Unmanned Surface Vessel

OUR TEAM

BARON YOUNG

WENJIN LI

DHRUV AGGARWAL

CAMERON BARRETT

MAXWELL JUNG

Contents

- Mission
- Technology
- Demo

Mission

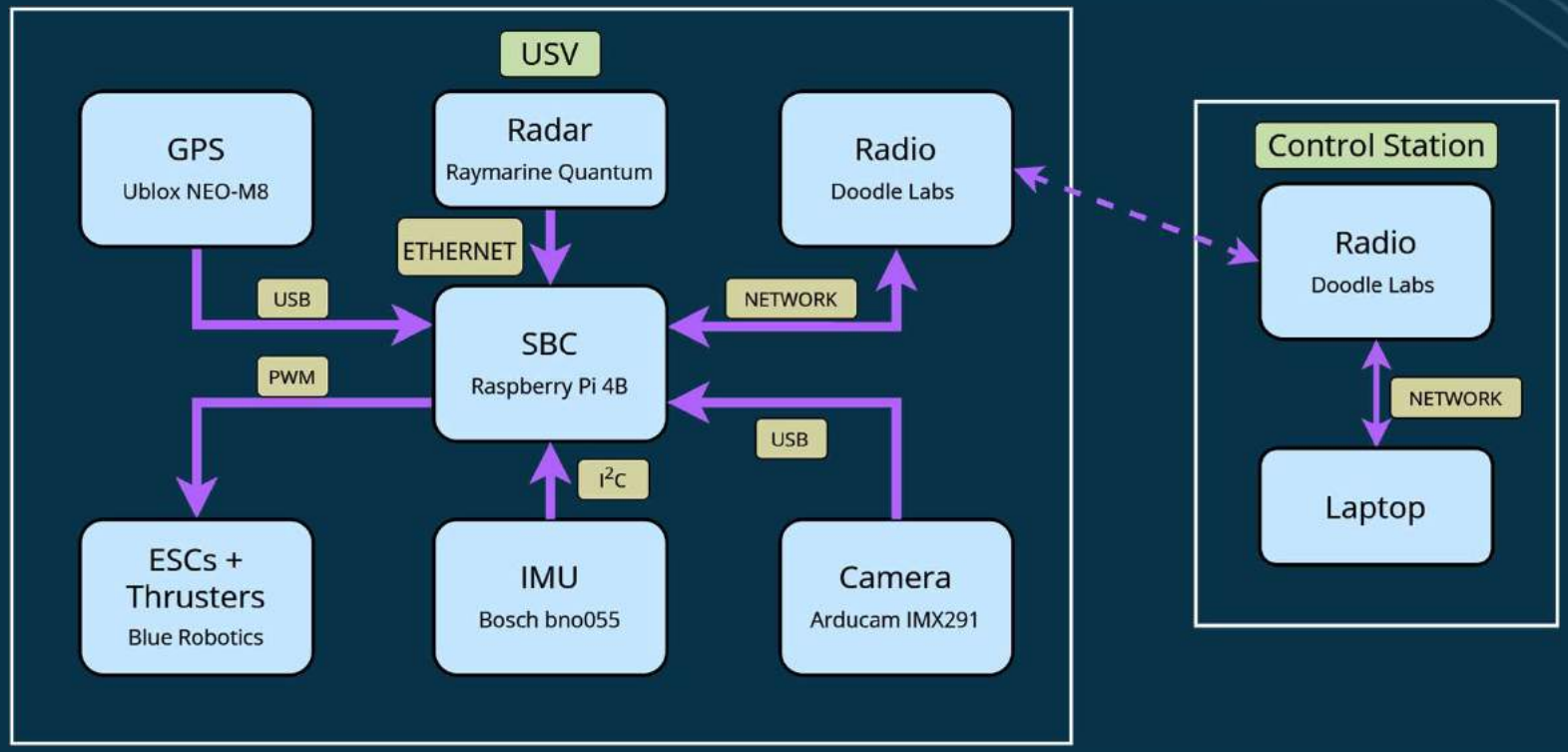
- Map and survey coastline with easily deployable unmanned surface vehicle

- Applications
  - Coastline erosion
  - Disaster preparedness/response
  - Maritime navigation
  - Military reconnaissance

Technology of Interest

- Radar based SLAM (Simultaneous Localization and Mapping)
  - Why radar?
    - Performs better in adverse weather conditions such as rain, fog, and snow.
    - Longer detection range (km)
    - Can penetrate through obstacles like dust, smoke, and foliage
    - Radar sensors are usually more robust and less sensitive to physical damage.
- Remote telemetry
  - Video
  - Coastal map

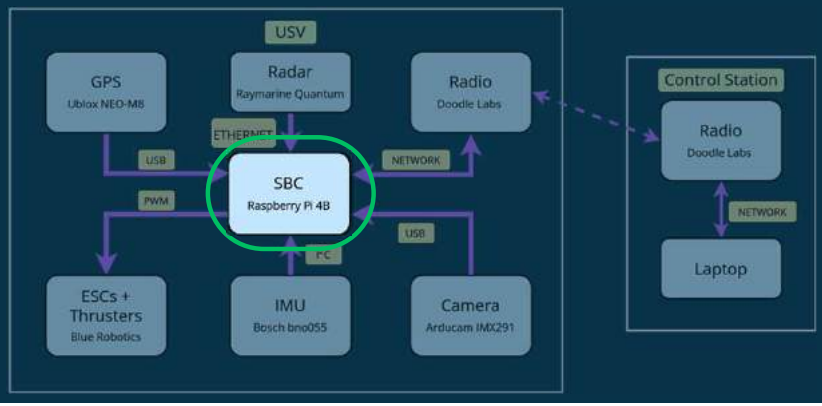
Block Diagram



SBC

RASPBERRY PI 4B

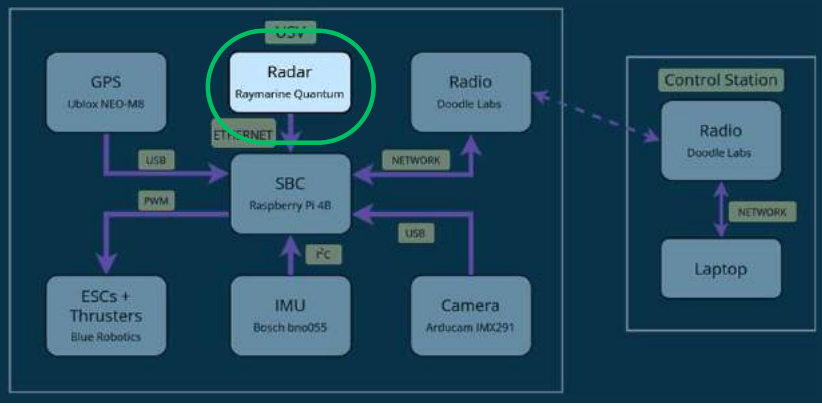
- Runs Ubuntu 22.04 LTS
  - controls hardware, processes data
  - Utilizes ROS2 DDS (data distribution service)
- GPIO
  - IMU
  - Thruster ESC
- Runs DHCP server
  - Used to assign radar IP



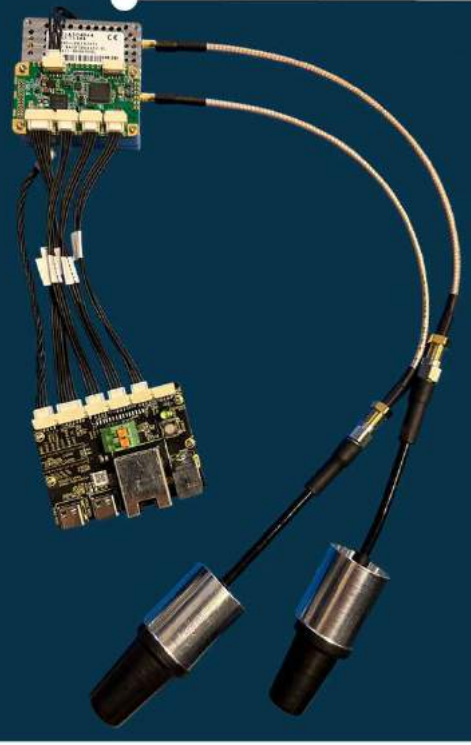
Radar

- Ethernet interface
  - send command over UDP unicast
  - receive data over UDP multicast
- 250 spokes per scan
- 20 zoom levels
  - max zoom = ~5m per pixel

QUANTUM Q24C RADAR

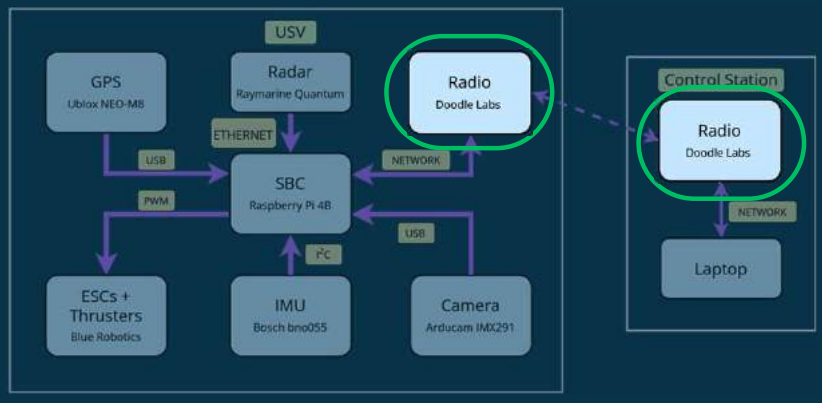


Radio

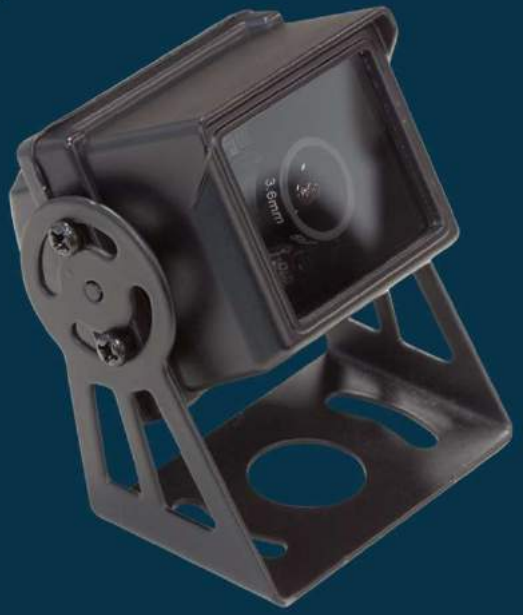


DL RM2450 MESH RADIO

- USB-C / Ethernet Connection
- Using DL Eval kit with ANT-2450-3-O
- Duplex data stream
- 2.4 GHz Band
- Range ~10km with 100 Mbps data rate
- Testing in urban environment successful at ~2km until loss of the LOS

