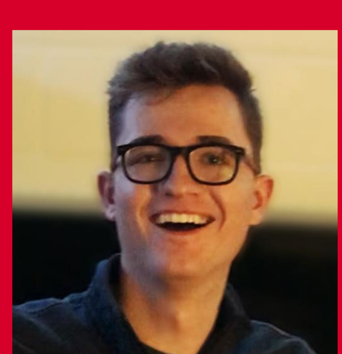
NC STATE

Department of Mechanical and Aerospace Engineering

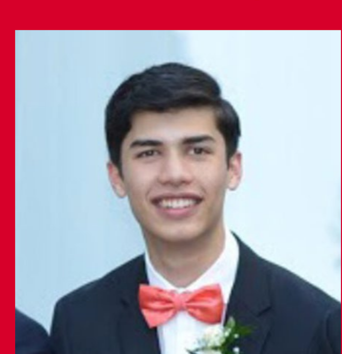
Tom Freeman
Kevin Gitushi
Michael Hughes

LOCH

Multirotor Unmanned Aircraft System



Marceli Lewtak
Project Manager
Software/Controls



Ethan Sites
Financial Lead
Propulsion/Electric

Katie Curtsinger
System Engineer
CAD and Simulation

Luis Villalobos
Testing/Safety Lead
Aerodynamics

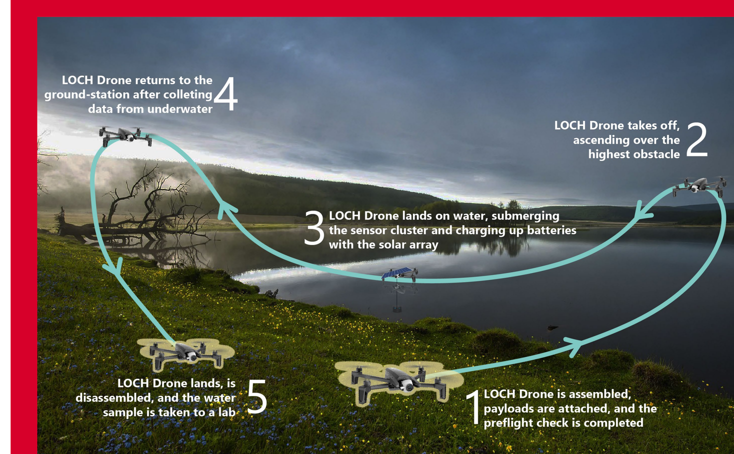
Ryan Wagoner
Manufacturing Lead
Structures

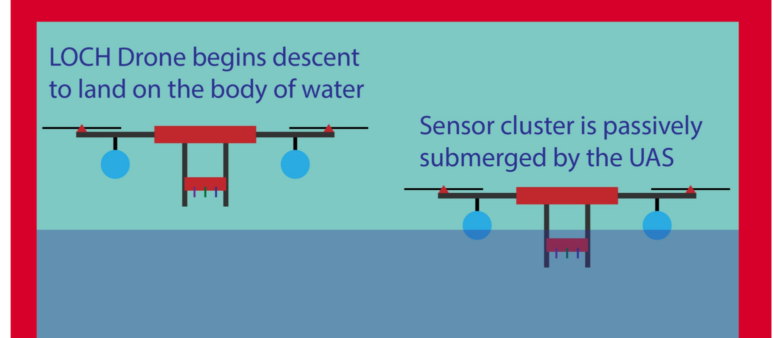
MAE 481: Aerospace Engineering Capstone Senior Design 2022-2023
Instructor: Dr. Felix Ewere
Teaching Assistant: S. M. Shovon
Teaching Assistant: Raf E. Ul Shougat

Mission Overview

The purpose of this project is to design, build, and test a multirotor UAS for the US Forest Service. The Forest Service is in need of a mobilized data collection system to maintain the health of forests quickly and efficiently. The objectives for the LOCH drone are to monitor fish and wildlife populations, plant species, watersheds, and to collect water and air quality data. The drone will be assembled and operated by a two-person team, following the Concept of Operations shown below.

