Autonomous Flight for Unmanned Aircraft Systems

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Introduction/Issues Confronting Site:

Mission Planner is a ground control station (GCS) software that communicates with the UAS, the Opterra (Figure 1), and autopilot via wireless telemetry through an RFD900 radio link. Mission Planner was used to setup the autonomous flight by configuring the autopilot, setting parameters, and establishing a mission of waypoints that the Opterra would fly autonomously. The autopilot utilized was the Cube Orange Flight Controller (Figure 3), which would load the parameter and waypoint files to tell the Opterra what to do. The internship consisted of three main categories: programming, construction, and flight of UAS, all of which were incorporated into the final mission assignment.

Figure 1: UAS in Flight from Horizon Hobby (https://www.horizonhobby.com/product/opterra-2m-wing-bnf-basic-with-as3x/EFL11150.html)

Activities:

First, I familiarized myself with Mission Planner by reading its documentation and practicing with the software. Then, I followed side-by-side as my mentor configured the autopilot and constructed the UAS. Finally, I was given two missions to program independently to test what I had learned, to which we ended the internship by flying the missions.
Mission 1: Takeoff and fly a four waypoint course.
Mission 2:

- Takeoff and fly pattern in Mission 1, then fly to a holding area.
- On command, move from the holding area to observe two targets.
- Return to the holding area after the targets have been observed.
- On command, enter autonomous landing plan.

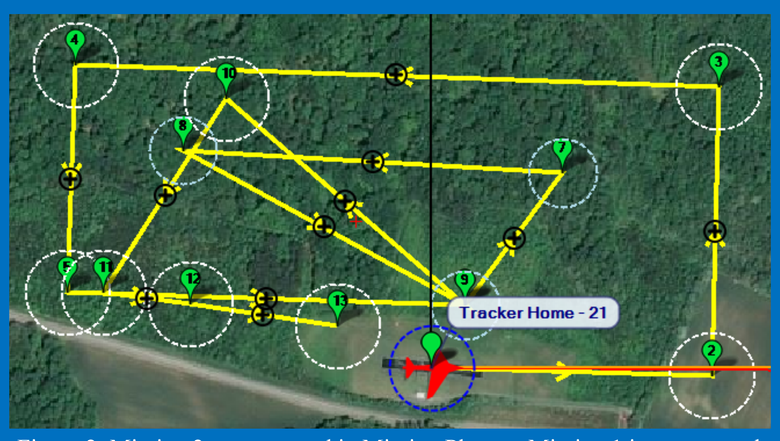

Figure 2: Mission 2 programmed in Mission Planner. Mission 1 is represented by Waypoints 1-5, with the UAS depicted as the red plane at Tracker Home.

Programming:

- Mission 2 was programmed using a series of waypoints and commands: takeoff, loiter, land.
- Accelerometer/Magnetometer calibration.
- Servo outputs established.
- Flight mode channels and PWM values setup alongside the radio calibration.
- RC connection from transmitter to receiver.
- GCS to autopilot telemetry via USB/RFD900.

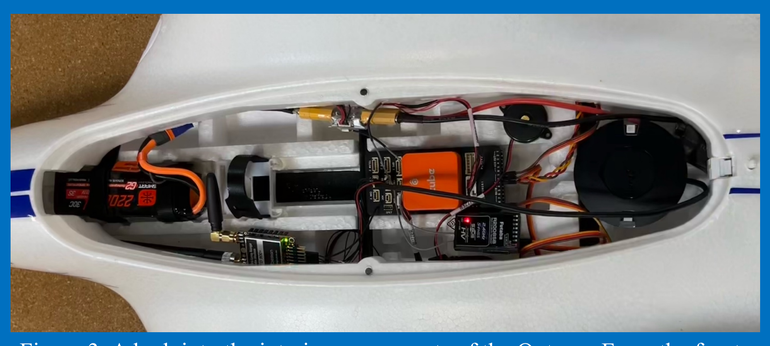

Figure 3: A look into the interior components of the Opterra. From the front of the Opterra to the back (left to right): battery, RFD900 modem and antennae, Cube Orange autopilot located in the center, Futaba transmitter, buzzer (small black circle), Here3 GPS (large black circle).

Construction:

- Components of UAS were strategically placed inside the Opterra to ensure steady flight.
- Soldering was performed on wires to extend the connective range of the battery.
- Battery placed towards the front to ensure the Opterra was nose heavy.

Figure 4: Me flying the Opterra in the Auto and Stabilize flight modes at Patuxent Aeromodelers RC Club, testing out Mission 2.

Flight:

- Mission 2 flown in the auto flight mode.
- Elevons trimmed to be flush with airfoil.
- Hand launch against wind for more lift.
- Stick time on transmitter in the stabilize flight mode.

Site Information:

- Site: Red Six Solutions, LLC (https://red-6.com/)
- Address: 4861 Tesla Dr Suite D, Bowie, MD 20715
- Supervisors: CEO Scott Crino, PhD, and Joe Allen
- Site Mission: To act as a strategic advisory consulting firm whose goal is to provide their clients with an aerial understanding of threats that might endanger the client.

Future Work:

I plan on interning at Red Six Solutions Summer 2022 to continue my work with autopilots, diving deeper into Mission Planner's capabilities and applications.

Impact:

The Opterra that I constructed with the programmed autopilot consisting of the parameter file that I developed was used by Red Six for counter UAS (Unmanned Aircraft Systems) testing supporting US government customers. I came out of this internship with hands-on, technical programming, and real-world applications of classroom content experience.

Acknowledgments:

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