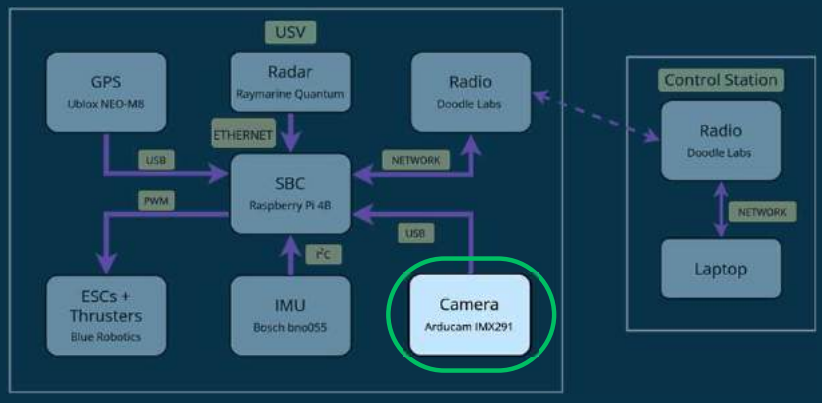


Camera

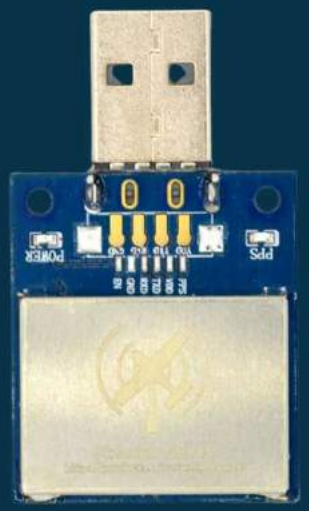


ARDUCAM 1080P

- Connects via USB
- 120° Wide Angle
- IP67 Certified

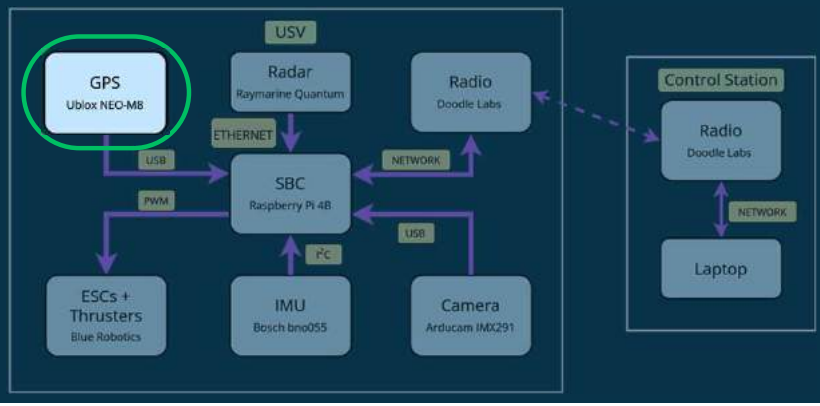


GPS

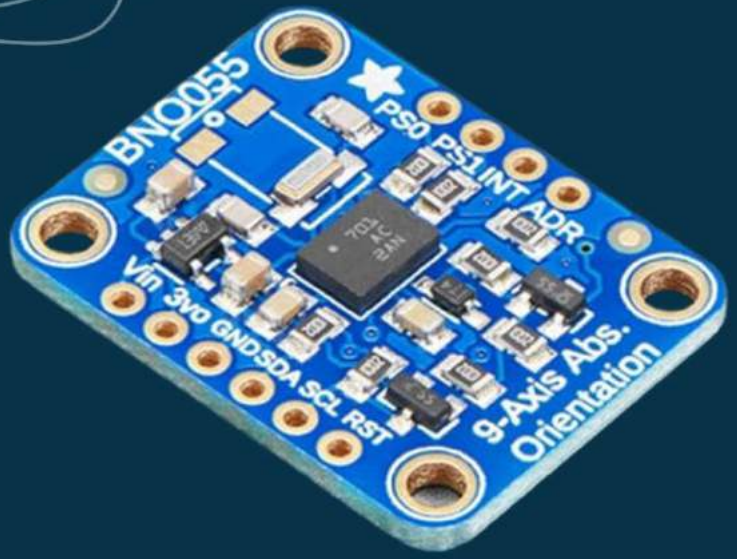


- Simple USB Connection
- 2 - 2.5m accuracy
- Attached antenna Requires Line of Sight (LOS)
- Used for ground truth position

NEO-M8 GPS

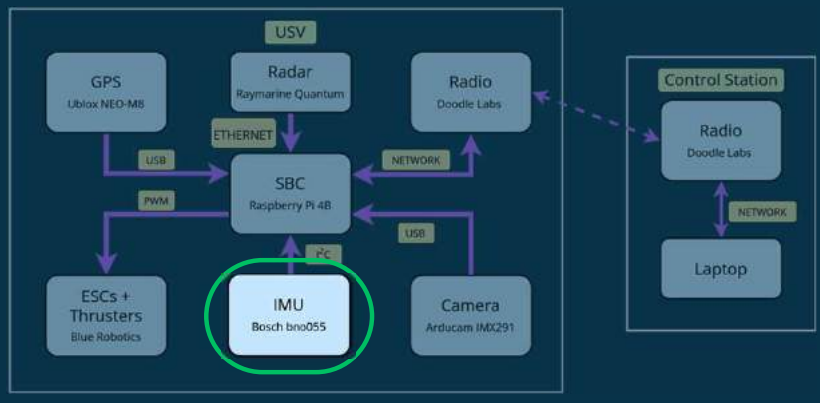


IMU

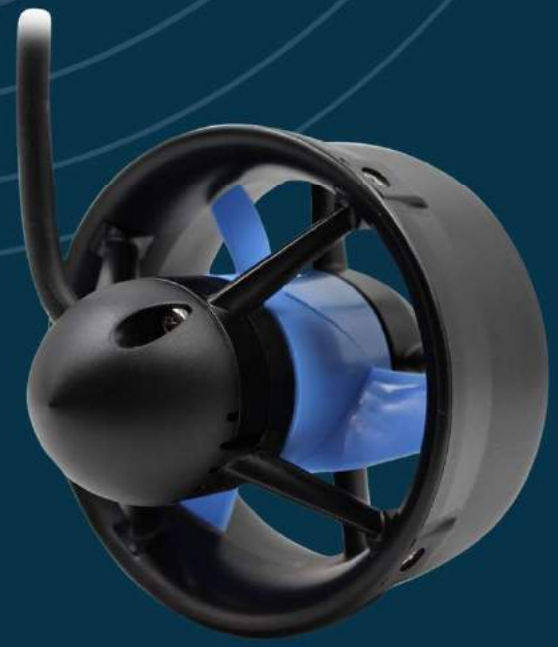


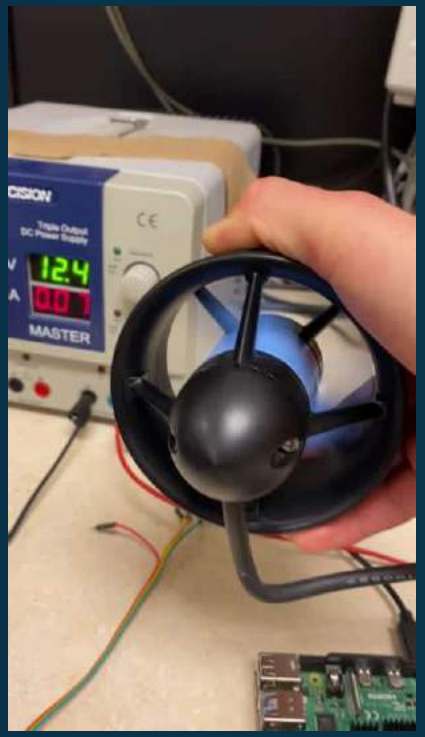
- 9 DOF
- Three axis of 'rotation speed' (rad/s)
- Three axis of acceleration (gravity + linear motion m/s^2)
- Communicate via I2C
- Used to estimate orientation

