TEXAS A&M UNIVERSITY Engineering

Disaster Response Observation Network (DRON)

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TEXAS A&M UNIVERSITY ROBOTICS TEAM & LEADERSHIP EXPERIENCE

Problem Definition

The Disaster Response Observation Network (DRON) is a proof-of-concept initiative that aims to leverage unmanned aerial vehicles (UAVs) to gather intelligence during structural fires to aide first responders in their scene assessment and emergency response.

Methodology

Autonomous swarm functionality allows DRON to assist in emergency situations with minimal required human input. DRON is designed around ease of use, speed of deployment, and quality of data gathered and presented.

Functional Requirements

- A network where each individual node can function independently of each other for redundancy.
- Data transmitted to a centralized Ground Control Station (GCS) for interpretation and use by responders without a technical background.
- Ability to display hotspots on interactive 3d structures to model surrounding hazardous areas.
- Ability to carry payload of instrumentation (~500g) while maintaining flight at ~100 ft long enough to appropriately gather critical data.

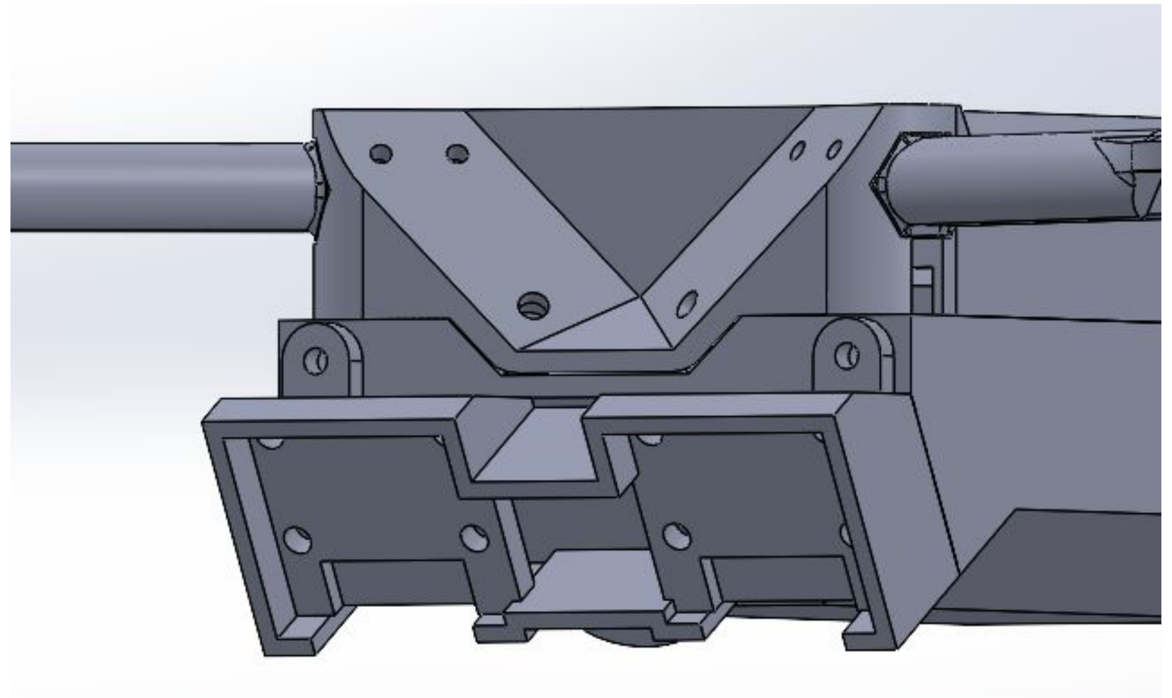

Figure 1. Updated Chassis

Mechanical

Optimized the chassis design to include:

- Modular removable camera assembly for improved maintenance and wire management.
- Smaller internal area for more efficient packing utilizing board standoffs.
- Enclosed IMU to minimize inaccuracies in flight.
- Revised arm attachment to minimize vibrations from motor harmonic excitation.

Thrust and Weight Distribution

Due to payload masses, each agent must be capable of lifting 500 grams and maintaining an altitude of 100ft for 3 minutes.

Initial thrust tests determined each rotor produced ~750g of thrust, or approximately 3000g per UAV. Following these measurements, the layout of the components were chosen to carefully distribute the weight for safe flight.

