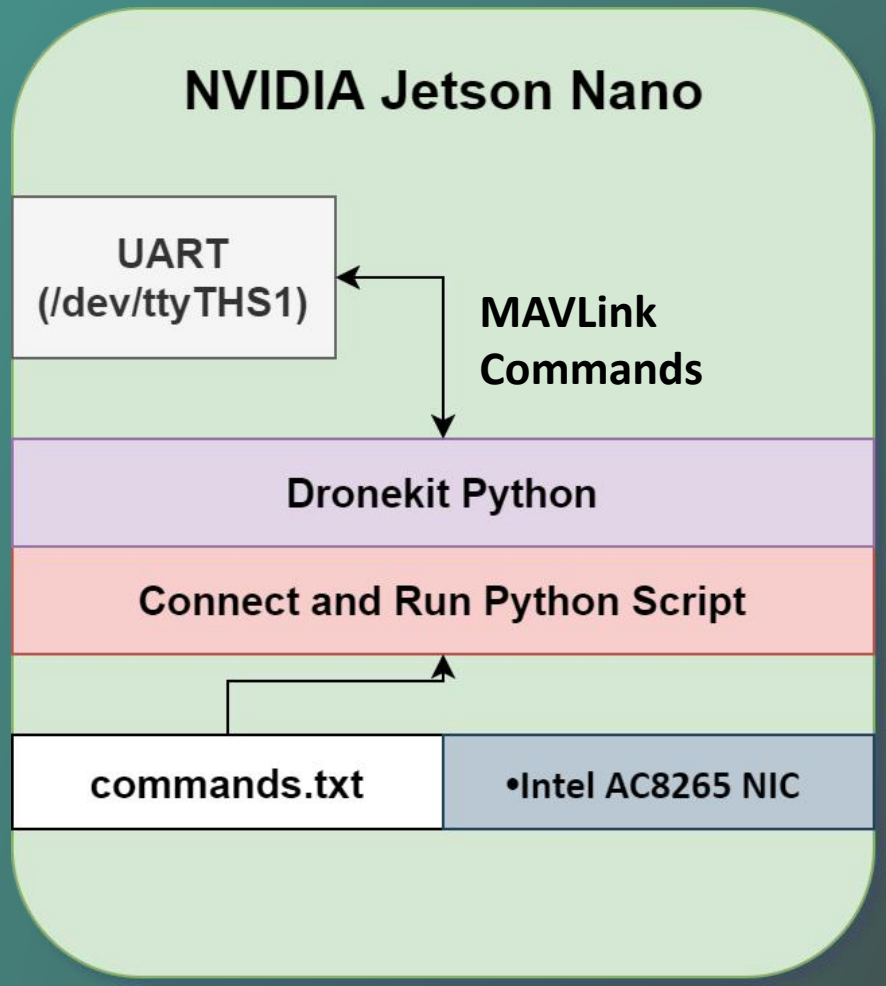


Control Flow

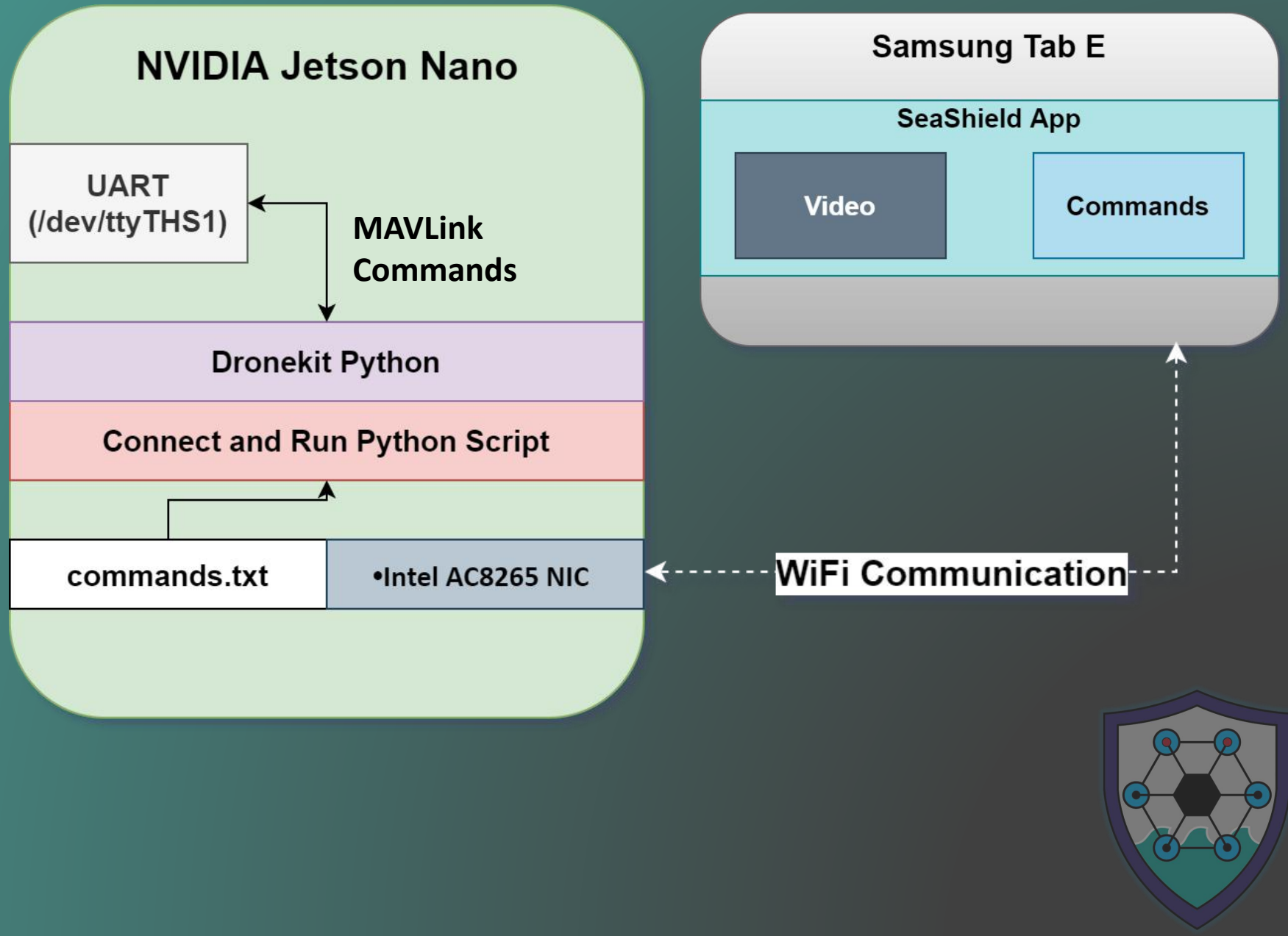
App Construction

- App built using Android Studio
- GStreamer library used to stream video from the Jetson Nano
- Java Secure Channel (JSch) used to connect App to Nano




NVIDIA Jetson Nano
UART
