NC STATE UNIVERSITY

Department of Mechanical and Aerospace Engineering

Team High Alpha - E.L.S.A
Aerospace Engineering Capstone Senior Design 2023-2024

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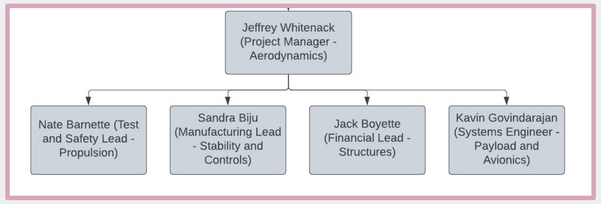
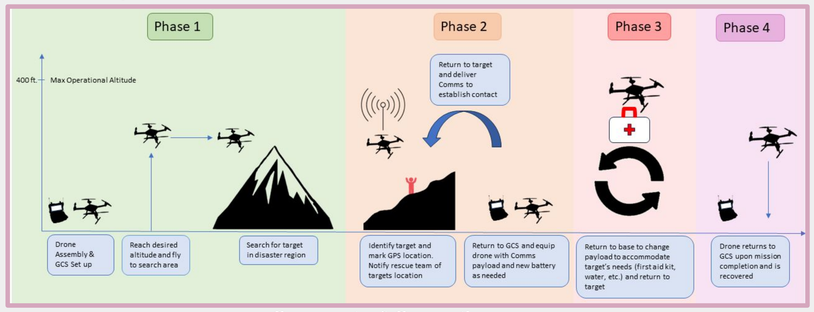
Team Organization



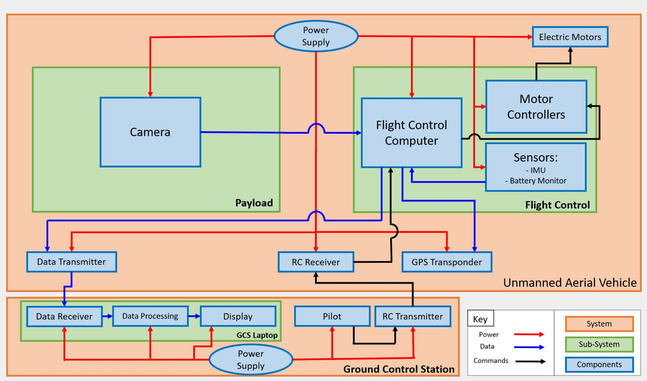
Project Overview

Purpose: To supplement first-responder capabilities and increase survivability of avalanches



Concept of Operations

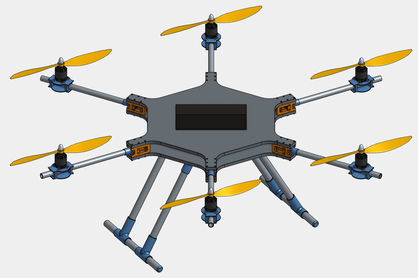
1. **Assembly and Search**: The drone is transported to disaster location and GCS is set up. Then the drone is deployed and begins searching for survivors
2. **Marking and Communications**: Upon finding the survivor the GCS marks the targets location and send its to recuse authorities. The drone then delivers the communication payload to attempt to speak with the survivor
3. **Additional Payloads**: After Assessing the survivors needs the drone can return to the GCS to equip new support payloads and change batteries to the mission.
4. **Drone Recovery**: Upon mission completion the drone will return the GCS and be disassembled.



Functional Block Diagram

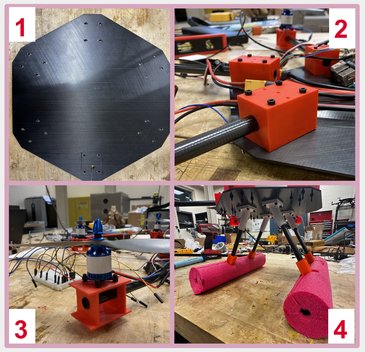
Design Solution: E.L.S.A.

Design Solution: ELSA (Emergency Life Saving Search Apparatus) is a 6 rotor search & rescue drone. It is equipped with a camera to search for survivors as well a payload drop system to provide aid. ELSA has a 3:1 thrust-to-weight ratio. The avionics stack is headed up by a Raspberry Pi and Navio 2 Hat.



E.L.S.A CAD Model

Manufacturing



1: The carbon fiber baseplate was cut down to the shape defined in CAD from the raw material shape using the waterjet. This serves as the mounting plate for all of the avionics.

2&3: The boom mount and motor mount (2,3 respectively) are PLA 3D printed parts that enable the mounting of the motor to the CF boom and the CF boom to the base plate.

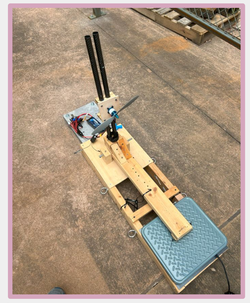
4: The landing gear was manufactured using carbon fiber tubes and custom 3D printed connectors. These were assembled using epoxy and attached to the drone with M3 screws. Pool noodles were cut to fit around the horizontal members, providing shock resistance and protection for the carbon fiber.

Final Prototype

Weight	7.3 lbs
Length	39 in
Height	14 in
Thrust to Weight Ratio (TWR)	3:1
Endurance	25 min loiter
Range	3.2 miles
Total Cost	$846.66

Testing

Static Thrust Test: The static thrust test was conducted in order to verify our drones thrust capability. The thrust stand functioned as a moment arm that applied a load to a digital scale. After doing a brief statics problem the thrust could be determined. The drones hover condition of 7.50 lbs of thrust was met at 45% throttle. At 100% throttle the drone produced 3.5 lbs of thrust.



Static Thrust Test Setup

Payload Deployment Test

Payload Deployment Test: The payload deployment test validates that our payload is delivered reliably and accurately to the target. After integrating the payload deployment system into the flight computer, dummy payloads of several different weights were dropped. The results showed that the system was capable of dropping a 3 lb payload with 100% reliability.

Iron Bird Test: The Iron Bird Test serves as a full integration test of the propulsion and avionics systems onboard the vehicle without actual flight. We were able to validate and characterize the performance of the vehicle with this test.

Iron Bird Test

Flight Test

Flight Test 1: The first flight test was a failure due to improperly tuned flight controller gains.

Flight Test 2: After fixing the controller issues the drone flew successfully in high wind conditions including a successful payload drop.

Acknowledgements

Team High Alpha would like to thank the customers and TAs for their support and feedback throughout this process. Team High Alpha would like to thank the Controls and Optimization for Renewables and Energy Efficiency (CORE) Lab for the generous donation of avionics components.