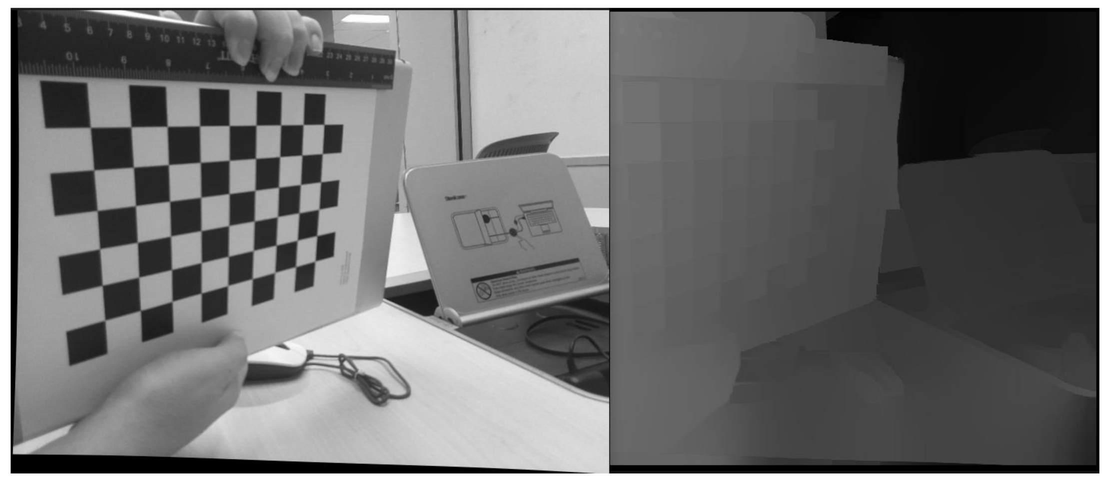

Figure 2. Generated Depth Map

Software

The software has the role of managing communications between components, detecting hotspots, and 3D mapping the environment. Two stereo cameras were successfully calibrated to capture depth of their surroundings. Stereo images are published through a ROS node into Unity where they are visualized.

The modules and libraries applied in the task of gathering, processing, and visualizing the drone's 3D environment:

A. **ROS2 Humble:** Open-Source Framework to handle communication between nodes.
B. **Senxor:** Library to interface with the thermal camera to gather video feed.
C. **Open CV:** Computer Vision library used to create Depth Maps from Stereo Images to generate the 3d point clouds.
D. **Unity**: 3D point cloud visualization.

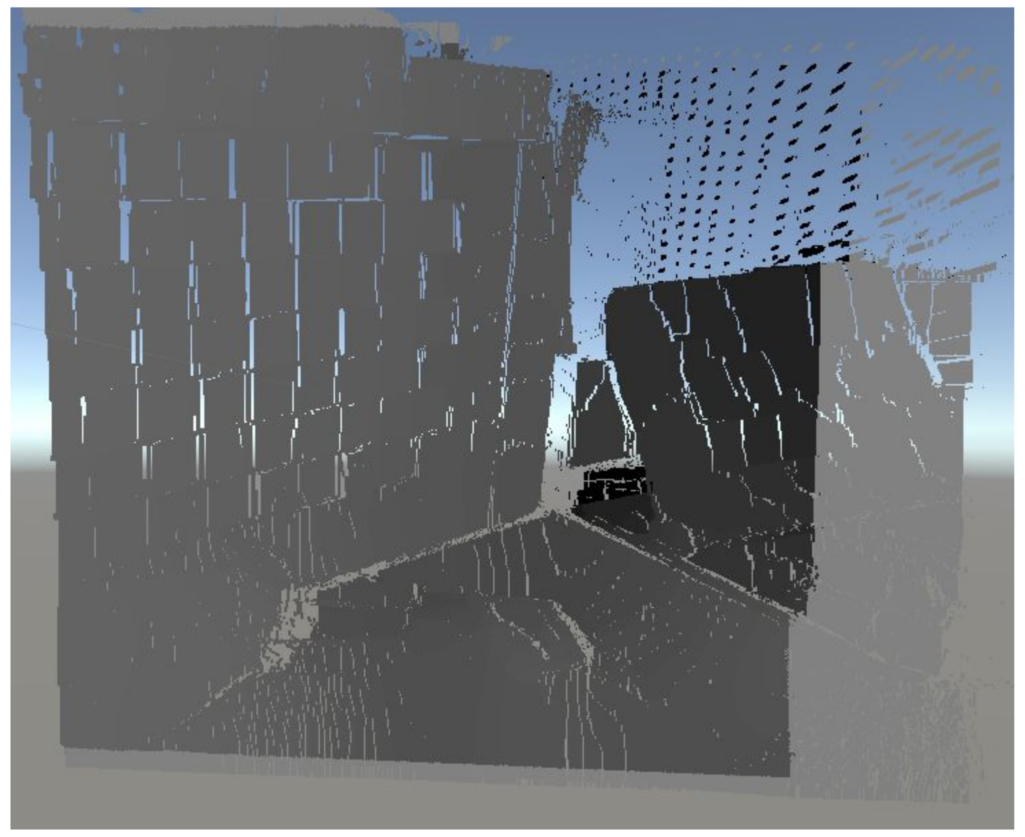

Figure 3. Reprojected Point Cloud in Unity, colored by depth

Electrical

Configuring INAV as the centralized Ground Control Station (GCS) for use with the Flight Controller (FC) and Electric Speed Controller (ESC) stack.