(/dev/ttyTHS1)
MAVLink
Commands
Dronekit Python
Connect and Run Python Script
commands.txt
•Intel AC8265 NIC


Samsung Tab E
SeaShield App
Video
Commands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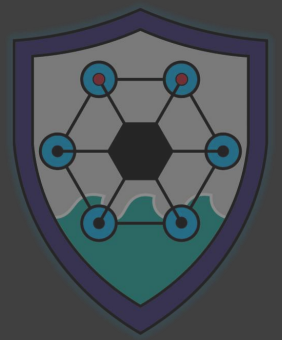
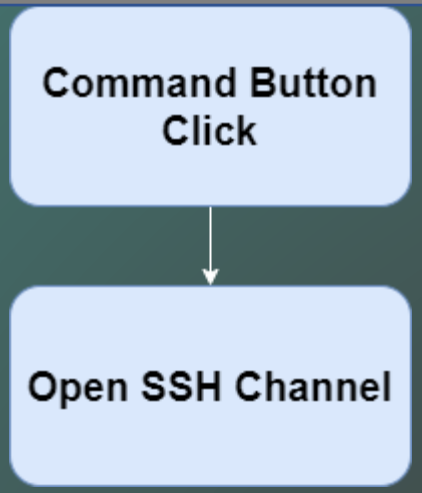
App Command