BNO055 IMU

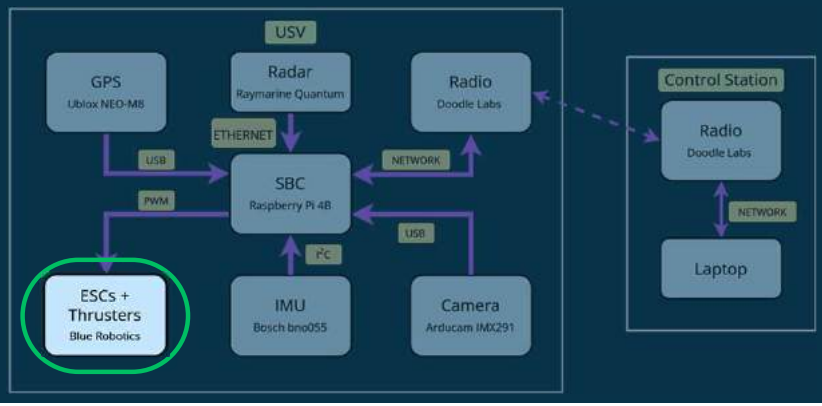


Thrusters





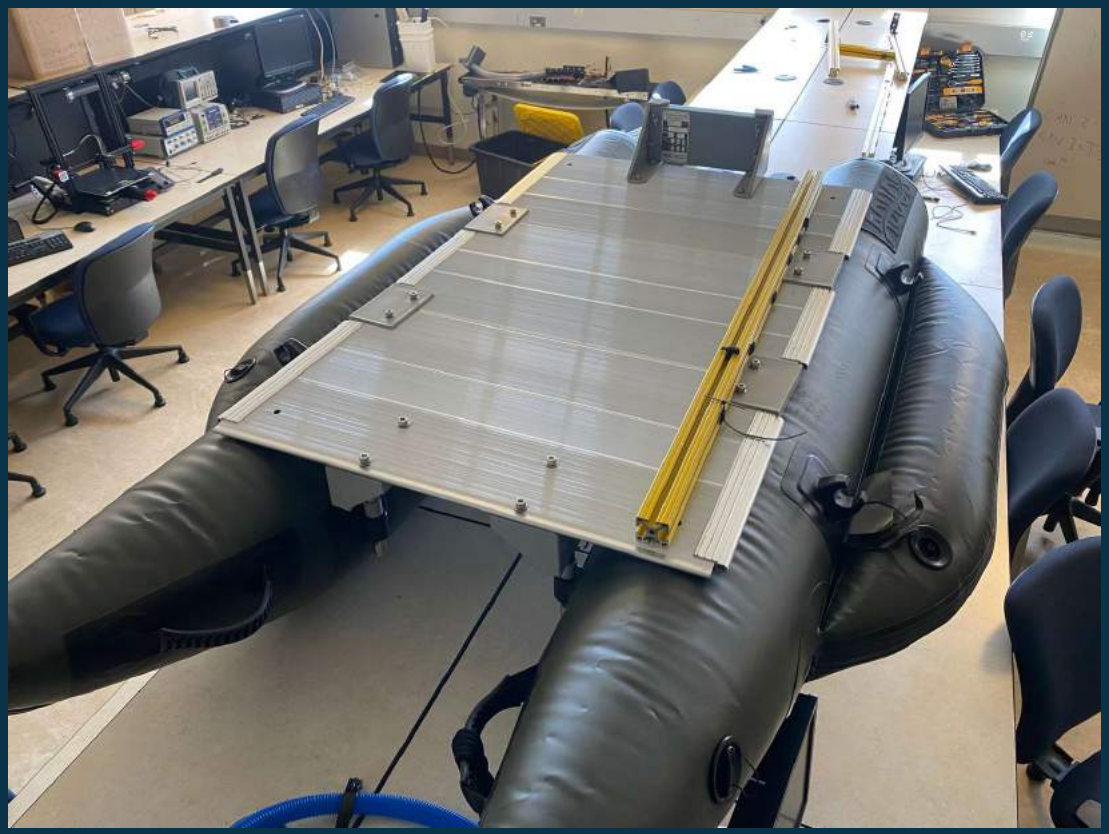
- Blue Robotics T200 Thruster
  - 2x counter-rotating
  - 17 lb f total thrust
  - Nominal power: 200W
    - 17A @ 12V



Power

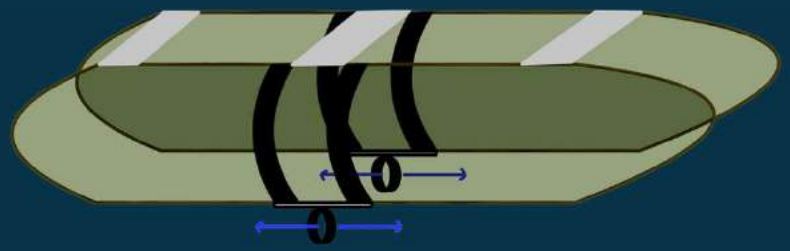
- Batteries
  - 2x 22.2V LiPo (bucked to 12V)
  - 14.8V LiPo (bucked to 5V)
- 12V rail
  - Thrusters
  - Radar
- 5V rail
  - Raspberry Pi
  - Camera
  - Radio

Boat



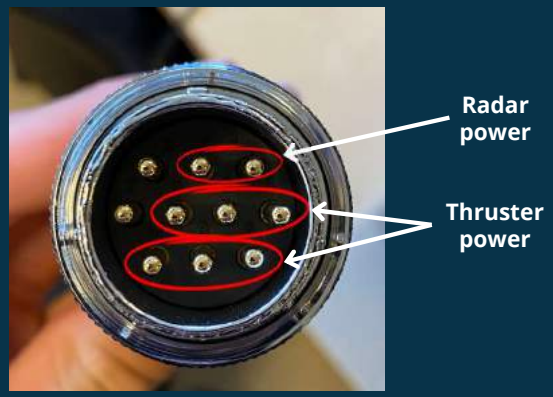
Assembly

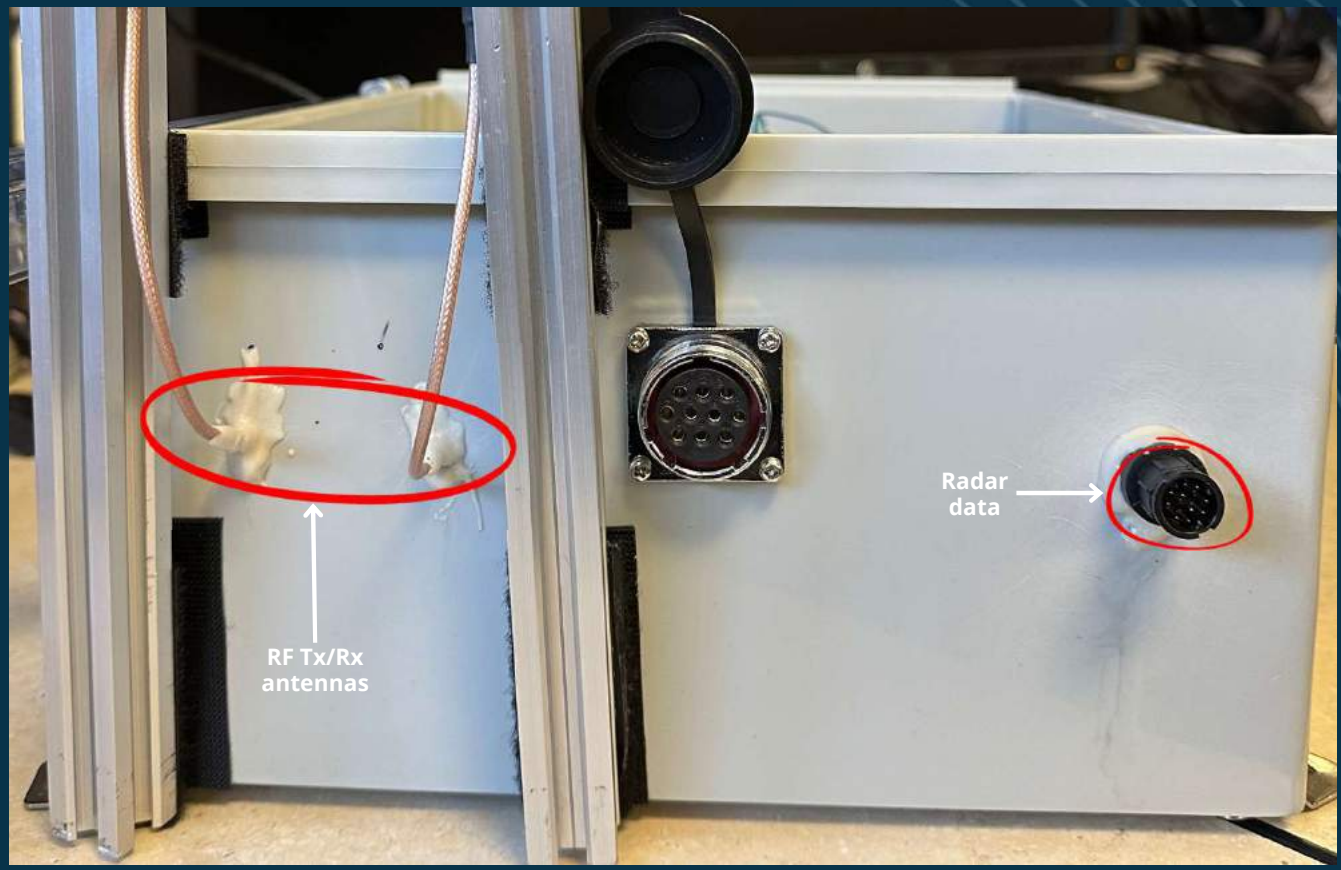
- Construct radar mount
- Construct thruster mounts