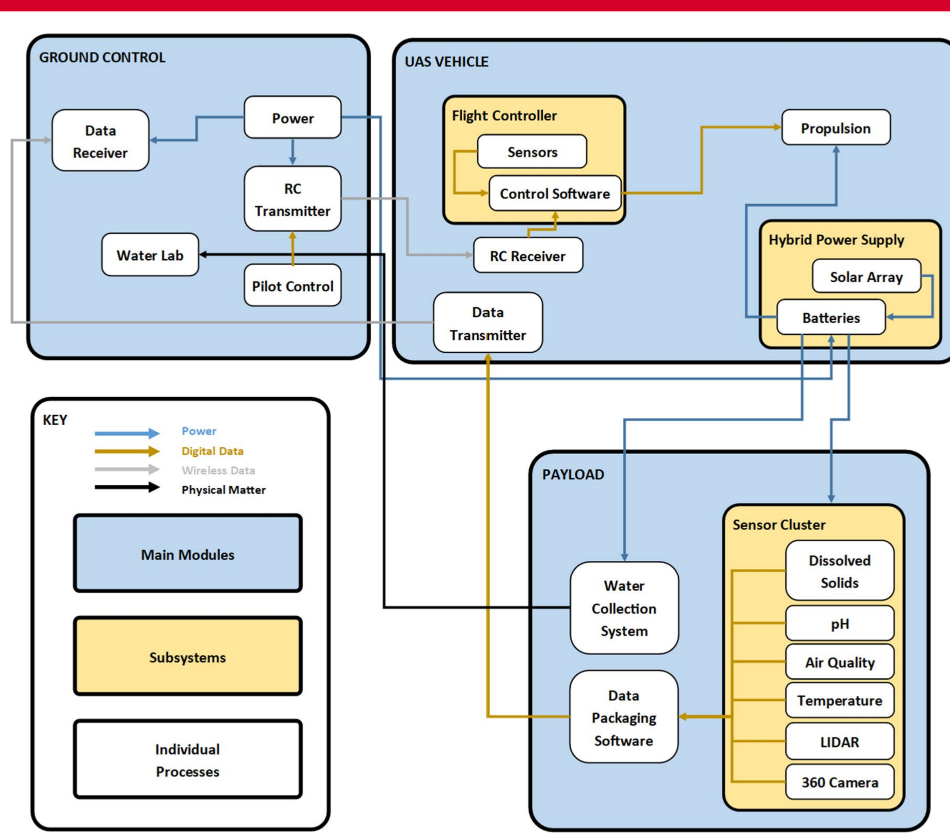
Concept of Operations



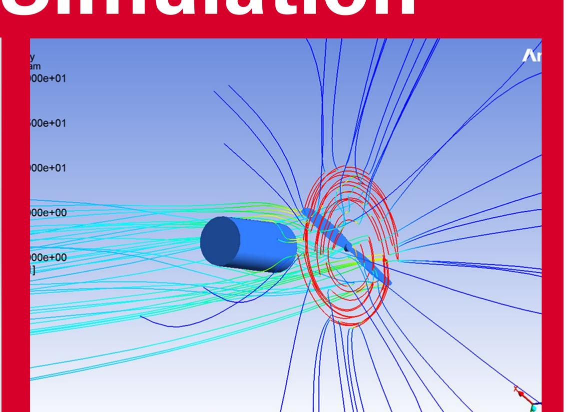


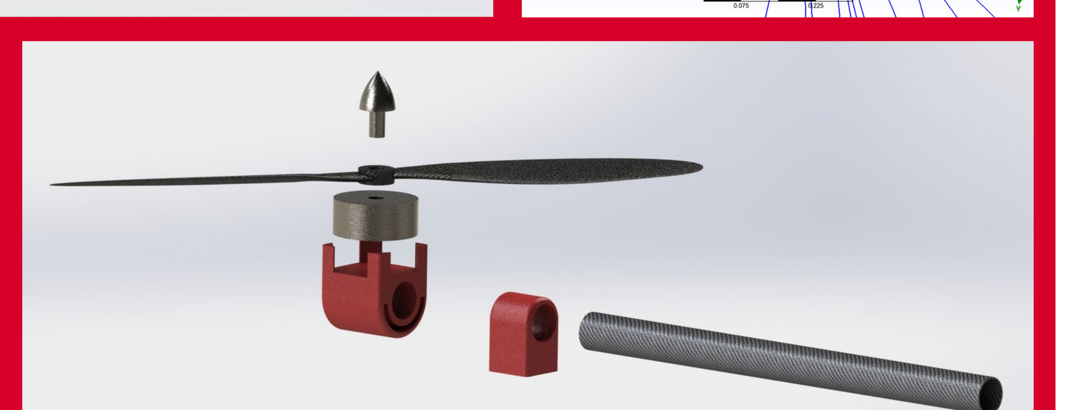
The concept of operations for the mission is fairly simple. The drone is assembled upon the arrival at the test sight. Then the UAS is flown over the water to an otherwise inaccessible location where the sensor cluster is submerged, and data is collected. Once the data is collected, the UAS returns to the team, and can be disassembled.

