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Search and Rescue Unmanned Aerial Vehicle

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Project Statement and Objectives

The current technology that exists to successfully locate a missing person in the vast wilderness of a National or State Park has not changed much within the past few decades. Although search and rescue UAVs currently exist, they only do so in bulky, expensive, and inefficient means for the average rescue team. The big question that must be asked in this endeavor is as follows:

"How can we work towards making SAR missions more efficient and time effective because time is of the essence and is basically a matter of life and death?"

The team used the above as a mission statement in the design. By taking all factors of a SAR mission into account, the following deliverables were established for the project.

- Fully Functional UAV
- Some level of Autonomy
- Long Range/High Endurance (6hrs)
- Thermal Imaging
- Easily Deployable (30 min)

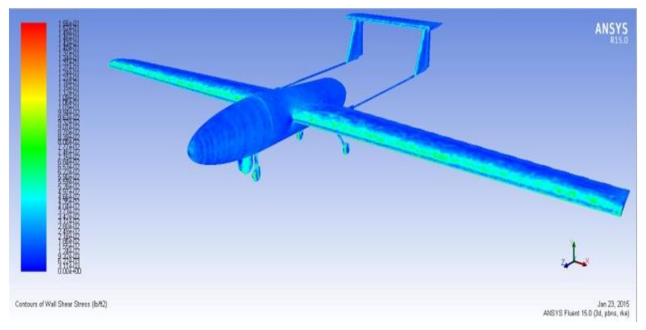
AERODYNAMICS

- Accurate model of UAV created so that major analysis could be completed.

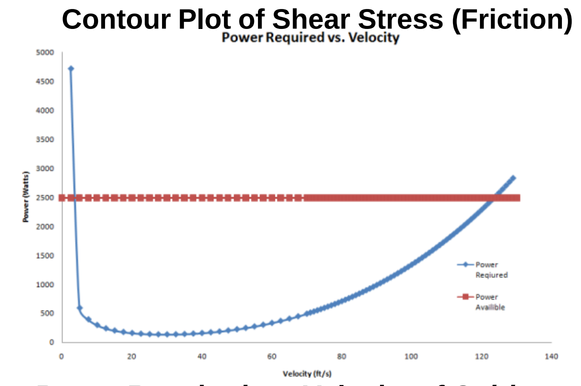
- Wings configured in such a way so that a high aspect ratio was achieved for greater flight time during cruise.

- Computational Fluid Dynamics of entire UAV completed in ANSYS FLUENT so that accurate measurements of lift and drag could be obtained.

- With CFD modeling, major propulsive analysis could be completed to predict flight time of aircraft.

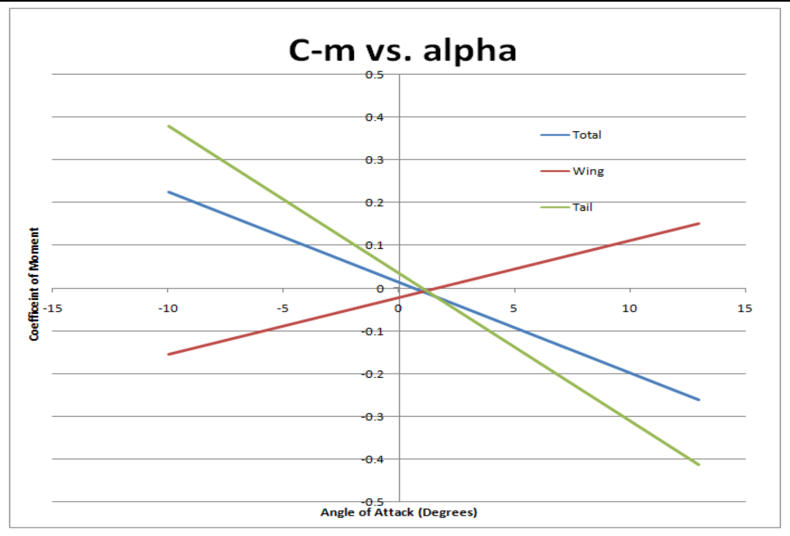


Contour Plot of Shear Stress (Friction)



Power Required vs. Velocity of *Spiritus*

STABILITY



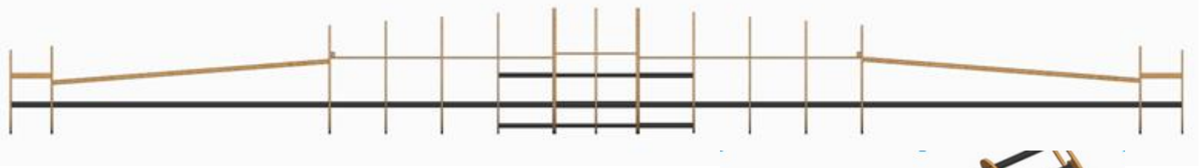
C_m vs. Angle of Attack of entire UAV

Static Stability analysis of the aircraft has been completed to determine correct configuration for control surfaces.