Assembly

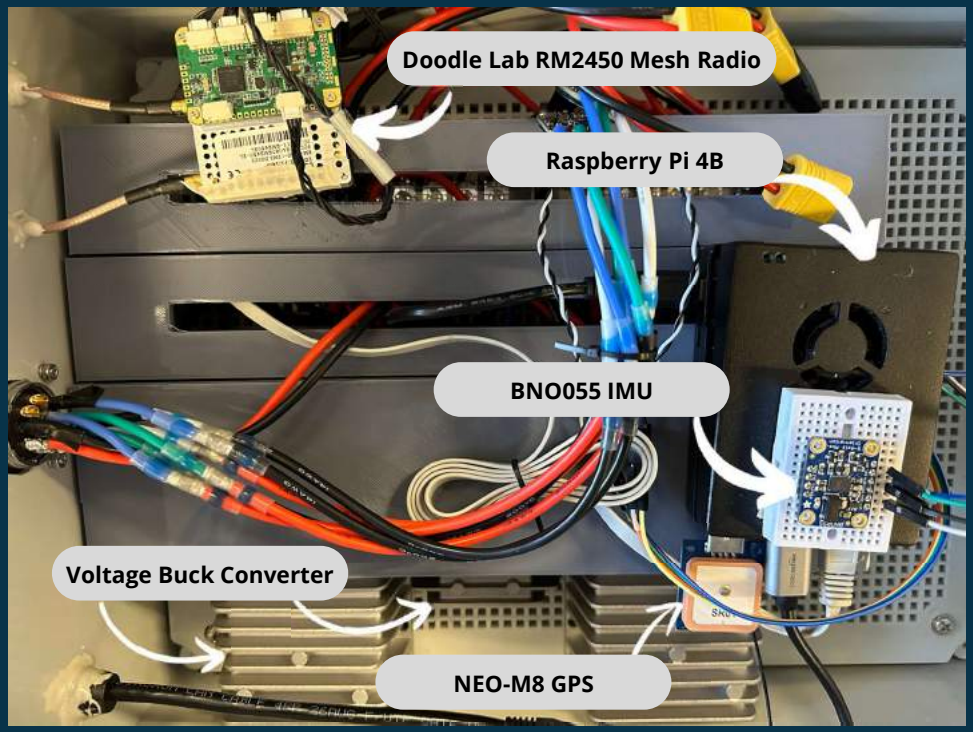
- Electronics enclosure
- Waterproofing I/O

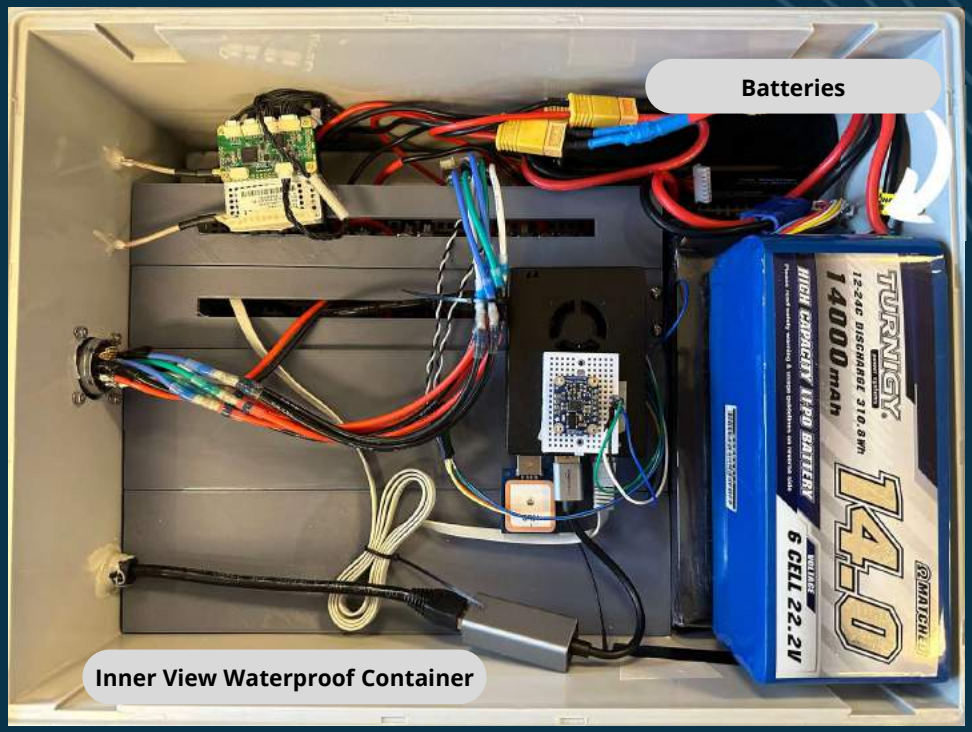




Assembly

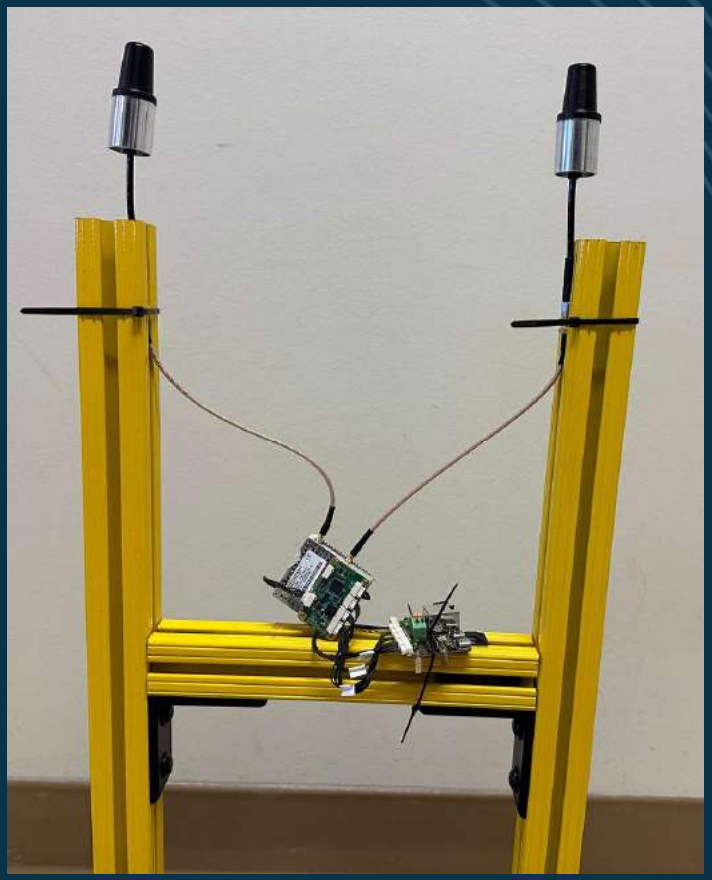
- Wire power rails
- Connect SBC to peripherals