- On button click listener:



App Command

- On button click listener:
- Open SSH channel to Nano

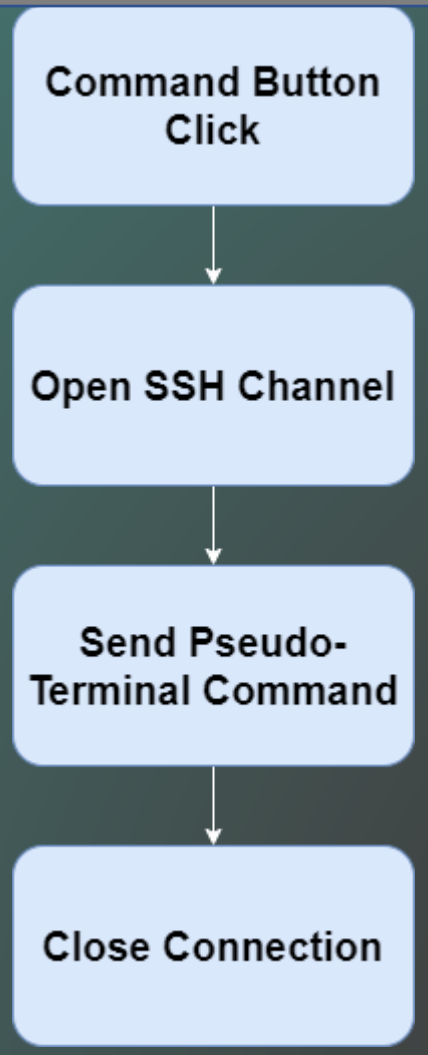


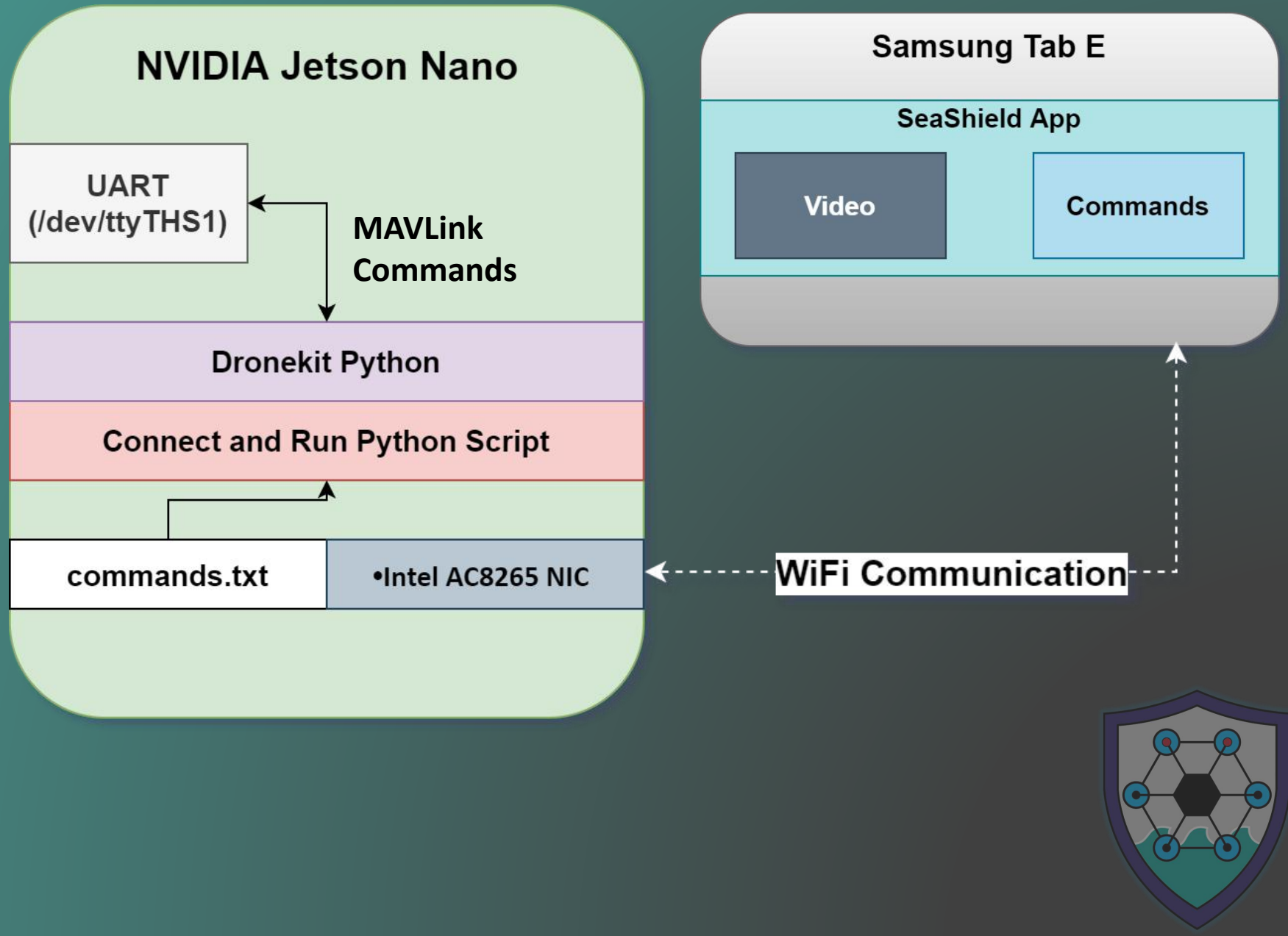
App Command

- On button click listener:
- Open SSH channel to Nano
- Send command

App Command

- com.jcraft.jsch.JSch
  (Java Secure Channel)
- On button click listener:
- Open SSH channel to Nano
- Send command
- Close channel

