Senior Project – Electrical Engineering– 2020

SAE AERO Propulsion Design

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What is SAE AERO?

SAE is an organization which holds yearly competitions where students from around the world bring electrically powered RC aircraft they have designed to compete in different events. These events include dropping autonomous gliders and other forms of payload.

Design Specifications:

1. Motor must be electric.
2. Power limited to 750watts
3. Multiple motors are allowed but are still limited to a total of 750watts.
4. Battery must be at least 6 cell 3,000mah

Design Goals:

1. I am looking to achieve ~10+lbf of static thrust at the lowest weight possible.
2. Minimum takeoff speed must be at least 17mph and cruise must be 2x takeoff speed.
3. Battery must meet design specifications but not be over sized for our application. This will help save on weight.

Figure 2: Cobra 4130/20 KV 300

Figure 3: T-Motor U8 Lite, KV 190

Plans for this Year

1. Testing the new motors on the test bench.
2. Since we have no wind tunnel that can accommodate the propeller size we are testing I will be experimenting with different ways of measuring dynamic thrust.
3. Finding the best propeller/motor combination for our aircraft.

References:

[1] S. Gabriel “Propeller Static & Dynamic Thrust Calculation,” September, 2013. [Online]. Available: https://www.electricrcaircraftguy.com/2013/09/propeller-static-dynamic-thrust-equation.html {Accessed Oct. 20,2019]

Initial Research

When conducting initial research I first looked at a variety of motors with varying sizes and performance. Most sites provide performance data for there motors with varying propeller diameter and pitch. This allowed me to narrow down my choice for a motor designed for RC airplanes. However research led to finding motors designed for a quadcopter produced much more static thrust with double the efficiency. However this means the motor RPM would be much lower. This raised the question of whether or not the aircraft would have a high enough top speed with this fancy motor. Using equation 1 (below) I found the aircraft would have a top speed of ~30mph. In theory this should work but only testing will tell.

Equation 1: Dynamic Thrust Equation [1]

Expanded Form:

$$F = 1.225\frac{\pi(0.0254\cdot d)^2}{4}\left[\left(RPM_{prop}\cdot 0.0254\cdot pitch\cdot\frac{1min}{60sec}\right)^2 - \left(RPM_{prop}\cdot 0.0254\cdot pitch\cdot\frac{1min}{60sec}\right)V_0\right]\left(\frac{d}{3.29546\cdot pitch}\right)^{1.5}$$

Analysis of Last Years Results

Last years team used a 400KV E-flite motor with an 16x10in propeller. Using our test bench we measured this setup to output 7.8lbf of thrust at 750watts. This setup provided sufficient thrust for the aircraft with 10lbs of added weight totaling ~25lbs.

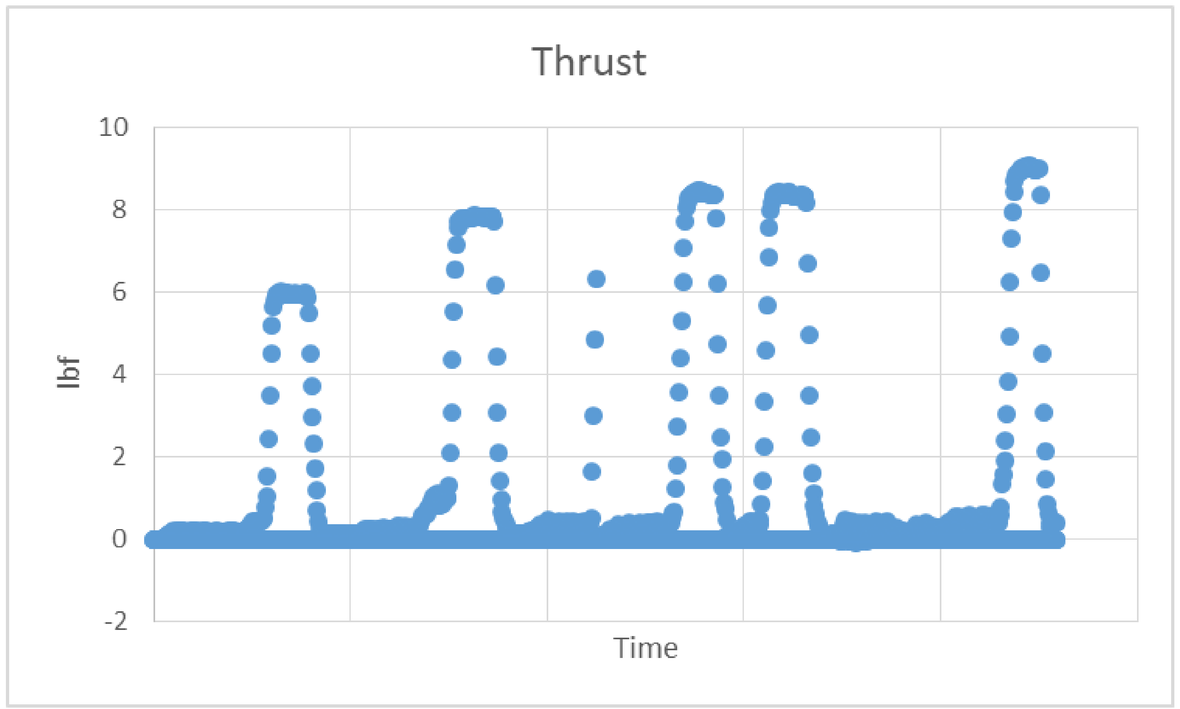

Figure 1: Thrust Data

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