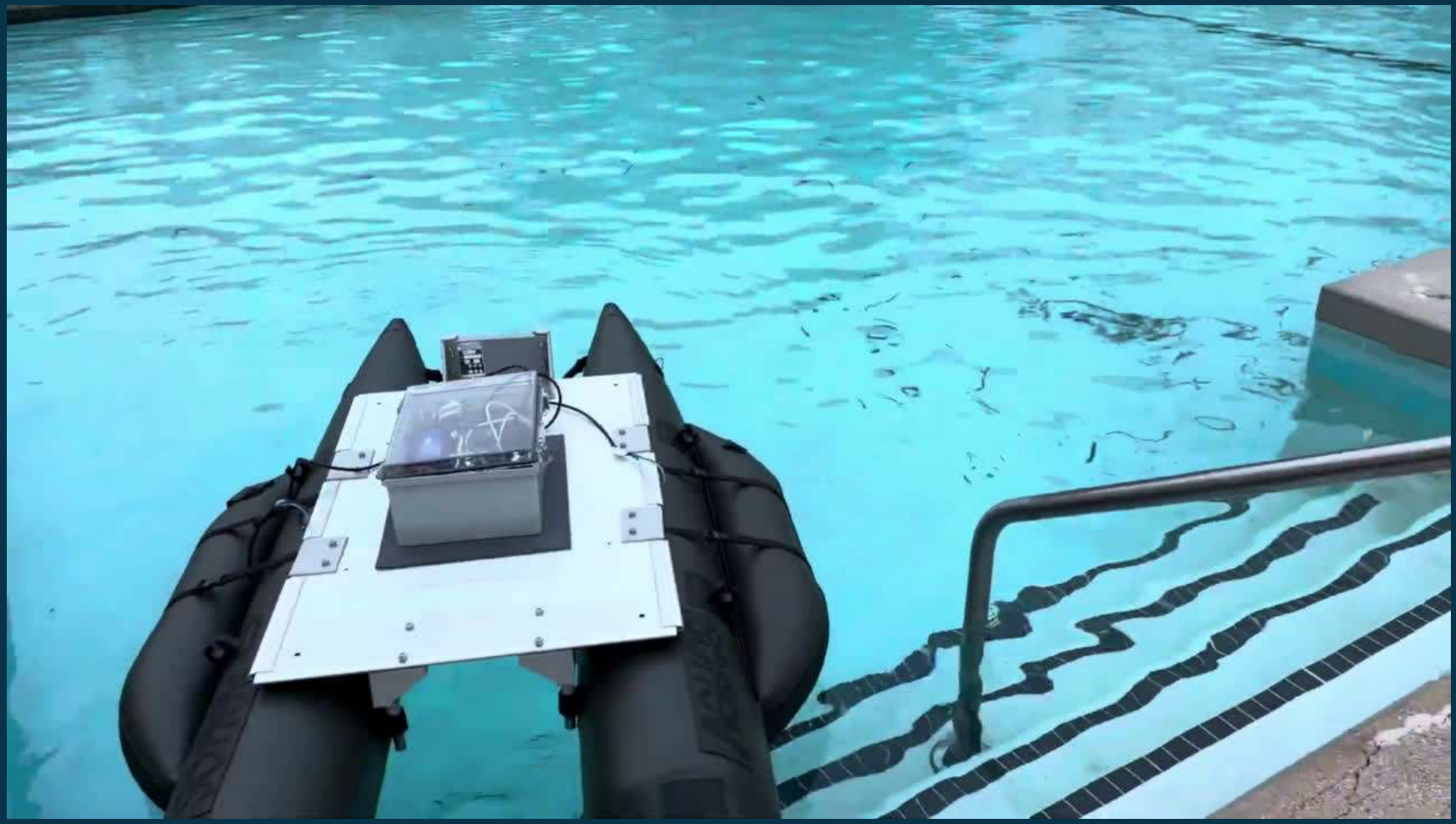


Assembly

- Final product



Thruster Control & Radio Test



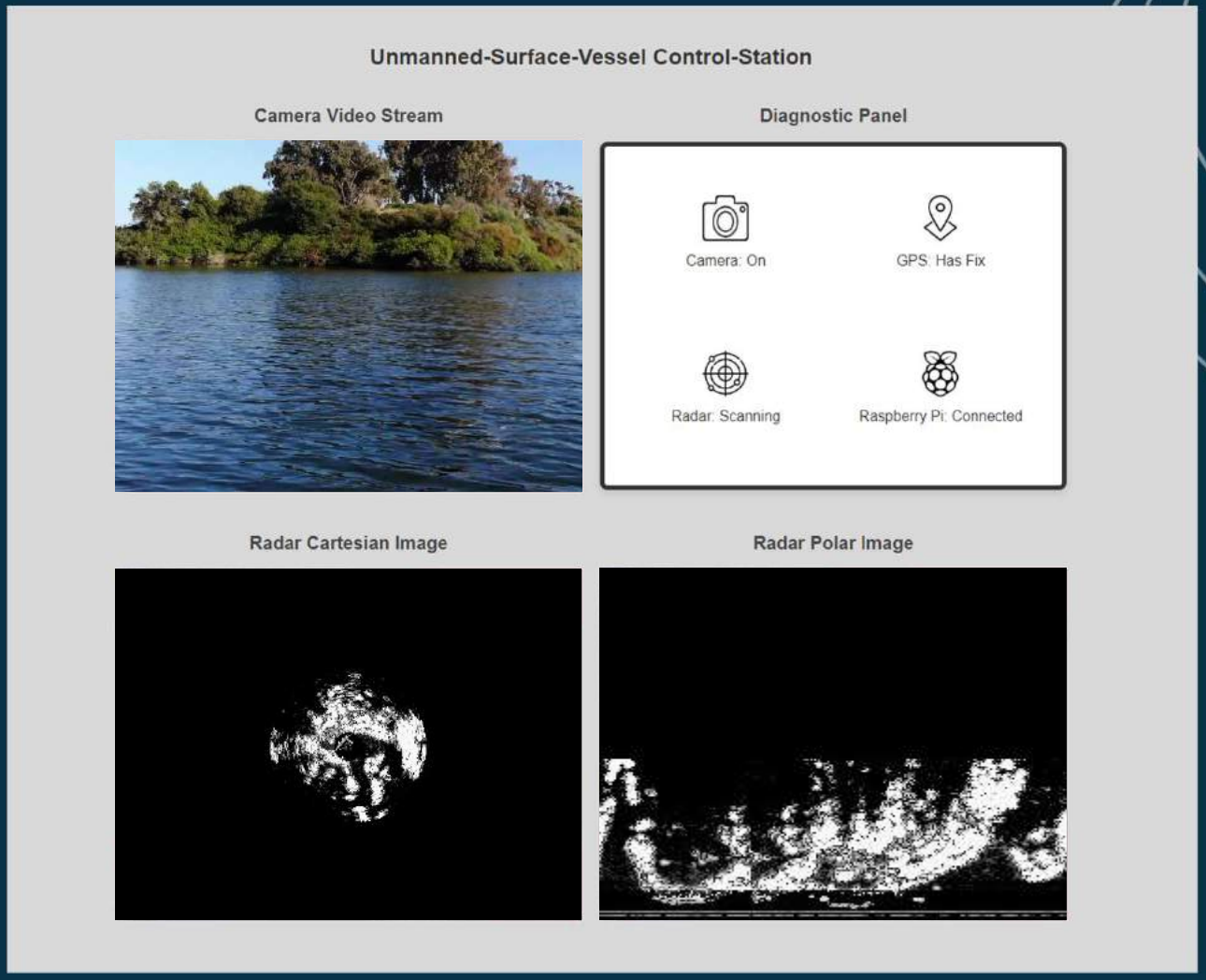
USV Design

- Fully Assembled

- Radar and GPS antenna

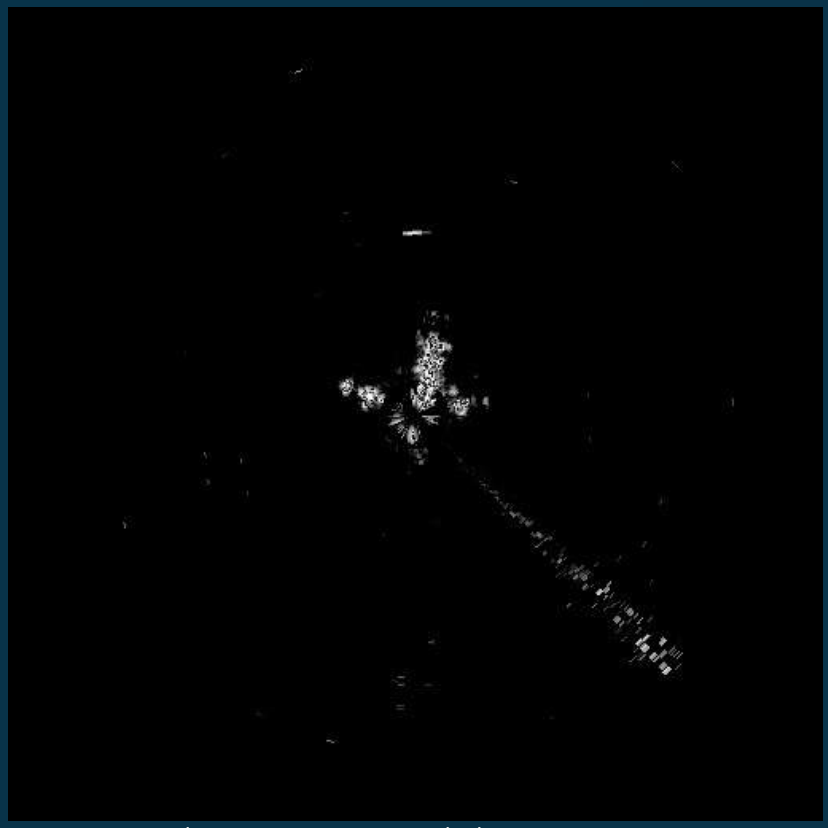