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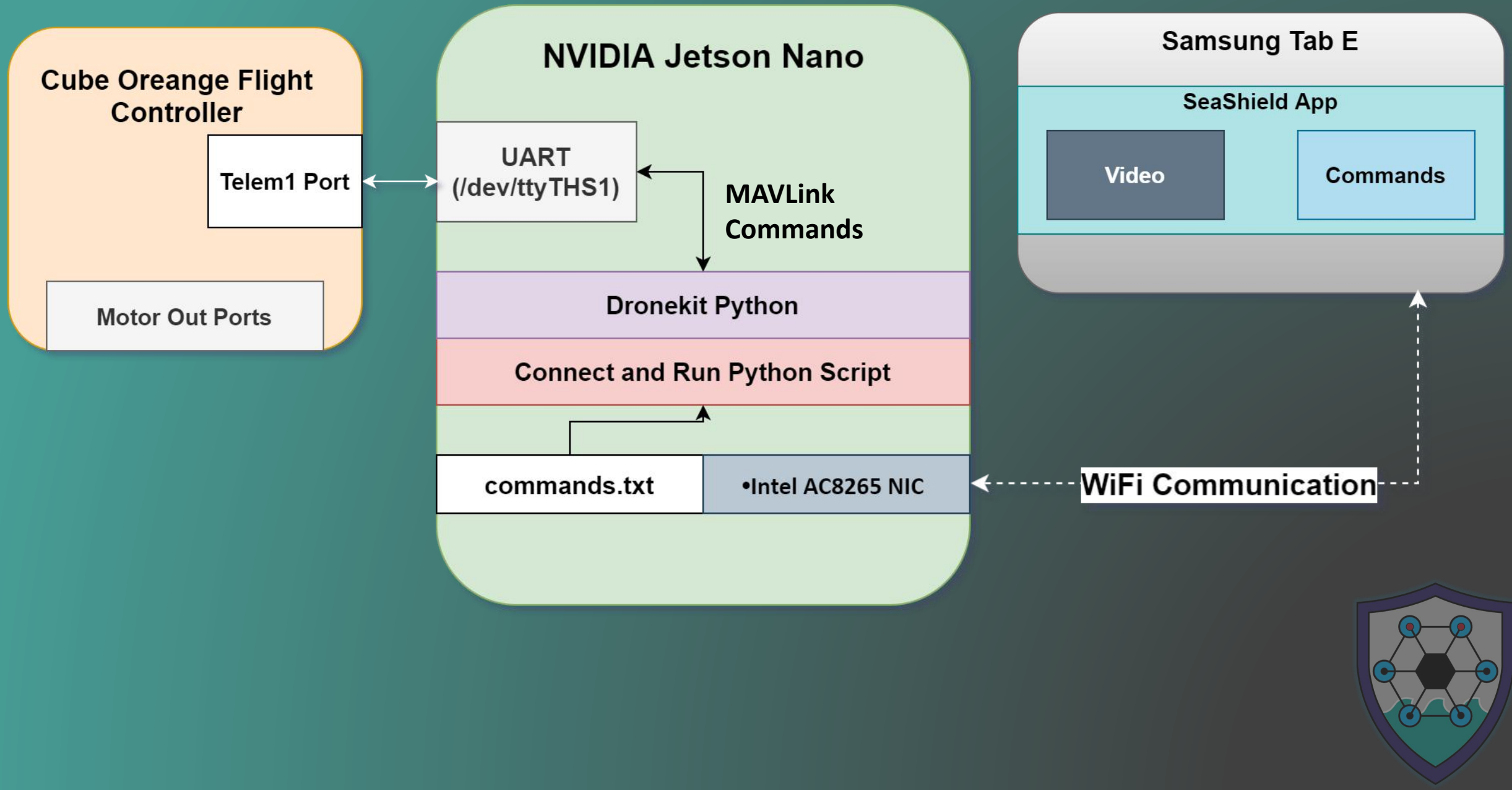
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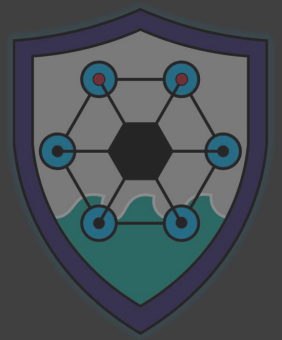
Python Script Control of Drone

- Open command file
- Read command, clear file
- Match command to instruction set
- Send instruction to drone
- Wait for instruction complete if applicable (Takeoff, land, return to launch)
- Update directional velocities and yaw
- Repeat

