Individual Lab Report #2

Progress Review 1

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Jet Situ

Team B

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1 Individual Progress

1.1 PCB Assignment

For the PCB assignment, I was assigned to Section 2 and onward. Building off of the initial schematic, and the provided board size, I routed the components in the appropriate location, as specified by the assignment. I then computed the minimum signal and routing widths, using an online PCB width calculator. By increasing the board thickness of the air layers to an appropriate manufacturable, but not too high of a thickness, I was able to safely route 15A signals from the base inputs around the board without danger. I created net classes that separated non-critical traces from critical traces, before using the autorouter to create non-conflicting placements, creating the needed board architecture. I then calculated the efficiency of the subsystems, as per the third section.

Finally, I opened up Autodesk Fusion, and imported my board, schematic, and library to create a new electronic design. With that, I was able to create a drawing file, and used ordinate dimensions to appropriately dimension the position of mount holes, alongside connector positions, marked by PIN1. I compiled all elements into a zip file, before sending it back to my team for verification.

1.2 MRSD Project

For the MRSD project, my work primarily focused on the updating of the drone's internal software and hardware components necessary to sustain flight. Particularly, I worked on the gimbal, radio, and ROS2 architecture of the system.

For the radio, our original radio, the Doodle Labs Smart Radio, proved infeasible for safe flight. Beyond a difficult configuration system that sapped away critical time that could be allocated to other workflows, the radio itself was inconsistent in reliability, having only a 50% uptime at peak, with frequent disconnections. In regards to this, we originally mounted a backup radio, but found that in the overall architecture, the combination of these would, in our team's opinion, have a level of reliability that is simply unacceptable for safe flight.

To address this, we've replaced our radio infrastructure with the Rajant, which I've dedicated my time too, at least until a Lockheed Martin DTC radio can be spared to be mounted on our system. My work consisted of integrating and powering this radio, and running tests to verify its capability in flight.

My next work was on the gimbal. Given that the Gremsy G-Hadron was our only viable gimbal, we had to get it working, despite insufficient documentation. Over a weekend, plus direct support from Lockheed Martin engineers, we were able to get the gimbal to operate, able to control it's roll-pitch-yaw while in flight, alongside being able to receive seperate optical and infared streams, critical to running our algorithms precisely.

Finally, my last bit of work was on the ROS2 architecture of the system. Working with Lance, we were able to talk back and forth with the ROS node onboard the aircraft, sending and receiving messages back and forth. I also spent additional time studying and designing around the Airlab behavior tree, provided to us as a means for controlling the onboard planner of the drone.

2 Challenges

2.1 PCB Assignment

The primary challenge of the PCB assignment was the routing of the system. Given the precise placement of several of the components, several traces ran dangerously close to each other and overlapping. While manual tracing could be done, the amount of traces was exceptionally high, and it would've been time-consuming. By doing a bit of research, I was able to use net classes to properly separate critical and non-critical traces, and perform autorouting to an acceptable level to prevent cross-interference alongside safe widths for all traces.

2.2 MRSD Project

The primary challenge of the MRSD project on this iteration was the gimbal control system. The existing documentation was lacking, and little manuals, beyond the initial quickstart, provided a clear view on how to control and operate the gimbal without additional, not provided components. It took a weekend to operate the camera feed, then another meeting with the Lockheed team, building on their insights and prior work, to debug the gimbal slowly over the course of several hours, eventually finding a fix that allowed the tests within the Gremsy-provided software development kit to function properly.

With little error handling nor provided documentation within the Gremsy SDK, we were unable to properly diagnose the problem, and had to rely on Lockheed's guidance on their own fixes to match our gimbal state with theirs, which eventually resolved the problem. With this blocker resolved, we can finally pass the gimbal software development across other team members, who can continue the work unimpeded and put us back on track to complete the project according to our timetable.