Raymarine

Control Station



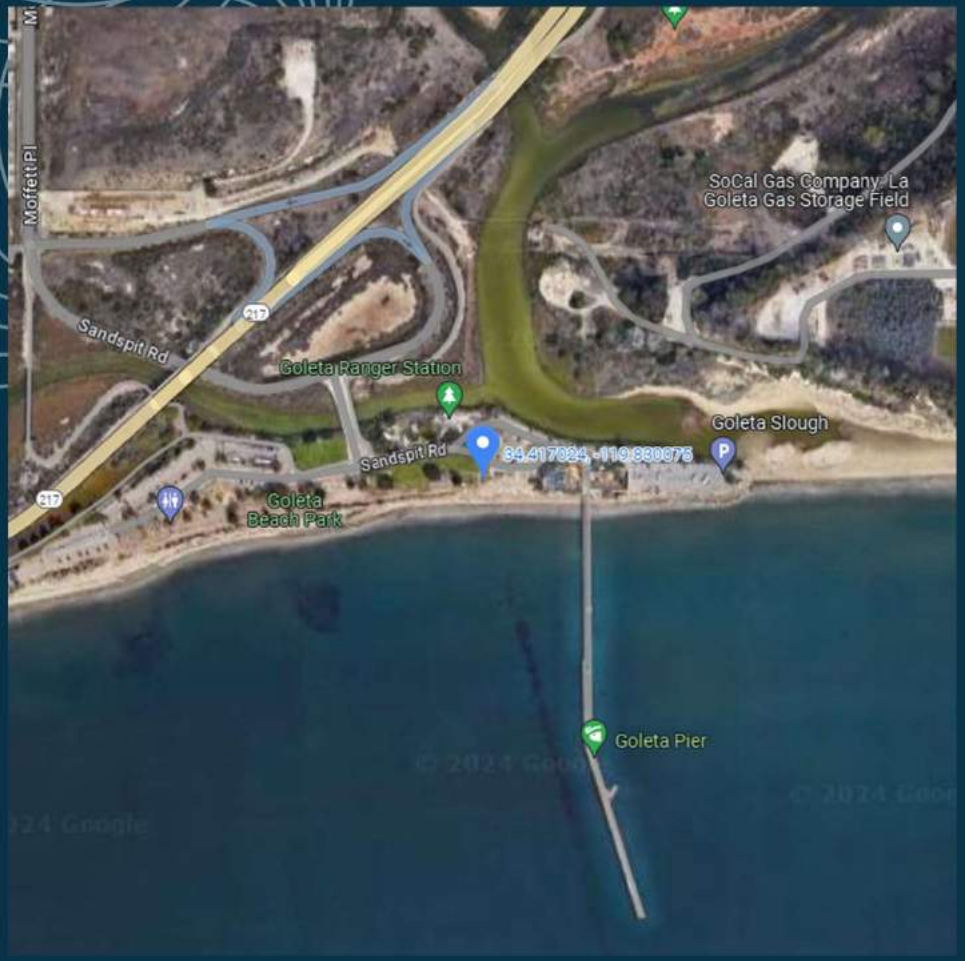
Radar Scan

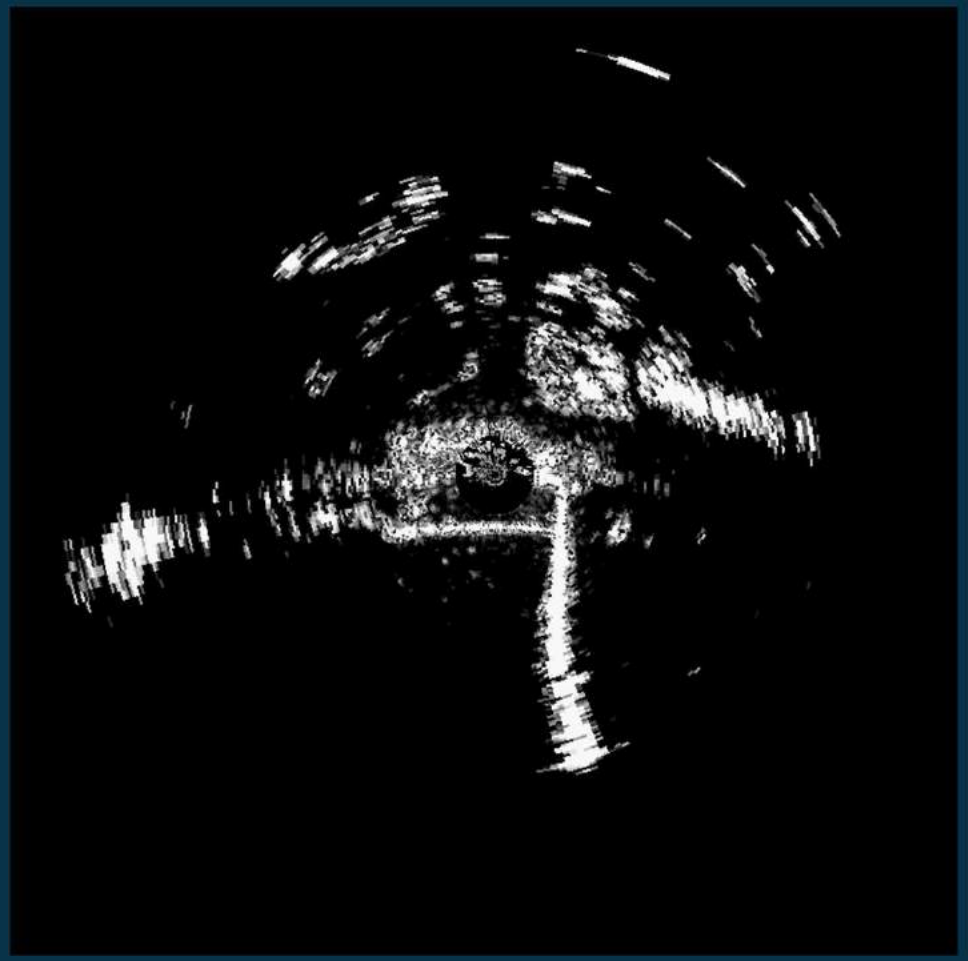
Radar scan in CE lab (polar)



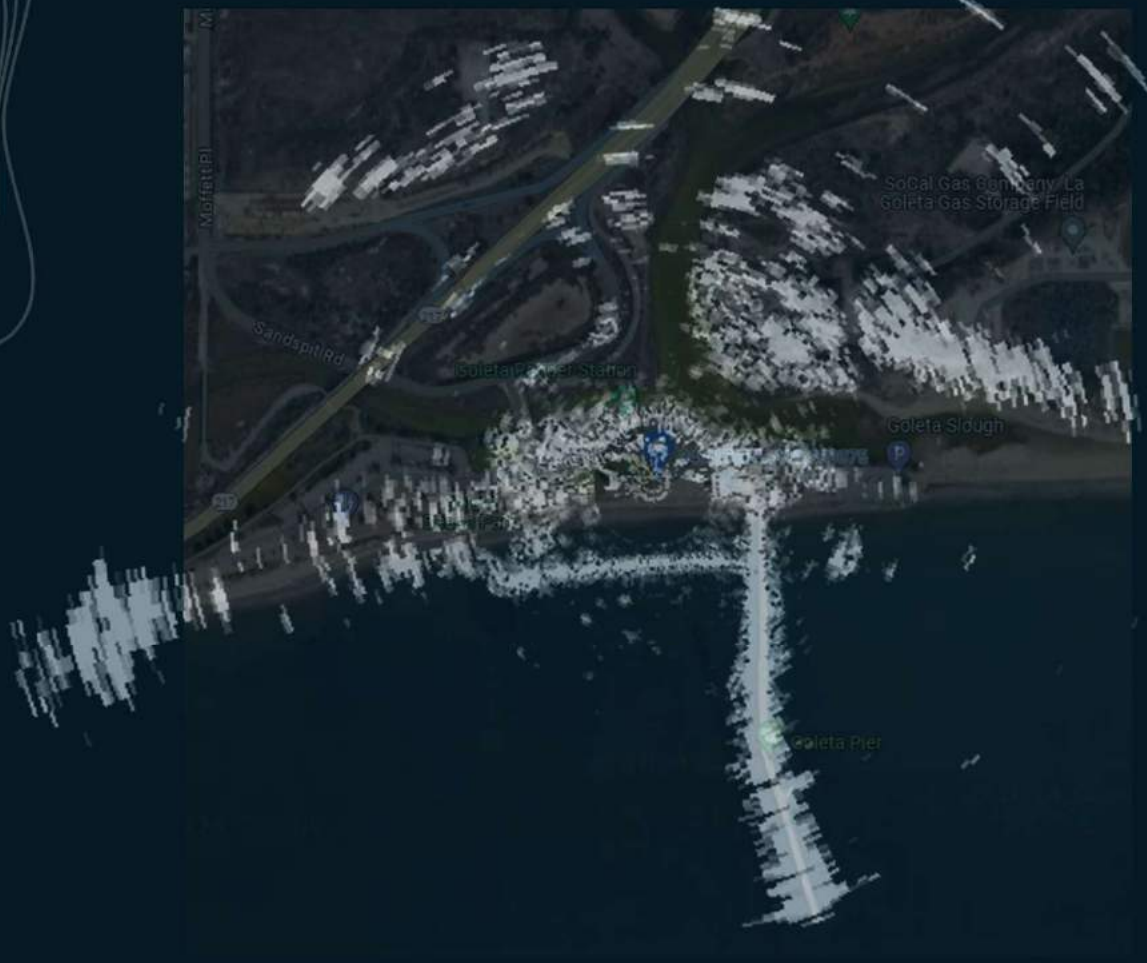
Radar scan in CE lab (cartesian)