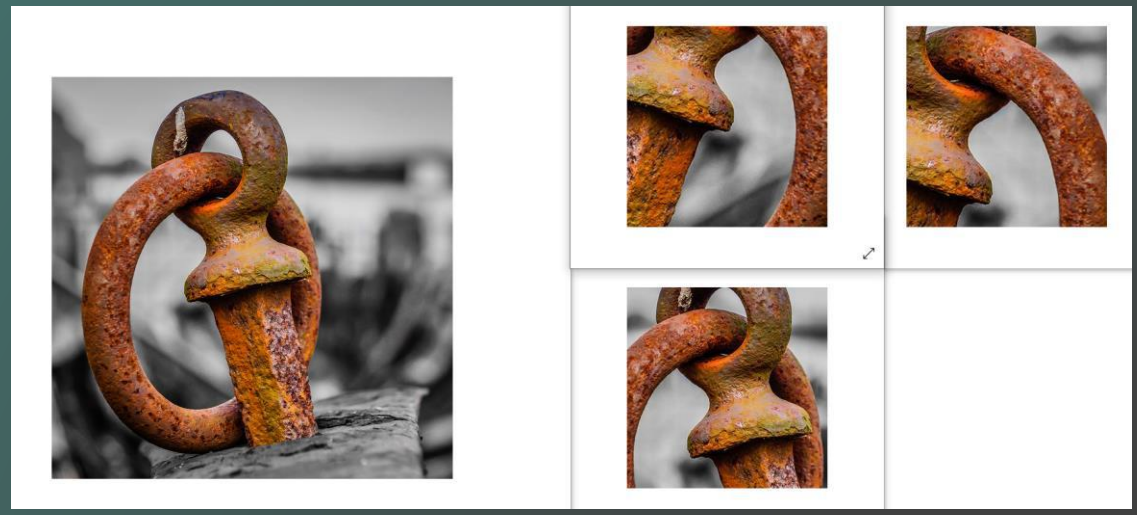


Rust Detection: YOLO Neural Network

- First algorithm used: pretrained YOLO (You Only Look Once)
- A regression-based neural network model
- Analyzes entire image and detects all objects of interest
- Model places box around objects in image

Rust Detection: Training YOLO

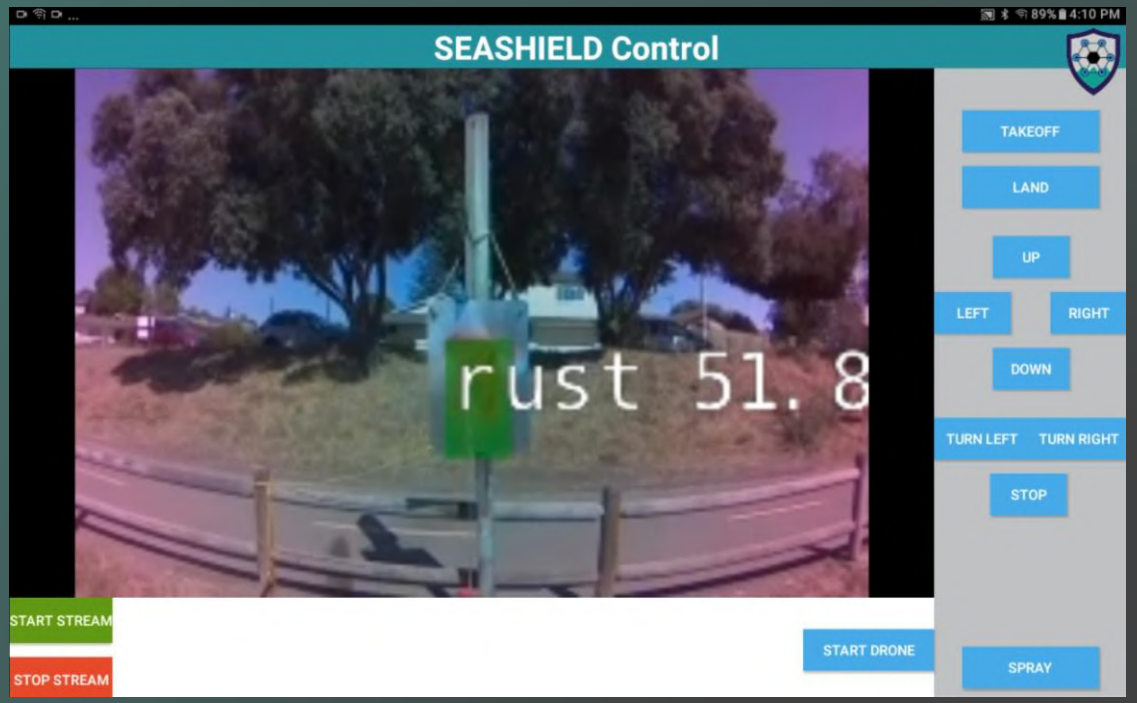
- Gathered image data of rusty boats
- Augmented the rust data and passed into the training network
- Training was unsuccessful
- Potential reasons:
  - Not enough images for training
  - Poor quality of acquired images



