Electric Propulsion Data Aqusition and Optimization

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Research question

What is the relationship between the maximum thrust capability of an electric propulsion source and the current airspeed of the device? How can this relationship be used to optimize an electric aircraft propulsion to maximize range and other aerodynamic characteristics?

Data Collection Unit + Filtration Program

- Arduino based
- Consists of onboard gyro/accelerometer + barometer
  - additional 7 analog sensor devices can be connected
- Powered via 1s lipo
- all data logged onto micro-SD

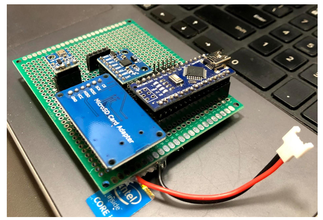

Fig 1. Data Collection Unit

Java filtration program runs post flight on collected data

- Auto detects SD card and stores filtered data in new file
- Runs several layers of filters (can be changed by user)

Fig 2. Java Filtration ProgramFig 1. Data Collection Unit

Results

No data was collected; However, Daniel Kosednar had a similar project and his data was used for analysis. The following data was collected via a rather limited data collection unit which only logged thrust and airspeed. The raw data collected and is rather unusable for calculations in its current state. This data was used to test the data filtration program developed as part of my project.

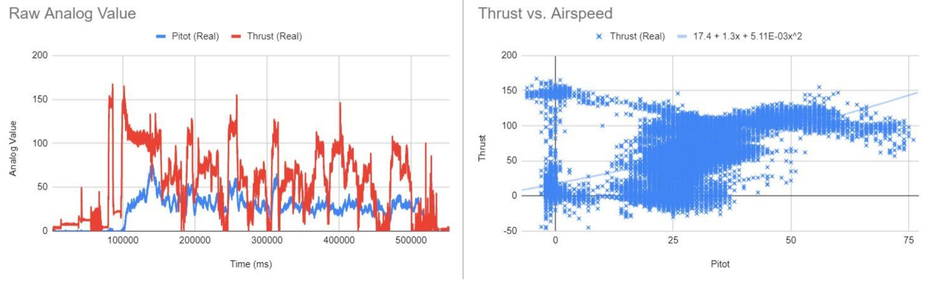

Fig 3. Raw Data collected by Daniel Kosednar

I have developed a Java data filtration program which runs post flight directly on the data logger SD card. Figure 4 is the filtered data and shows the relationship between thrust and airspeed. Unlike the raw data, the curve of best fit indicates the thrust capability of of an electric propulsion source decreasing with airspeed. As a result, it has been proven that airspeed is one of the characteristics that could be optimized to maximize the range of an electric aircraft.

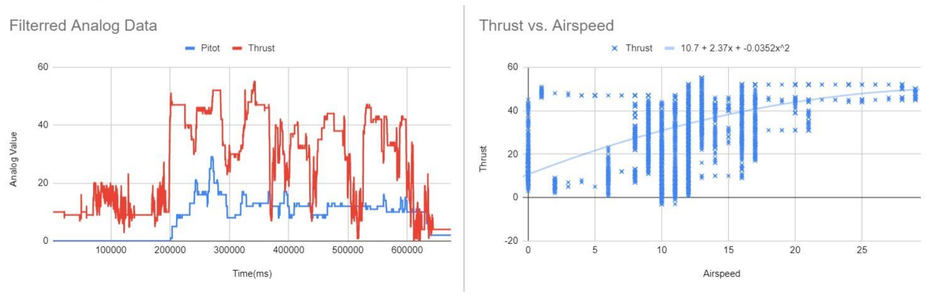

Fig 4. Digitally filtered data. Obtained post-flight

Static Thrust Stand

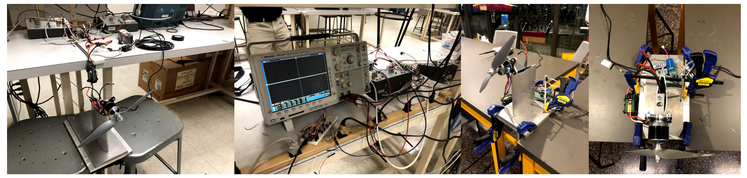

Fig 5-8. Final Circuit, Breadboard Circuit, First Data logging PCB (from left to right)

Static thrust stands were used to measure the total thrust produced by a motor and propeller configuration. The noise in the data was also observed using an oscilloscope in order to design an analog RC circuit and tune the data filtration thresholds, which further improved filtration.

Improvements

Considering that this project is not complete, there are several things that can still be improved before an actual test flight is conducted:

- implementation of an RC filter
- throttle to thrust data mapping
- airspeed verification via onboard sensors
- climb rate optimization

Partial Conclusion

T(A) = (-0.0352)x^2 + 2.37x + 10.7

From a quick calculation, the max of the Thrust function occurs at an airspeed of 33.665 (analog value 0 - 255). The value still needs to be mapped to a velocity.

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