Goleta Beach Park Radar Scan



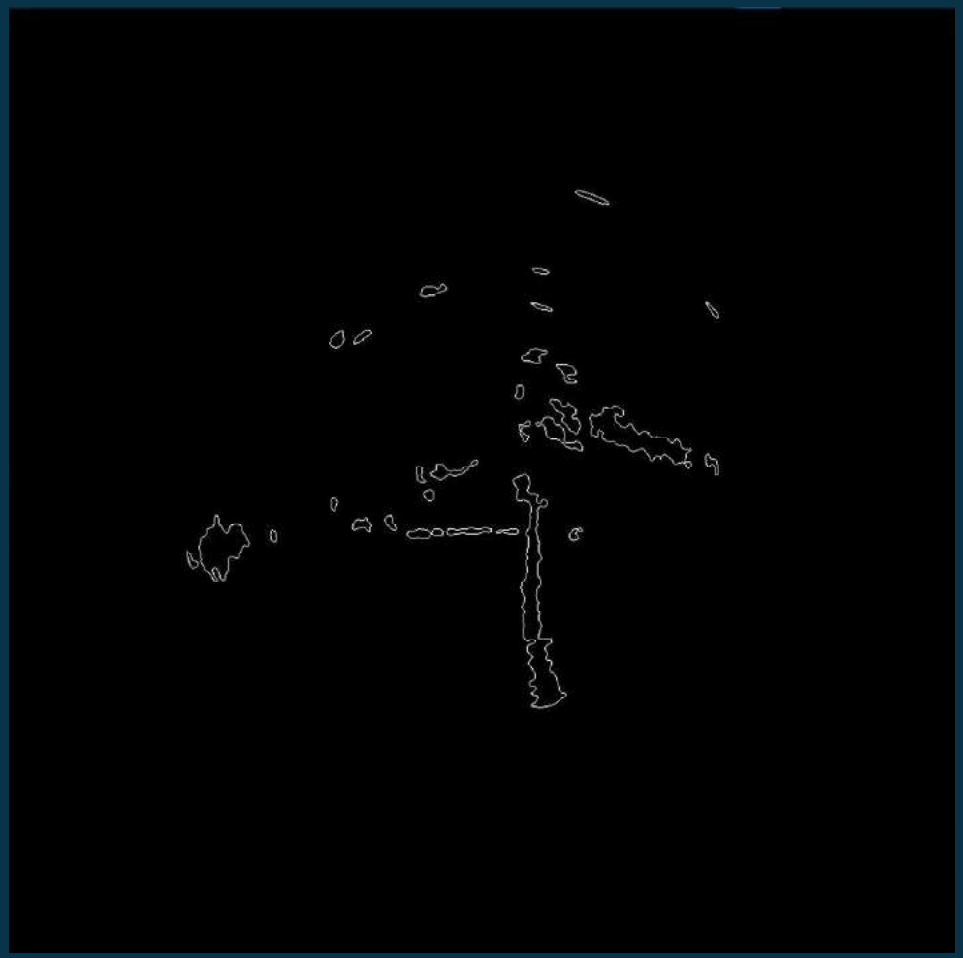


Goleta Beach Park Radar Scan



Radar Image Filtering

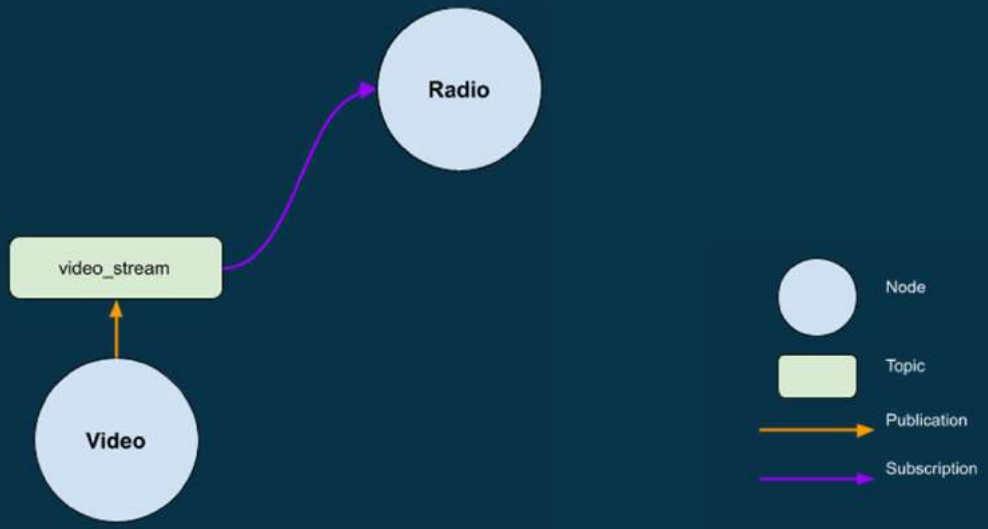
Morphological + Bilateral Filter



Thresholding + Contour

ROS Graph

ROS Graph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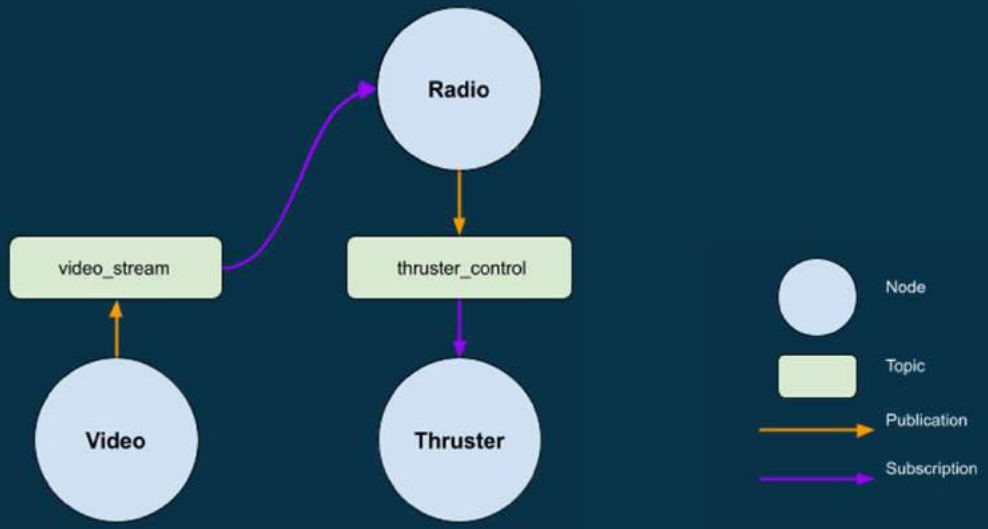
Topic
Publication
Subscription