Augmentation Sample

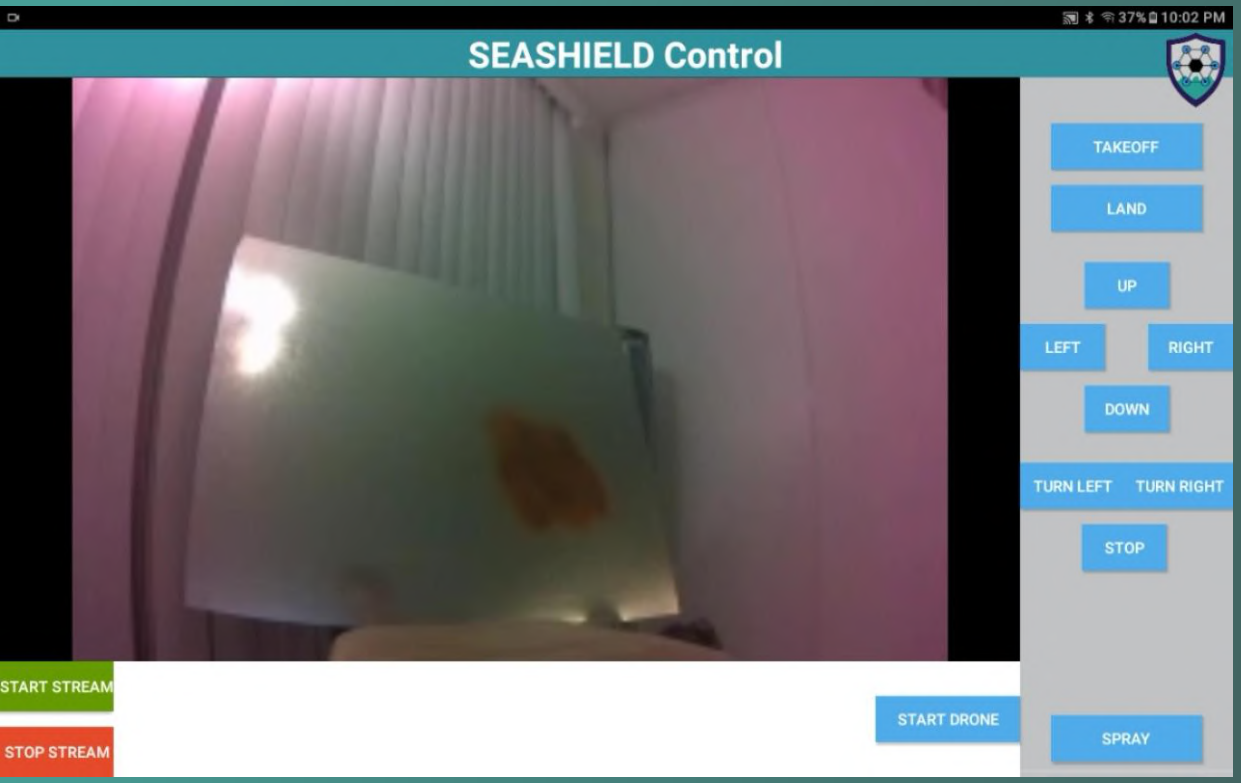
Image Detection Utilizing Jetson Nano

- Collected rust dataset
- Trained a model on the Jetson Nano
  - Utilizes PyTorch for image detection
- Runs model on the live camera feed
- Sends camera feed to our Android app
- Box Center coordinates sent to file

