SAE Aero Micro 2021-2022

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Abstract

The Society of Automotive Engineers (SAE) Aero competition is a regional event held annually, where teams of college students compete with aircrafts of their own design. The team designed and manufactured an original aircraft based on the criteria provided in the competition rules. Our team consisted of 6 mechanical engineering students who collaborated to create an original aircraft made mostly of carbon fiber with integrated subsystems such as the main wings, landing gear, propulsion system, and control surfaces. The rules provided for the competition required designated cargo to be carried within an enclosed space as well as a maximum wingspan [1]. The design process of the aircraft for the competition was focused on the understanding of aerodynamic principles and how they apply to low Reynold's number flows.

Requirements

The goals set by the team were based on the rules and regulations established by the competition. The restrictions are:

- The given wingspan constraint for the aircraft is 48 inches
- The aircraft is to have a 450-Watt power limiter
- The aircraft must have an easily accessible kill switch
- A 2.4 GHz radio system must be installed for flight control
- Must have an enclosed spacing for holding cargo
- Must be able to add payload and replace battery in under 60 seconds
- Must be able to take off on a 100ft strip, and land on a 200ft landing strip

Design Approach

The design started by selecting the best airfoil for the aircraft's wings based on the best lift to drag ratio. Analyses on xflr5 resulted in NACA 6412 being selected for the wings which were spanned to 46 inches. The fuselage was designed on SOLIDWORKS to fit a 6"x6"x4" payload inside its cargo bay. Flat plates were chosen for the elevator and rudder for ease in manufacturing and install. The interior is hollow to allow quick installment of the aircraft's electrical systems. The motor, batteries, servos, and power limiter can be strategically placed within the interior to help move around and establish a desired center of gravity.

Manufacturing

The wing began as a 3D printed model of the airfoil. It was sanded beginning with a low grit sandpaper and perfected with a higher grit until it was completely smooth. Wax and a release agent were applied. Then carbon fiber was laid onto the mold and resin was pushed into the fabric. After multiple layers, peel-ply was applied to the mold, and was placed in a vacuum bag overnight. Once the part was cured, imperfections were cut away with a rotary saw. The fuselage was a wet-layup as well, with the top and bottom sections enclosing the foam. A hole was cut in the fuselage and acetone was poured inside to remove the foam.

Testing

Engineering Requirement	Target	Calculated Value
Wingspan	48 in	46 in
Cost	$1,500	$738.93
Battery Life	60s	120s
Thrust	5N	3N
Cargo Bay	6x6x4”	6x6x4”
Max Lift	30N	31.5N
Drag	5N	4.631N
Weight	1.2kg	2.5kg
Take off Speed	22m/s	20m/s
RC Signal Range	1000ft	5000ft

The tests conducted show the validity of the plane, and flight characteristics. Testing gave us a good idea of how it will perform in flight at competition to ensure all requirements are met. The table included summarizes key tests findings from the tests and how it compares to expected values. Several in flight tests were not conducted as takeoff has not yet been achieved but will be considered moving forward in future work.

Conclusion

The team successfully made a plane that adhered to the regulations specified by the SAE competition. The plane was manufactured out of carbon fiber then underwent a series of tests to establish an understanding of its capabilities and areas of needed improvement. Certain subsystems met the team's requirements while others did not, leaving area for further development in future work. The team learned skills that will be valuable for their future.

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References

[1] SAE Aero Design Rules Committee, “2022 Collegiate Design Series SAE Aero Design Rules,” SE International, 31-Aug-2021 https://nau0.sharepoint.com/sites/2021-2022SAEAeroMicro/Shared%20Documents/General/Competition%20Guidelines/SAE_AeroDesign_2022_Rules.pdf?CT=1