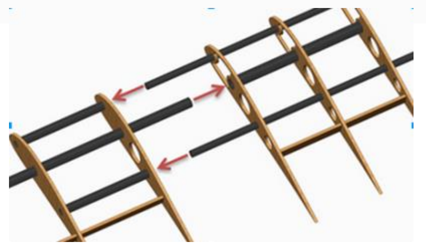
- Static Margin of Aircraft determined to be 0.235 (More on the stable side)

- CG location at 3.55ft with Neutral Point at 3.87 ft

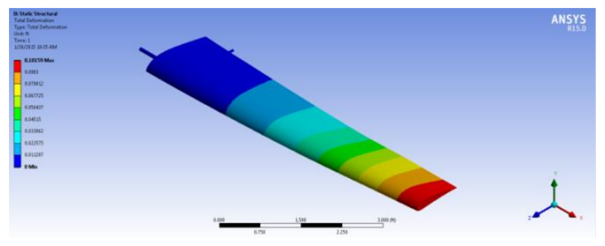
STRUCTURES



- Internal structure consisting of wood ribs and carbon fiber spars created a form to wrap carbon fiber skin around to help support loading of the wings, as well as attach removable wings to the wing box.
- Composite theory and Tsai-Hill failure criterion to analyze the strength of the carbon fiber skin.
- Ansys analysis used to confirm and find maximum deflection of the wing as well as to find maximum stresses in the wing. Material properties assigned to each component for accurate results.



Detachable wings from wing-box



Max Deflection of wing modeled in ANSYS

AUTOPILOT/COMMUNICATIONS

Autopilot

- The PX4 Pixhawk was selected as the microcontroller to be used on the aircraft, running the flight system as well as to carry out the autonomous functions of the *Spiritus*.

-The PX4 Pixhawk has been programmed with autonomous functions, such as maintaining steady level flight, waypoint flight mode, etc, to enable ease of usage for operators of *Spiritus*.

- The Microcontroller comes with built in safety features such as a secondary processor and "return to home" function should there be a loss of communication with the ground.

Communications

-The DJI Lightbridge was chosen as the video feed and control input relay due to its HD video downlink/16-channel PPM input uplink dual digital stream, very compact size, and it is also a digital signal with frequency hopping spread spectrum and encryption support.

-The Lightbridge was also coupled with two 4-watt linear amplifiers and a high gain (16 dBi) directional MIMO panel antenna. These enhancements allow for a ERP of approximately 30 watts.

- The telemetry unit selected was the RFD-900 due to it also having a diversity antenna system and also because the unit has a 1-watt amplifier built in. The unit operates in the 915 MHz (US-legal) band and transmits the flight controller data to the GCS computer.

POWER SYSTEMS

-The electrical systems are powered by a the three-stage alternator that converts the mechanical energy from the engine into electrical power from AC to DC through a ball bearing.

- The power module is the central hub that regulates the current and charges the battery array onboard the UAV.

DESIGN PROGRESSION

- Longer wing span (12-14ft) more lift at cruise.
- Larger control surface area for more control and stability.
- Two bladed prop over three blades gives higher efficiency for more endurance at cruise.
- Larger Airfoil Shaped fuselage reduces form drag & more room for components

FLIGHT SIMULATION

- UK base flight simulation group performing a critical roll in design validation. The team sends MERLIN aircraft geometry and characteristics which is simulated in a flight profile. MERLIN then sends back the flight data for analysis.
- The Simulation is used for the prediction of aircraft handling and stability, since an accurate dynamic stability analysis is hard to achieve analytically.
- Special thanks to Chris Neal, the pilot of the Simulation, for all his help and advice in the process!

SPIRITUS

NORTHROP GRUMMAN

Engineering & Science Student Design Showcase at Florida Institute of Technology

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