3 Team Work

3.1 MRSD Project

Name	Contribution
Jet Situ	Worked on primary integration of the gimbal control and camera interface. Was able to tune, calibrate, and control the gimbal via integration of the Gremsy SDK, in collaboration with Lockheed Martin. Worked on ROS2 integration with the ground station, validating communication infrastructure to onboard MAVROS system. Removed Doodle Labs Radio and electronic infrastructure, replaced with Rajant Breadcrumb radio, and actively working on the electrical section to integrate the newer radio. Held meetings with Prof. Scherer and Yaoyu Hu to realign timelines and priorities in preparation for the DARPA March workshop.
Joshua Pen	Assisted in integrating and configuring the Hadron 640R payload with Cube Blue ArduPilot and NVIDIA Orin NX. Initiated development of a GeoFence path planner, creating an algorithm for generating lawnmower-style waypoints within a bounding box and filtering out those outside the geofence to establish an initial drone search path post-launch. Replaced the Rajant Breadcrumb radio on the drone, upgraded the gimbal attachment plate to reduce weight, and renewed the rubber padding on the drone's legs. Contributed to project management and logistics.
Lance Liu	Worked on radio, IssacSim, and gimbal integration. Primary work was on configuring the new RFD900 radio and integrating for use as a primary RC link between the CubePilot and the ground station. Work was done on integrating our design and the MAVROS behavior tree into IssacSim, where simulation of the drone and tree can be done in a safe environment. Contributed to attempted test flight and follow-up analysis of the drone's new payload configuration. Assisted in gimbal configuration process and debugging the SDK system.
Gweneth Ge	Primarily worked on communication with AirLab and lockheed team for the overall plan of our team participating the workshop in March, and the role to the DARPA Triage Competition this year. Additionally, worked on the Spring Test Plan, settling down the milestones for each Progress Review with other team members. Assisted in reintegration of the drone after gimbal control and Radio system issues resolved.
Yi Wu	Created a pull request for the AirLab/HumanFlow GitHub repository, implementing two ROS2 packages for 3D&2D pose estimation and pose visualization. The package enables human pose visualization in RViz2 and includes NLF algorithm (https://github.com/isarandi/nlf) testing on DARPA datasets. Additionally, started to implement YOLOv11 for comparative analysis of 2D joint pose detection performance.

Table 1: Team Members and Their Contributions

4 Plans

4.1 MRSD Project

Name	Contribution
Jet Situ	Will work on coordinating all key features needed for the March workshop, developing software psuedocode and baseplates needed to aid other team members in developing feature packages. Will assist with IssacSim simulation of drone behavior to develop safety features needed to qualify the drone for the workshop. Will redevelop the electrical configuration of the drone to appropriately route power to the motors and all newer subsystems, and test tuning to ensure that the ESCs produce the expected output. Will work on mechanical integration of newer drone components and hardening in preparation of outdoor test flights.
Joshua Pen	Collaborate on developing gimbal control protocols and implement mechanical enhancements. Design and code a GeoFence path planner, creating algorithms for lawnmower-style waypoint generation within a bounding box and filtering out waypoints outside the GeoFence to establish an initial search path for drone deployment. Contribute to developing the IsaacSim pipeline for testing path planners. Additionally, manage project logistics and oversee project management tasks. Will also replace broken motors on drone.
Lance Liu	Will work on integrating the new control protocols for the RFD900, and the Rajant Breadcrumb radio, and work on setting up the ROS2 communication and router nodes between them. Will continue to work on IsaacSim integration and develop a simulated environment to test the behavior tree in, integrating Josh's software code and testing it within the virtual environment. Will also assist in overall code architecture and structuring for deployment within ground station, Docker containers, and deployment onto aerial computer.
Gweneth Ge	Now that the gimbal and radio issues resolved, I will continue working on on Inter-UAV collision logic and planner launch. Moreover, I will assist gimbal control and sensor nodes development, detection launch, visualization and clicking interaction. I will continue supporting on project management and logistics, including the plan for the DTC workshop in March, as well as the demo and space setup for National Robotics Day in April.
Yi Wu	Deploy the current pose estimation algorithm (NLF) on the Jetson Orin, and test its performance. Finalize the YOLOv11 pose estimation ROS2 packages. Initiate development of pose estimation algorithms for thermal camera data. Implement gimbal control functionality by tracking a designated target patient point within the camera frame.

Table 2: Team Members and Their Plans