ROS Graph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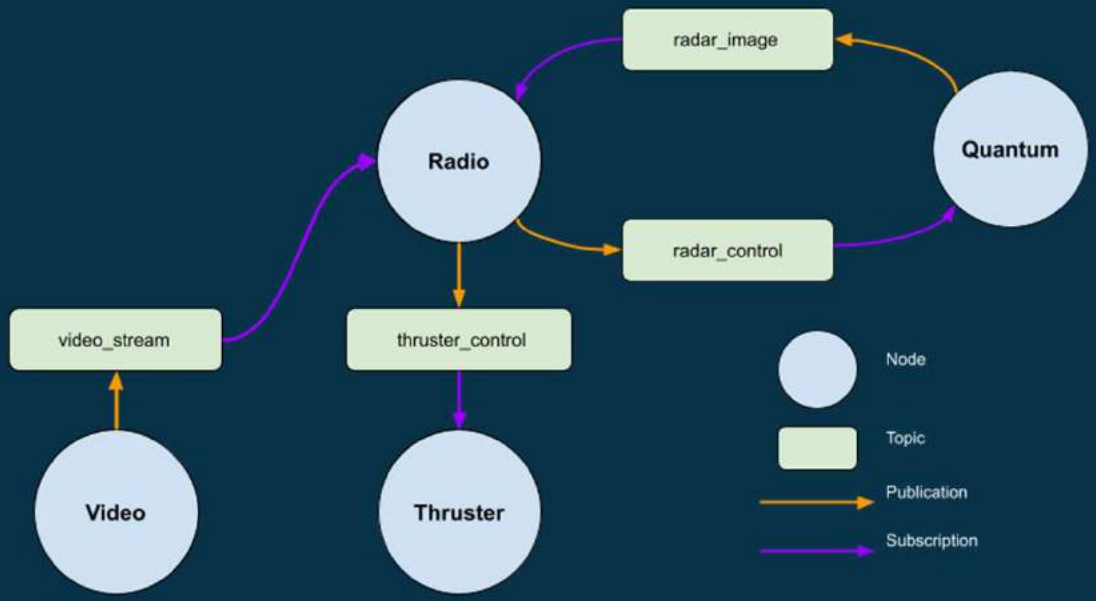
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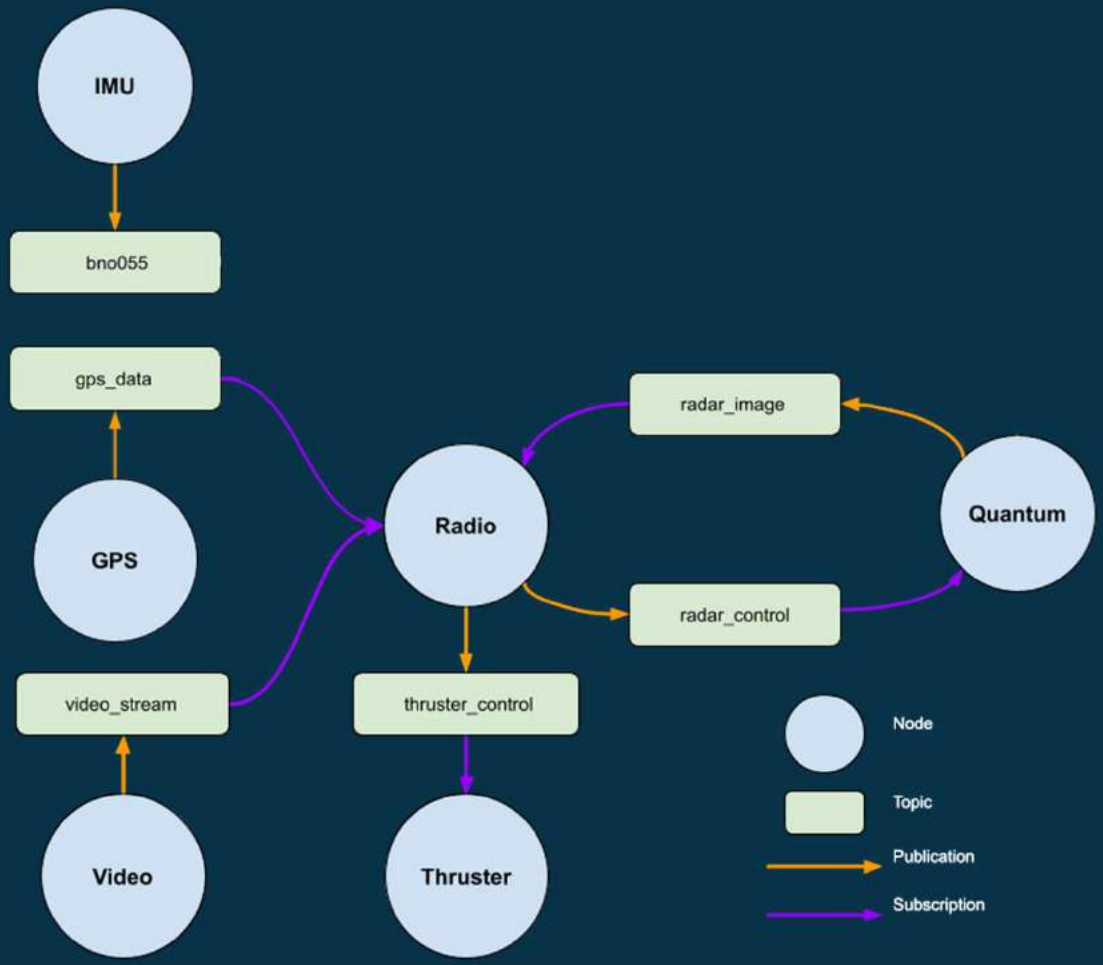
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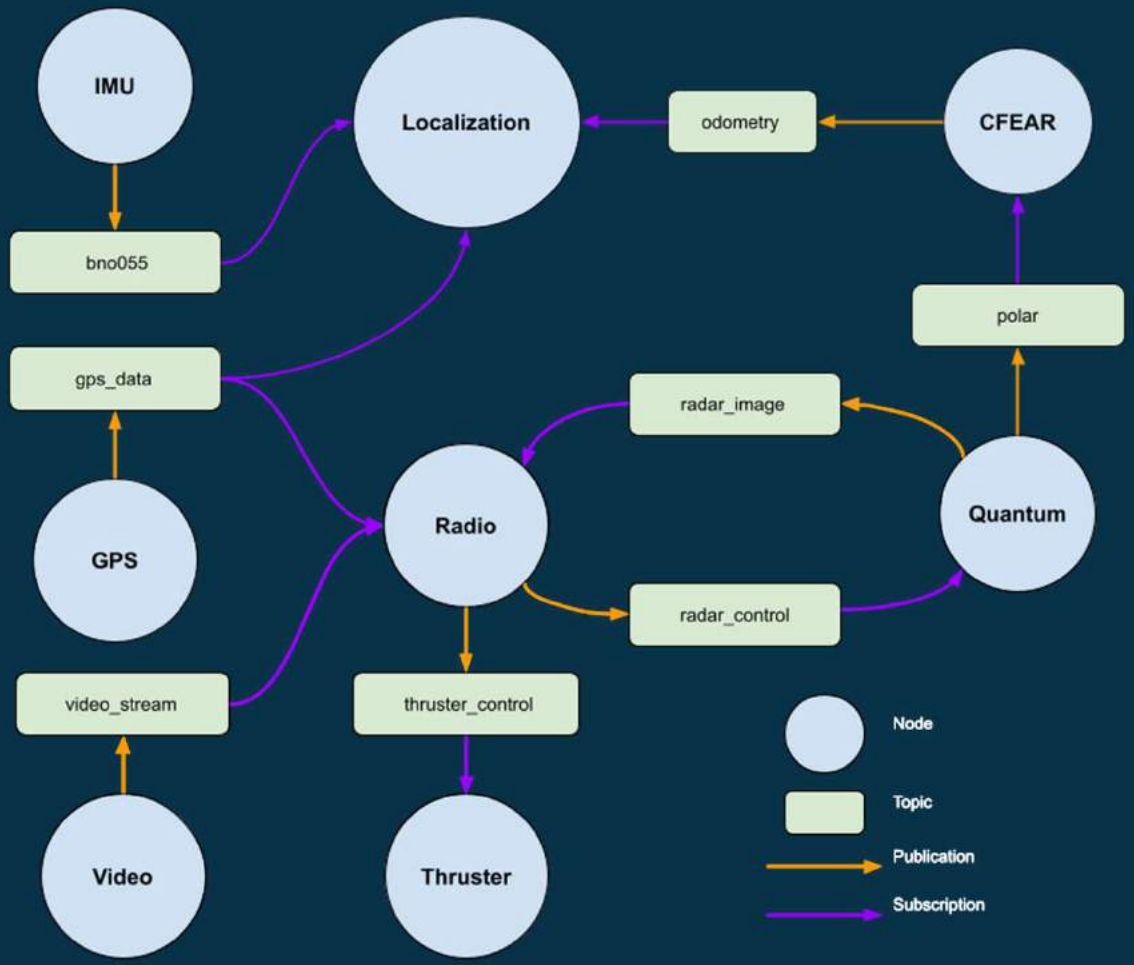
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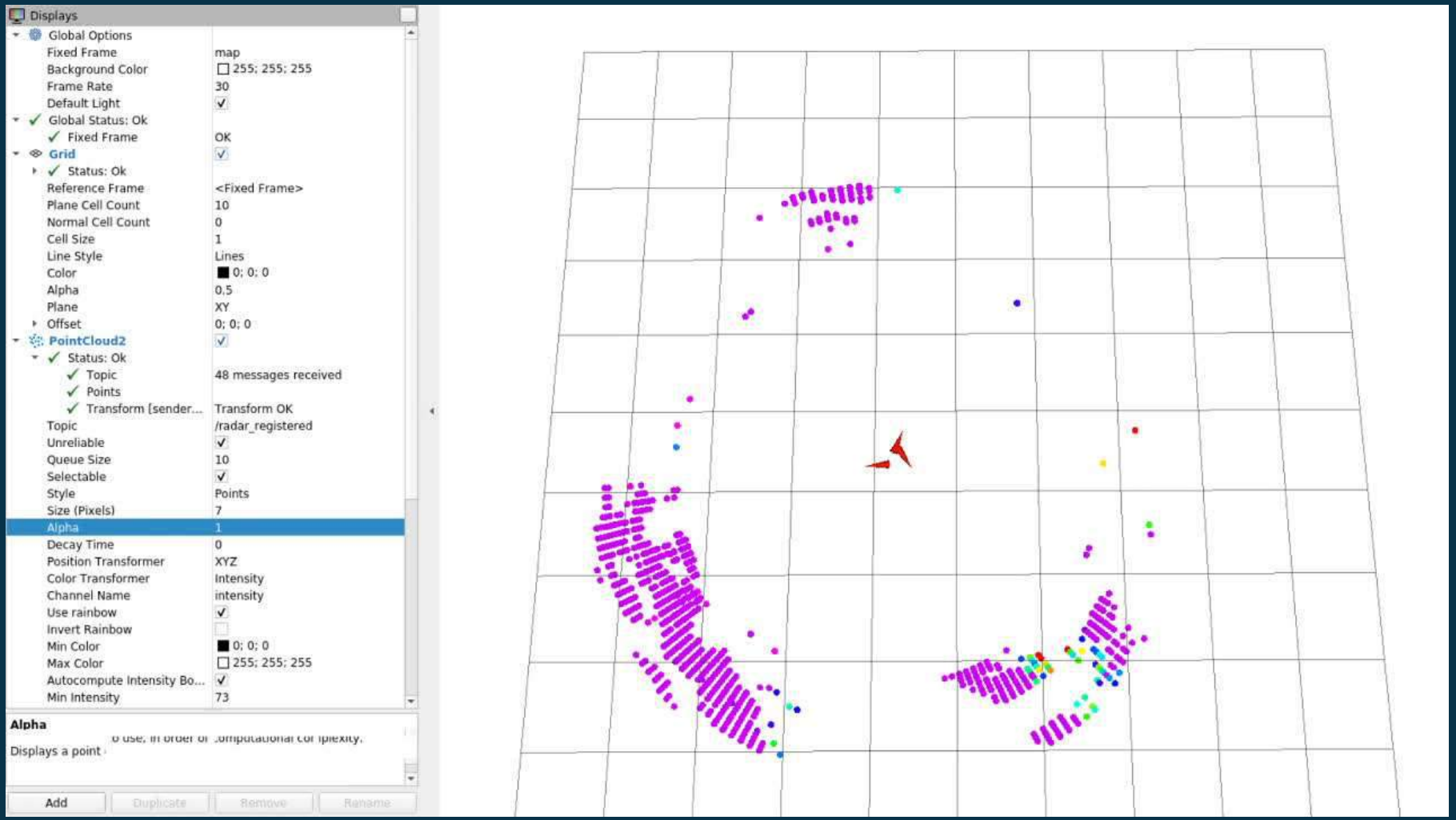
Lagoon Scans Fed into CFEAR



Demonstration

Acknowledgements

Professor Yoga Isukapalli
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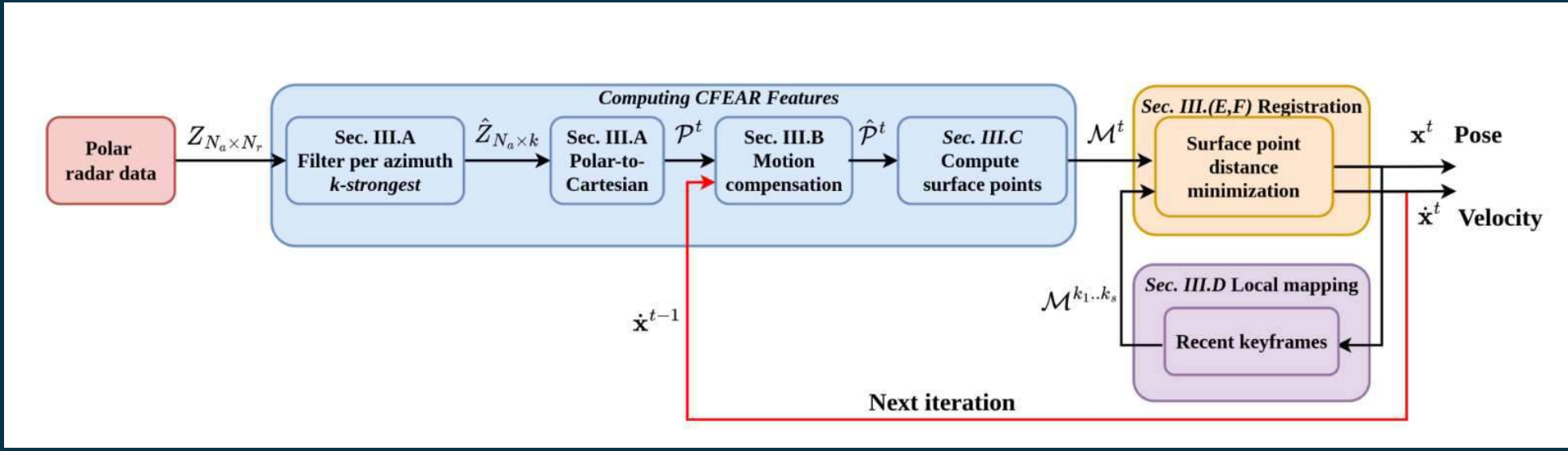
Matthew Fehl - Advising Engineer
Ryan Friedman - Advising Engineer

Questions?

CFEAR: Conservative Filtering for Efficient and Accurate Radar Odometry



Initial Lagoon Test