Functional Block Diagram

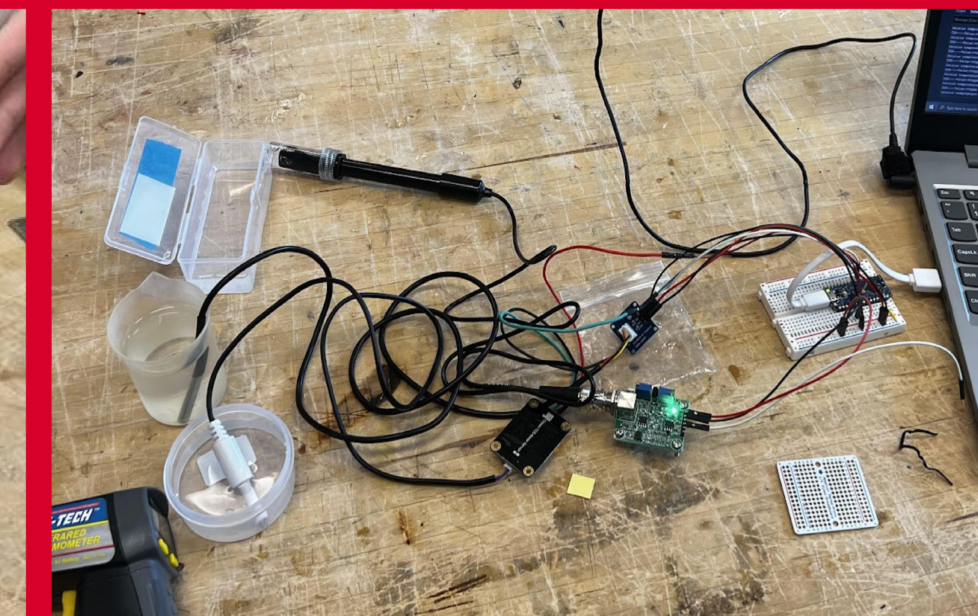


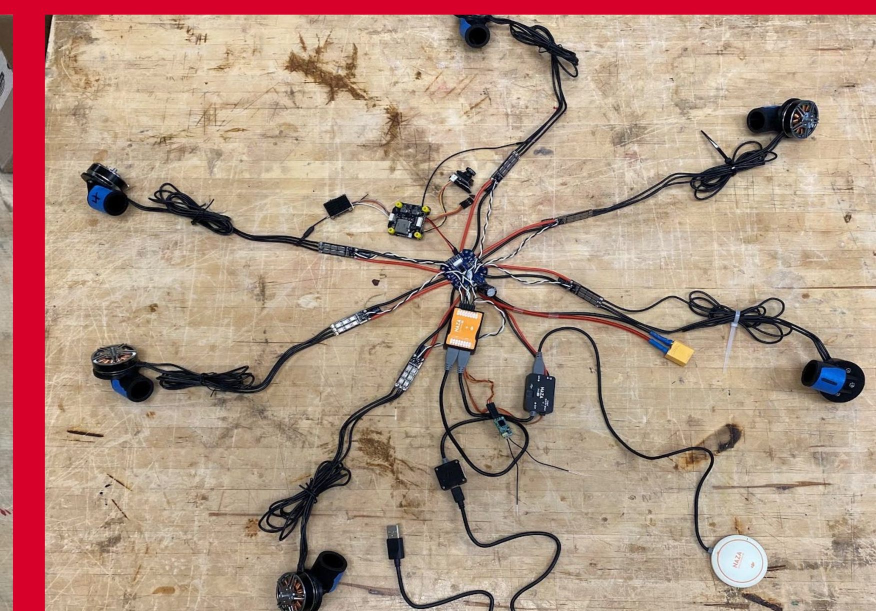
CAD Designs and Simulation





Manufacturing





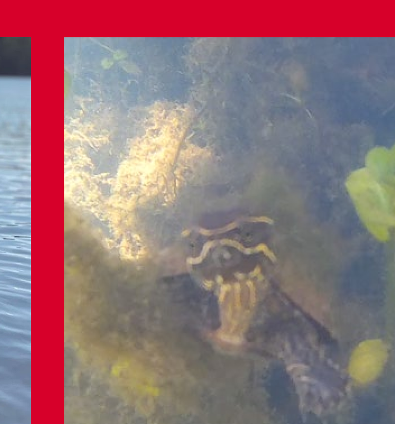
Testing

Sensors: Verified that the temperature sensors were giving back accurate readings.
Buoyancy: Ensure that the LOCH drone would float for extended periods of time. Verified that the water pump, camera, and sensors were properly submerged.
Conformal Coating: Used UV light to ensure that all surfaces on the electronics were coated in waterproof conformal coating. In the event of a splash, all electronics would be safe.
Landing Gear: Landing gear successfully held over 30 lb with no noticeable deformation.

Final Prototype

The LOCH drone utilizes several parts to aid in the successful mission completion. It uses the DJI Naza M V2 Flight controller. Connected to it are the GPS Module and Power Management Unit, which both came with the flight controller. The heart of the drone is the TURNIGY 10,000 mAh 4S LiPo battery, which is connected to the XT-90 Power Distribution Board. Additionally, nine solar panels were mounted to the top of the frame. From the flight perspective, six 40A ESCs are connected to Sunny Sky V3506 brushless outrunner motors. Connected to these are the EOLO 13x5 inch propellers, which were specially chosen to decrease the takeoff RPM to prevent water from splashing due to the propeller downwash. Due to their larger size, they also run significantly quieter, preventing any further wildlife disturbance via noise pollution. Also, to assist in controlling the drone, a Tyro79 FPV Camera was included and mounted to the drone. The other camera, most notably known as the underwater camera, is the Akaso E7000 4K, which is mounted in the payload bay. To monitor forest health, along with the underwater camera, are the various sensors in the payload bay. These consist of a pH sensor, PMS7003 water and air quality particle sensors, and a temperature sensor. To help with structural support, carbon-fiber tubes were used, along the 3D printed frame and other parts. Finally, to help the drone float, a pool noodle was cut and attached to the arms.

Results



Overall, the LOCH drone demonstrated tremendous success in mission objective completion. It performed several takeoffs and landings on the water, and successfully captured underwater habitats and water data. It additionally demonstrated maneuverability on the surface of the water without needing to takeoff. The flight endurance time in loiter was approximately 24 minutes with a used 10,000 mAh battery, which can easily be increased by using a new battery. In terms of flight stability, it maintained its attitude and position well with the GPS ATTI attitude stabilization mode on the flight controller. Finally, all flight performance data was transmitted through a Remote ID Module in accordance with FAA regulations.