Summarization of Journal Paper for AUVSI SUAS 2022

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1 Design component

- The flight controller, Pixhawk 2.1 Orange Cube,
- The microcomputer was raspberry pi 4
- The RFD 900+ and Ubiquiti AC Bullet for telemetry and communication
- A carbon fiber landing gear for the aircraft to take off and land smoothly

  These were the some of the main components to create their UAV called Horus.

2 System Design

2.1 Aircraft

- Horus was selected because of its remarkable performance during the flight test. The airframe has been proven reliable as it has over 45 hours of flight time. The aircraft is shown in figure 1.

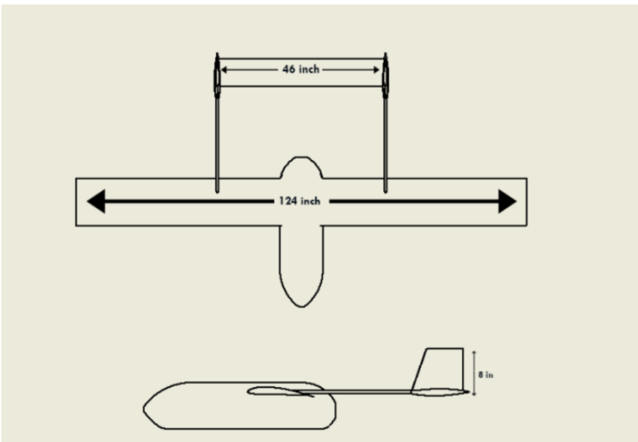

Figure 1: Aircraft Projection Dimensions

- Used material for the design:Fiber glass, carbon fiber and black ash wood.
- As for the assembly, they used composite resin and adhesive to attach the parts together, and used abrasive sheets to provide a smooth finish to put the final polishing layer of the resin.
- Finally, They started by manufacturing the wing as it's the hardest and most time-consuming part of the aircraft then, the process was repeated for the fuselage and tail.

2.2 Autopilot

- Horus control system uses the Pixhawk 2.1 Cube Orange flight controller along with the required modules and some additional for autonomous navigation and accuracy. The component design is shown in figure 2.

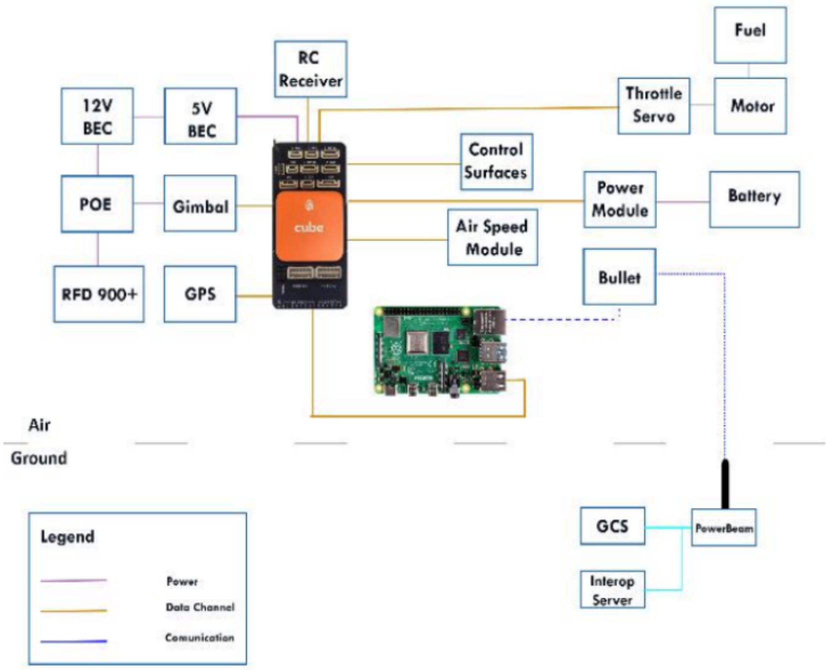

Figure 2: Control System Design

- The Pixhawk 2.1 runs the latest ardupilot stable firmware allows multiple calibrations and allows the connection to external peripherals like a LiDAR, Airspeed sensor and an external GPS for better navigational accuracy and a precise coordinate representation of the captured objects.
- The team designed a custom flight termination system algorithm that determines the wind direction facing the aircraft during flight and draws a sequence of height descending waypoint that in the opposing direction of the wind to gain maximum lift and allow the aircraft to descend smoothly until it finally lands.

2.3 Obstacle Avoidance

- In the presence of obstacle in between two waypoints, the path of the waypoints is then reconstructed by adding three waypoints to avoid the obstacle and trigger the obstacle avoidance algorithm.