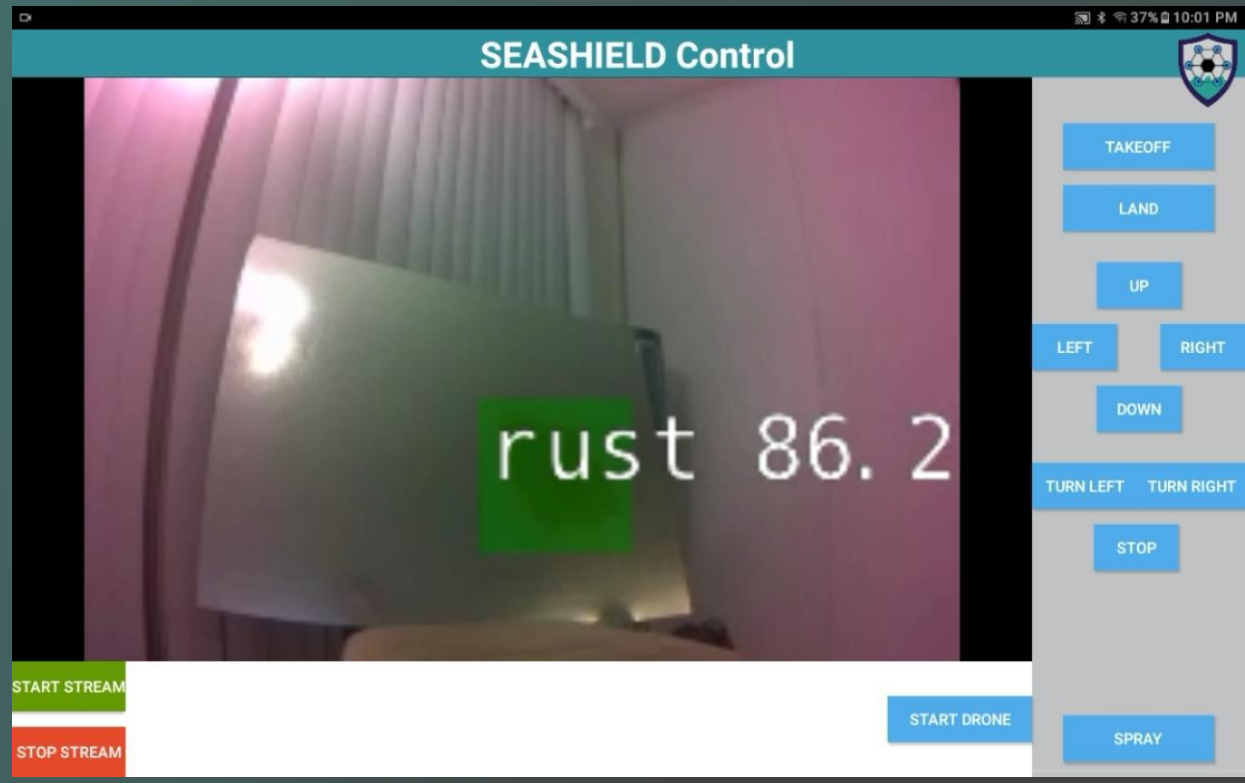


Video Stream to Apps

Without Rust Detection



With Rust Detection



Acknowledgements

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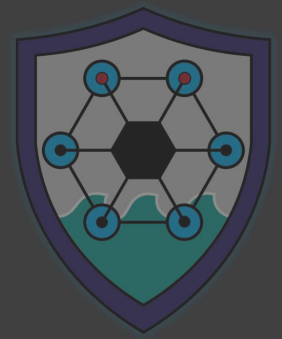
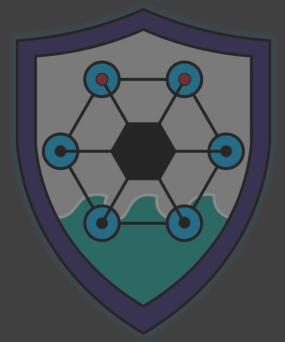
  - Professor Yogananda Isukapalli
  - Teaching Assistants Boning Dong and Trenton Rochelle
- **Naval Sea Systems Command**
  - Ramon Flores
  - Alan Jaeger
  - Armen Kvryan



Thank you for listening

Additional Information

- Project Website:
  - https://tinyurl.com/seashielducsb
- UCSB CE Capstone Website
  - https://web.ece.ucsb.edu/~yoga/capstone/



Questions?

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