The GPS and IMU provide low-level waypoint based autonomy, and the Raspberry pi collects sensor data and uses wifi to transmit data and receive flight commands.

The battery selected is rated for 3000mAh and can deliver enough power to sustain maneuvering flight for ~12 minutes, and low speed flight and hovering for ~15.

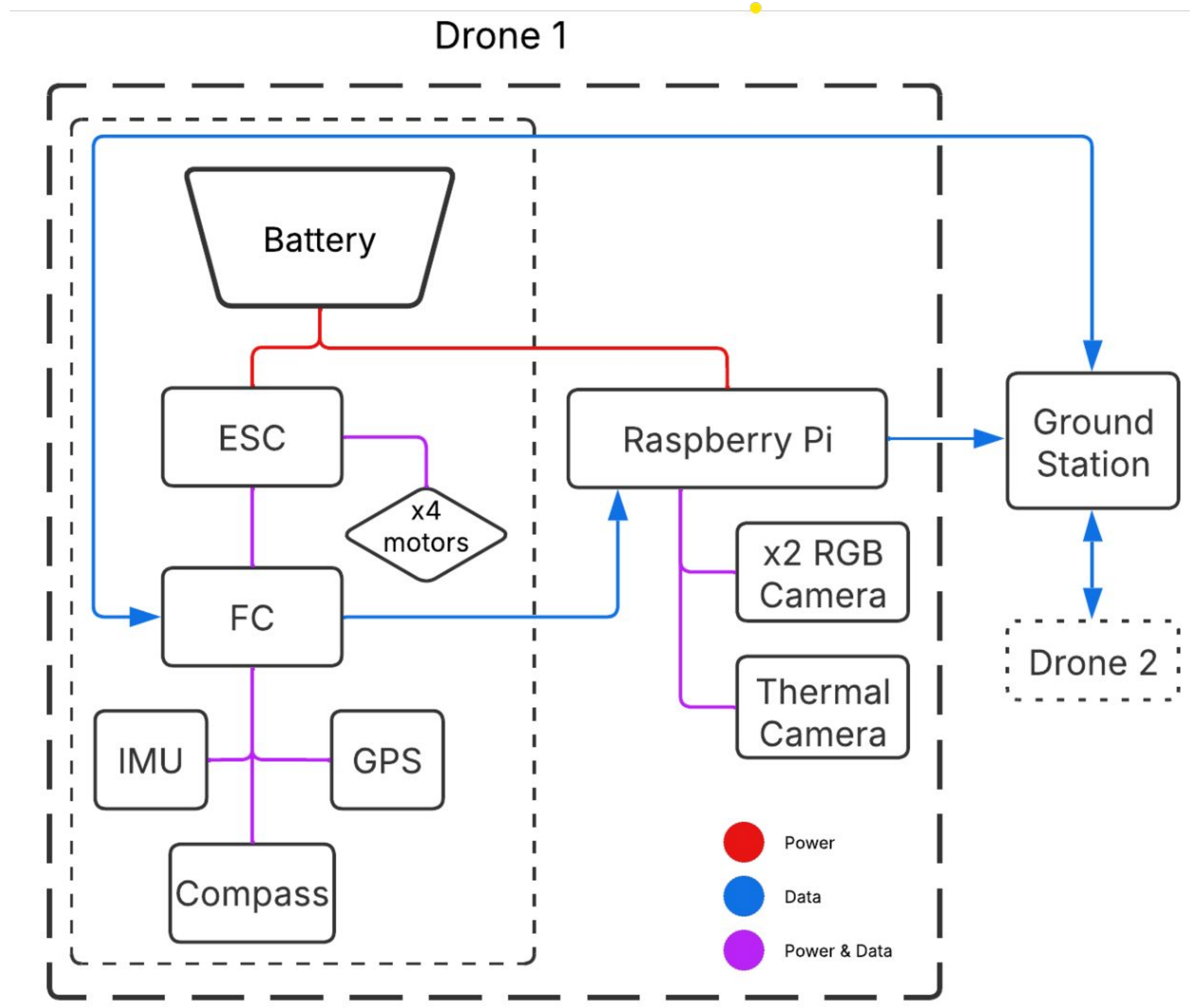

Figure 4. Revised system architecture illustration

Next Steps:

Next semester goals will be centered around implementation, scalability, and swarm strategy:

Mechanical: Stress testing for final revisions to chassis and moving towards mass manufacturing.

Software: Processing a live data feed and consolidated tests of sensor fusion in plotting and visualization from multiple frames.

Electrical: Handle autonomous flight control through INAV, establish onboard computer publisher nodes, and finalize connections between the ESC and Flight controller.

Research: Exploring the ability of the ground control station to generate optimal waypoints for agents to improve model resolution.

Testing: Obtaining FAA licenses for an full autonomous systems test with a reasonable structural fire analog.

Texas A&M University Robotics Team and Leadership Experience (TURTLE) Lab