- In the case of presence of several obstacles with proximity to each other, the algorithm considers all those obstacles as one larger obstacle to be avoided.Example of mission modification for avoiding the obstacle shown in figure 3

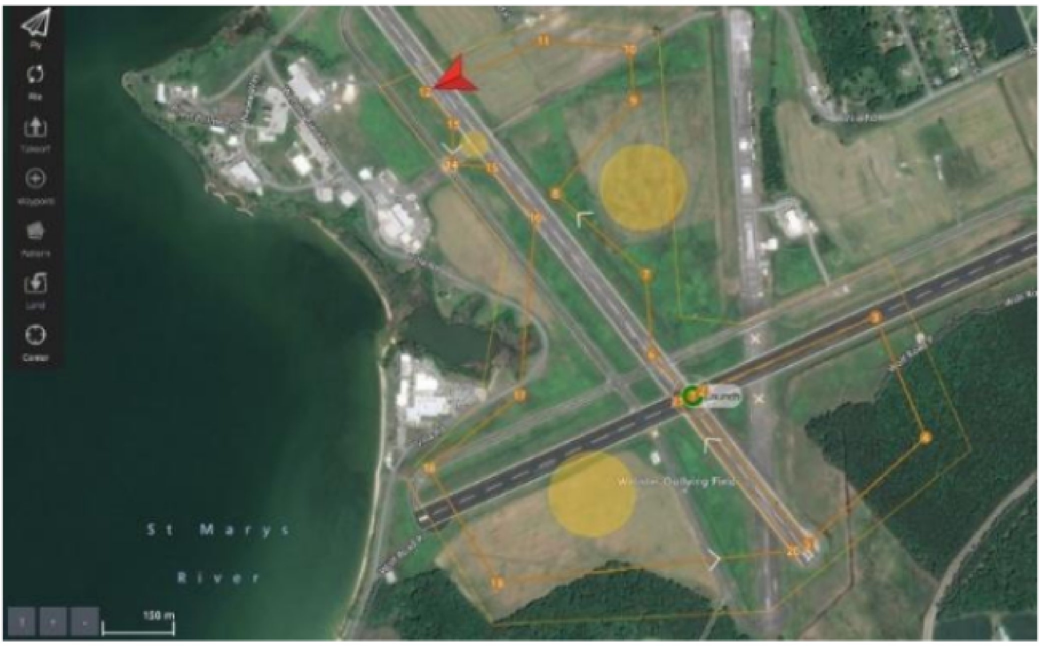

Figure 3: Mission Modification after Obstacle Avoidance Algorithm

2.4 Communications

- The UAS has Four wireless transmission links between the Horus and the ground control station.

- The first transmission link is the spektrum RC transmitter with a frequency of 2.4GHz that uses the DSMR technology.

- The second transmission link is the RFD 900+ telemetry link that has a frequency of 900MHz and will act as the main telemetry link between the UAS and the ground station.

- The third wireless transmission link will be ubiquiti AC bullet with a 5GHz of frequency and this will act as our backup telemetry link and will be the main link for the data transfer of the object detection, localization and identification system.

- Finally, the fourth data transmission link will be the zoon telemetry pair connected to send and receive telemetry data between the UAS and the antenna tracker.

- They also implemented a separate data transmission system that handles the transmission of the data between the UAV and image recognition system.First Encrypting the data. Second, authentication is done. After that, establishing a secure transmission channel.

- In case there was a failure in connection, the data that was meant to be sent is stored inside the UAV sender system and the system attempts to create a new channel then when the connection is restored the data delivery can continue without any loss.

  The flow described above is shown in figure 4

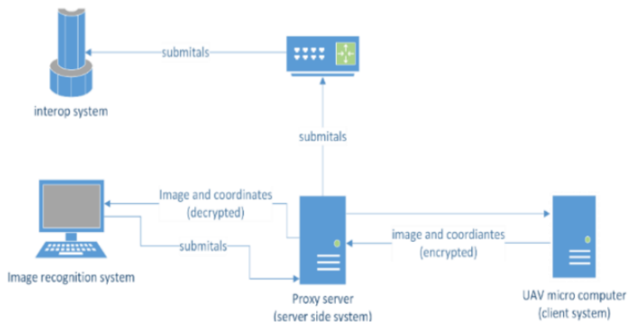

Figure 4: Communication System Flow

2.5 Airdrop

- The Airdrop mechanism is a door held by a servo that awaits an electronic signal from the Pixhawk once the aircraft reaches the desired coordinates to drop the UGV.

- The retraction mechanism of the airdrop door is to attach springs to it to bring it back to the closed position.

- The UGVs controller will be the Pixhawk4, and will communicate with the GCS with a telemetry connected to the Pixhawk4 and finally the power system will be a small 2s Battery to power the Pixhawk and the motors.

- A servo will be attached to the UGV to release the parachute after successfully landing while trajectory equation is taken to consideration.

2.6 Imaging System

- The EH314 was choosen as it fit their requirments perfectly

2.7 Object detection, classification and localization

- During Skyscanner phase the image data is passed through a Super Resolution Neural Network model (SRCNN) to enhance image quality then passed through a YOLOv4 model for detecting and localizing Regions of interest for later analysis. The shown figure 5 for illustration.

Figure 5: Detected Regions of Interest

- Depending on the type of object of the image, the ppr software may go through the following algorithm: Emergent object detection, Image captioning, Standard object detection, Shape classification and OCR.

  The output of the model should be like in figure 6

Figure 6: Object Detection and Localization