Aircraft Performance Data Aqusition

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Research question

Obtaining electric fixed-wing UAV performance data to verify and optimize aircraft design from a single flight. Specifically, mapping the thrust lapse and efficiency characteristics.

Data Logger + Digital Filtration

- onboard gyro/accelerometer, barometer
  - additional 6 analog sensor can be connected
- Power: 1s lipo / 5V power supply
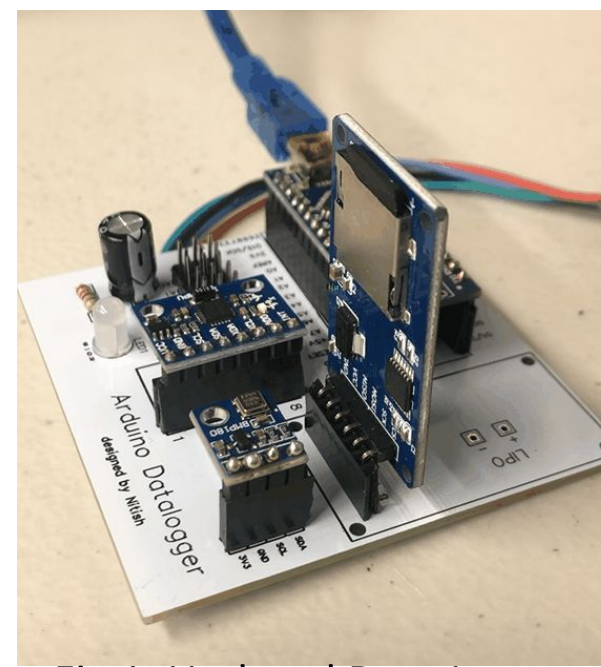- data logged onto micro-SD (for post-flight analysis)

Fig 1. Updated Data Logger

Java filtration program runs post flight on collected data
- Auto detects SD card and stores filtered data in new file
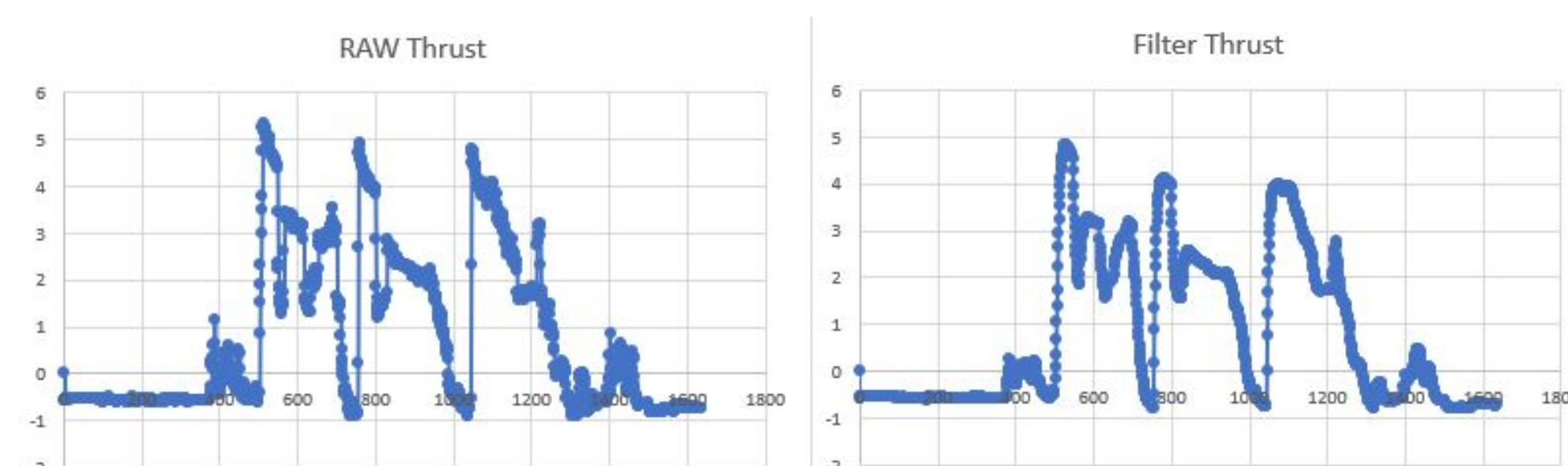- Runs several layers of filters (can be changed by user)
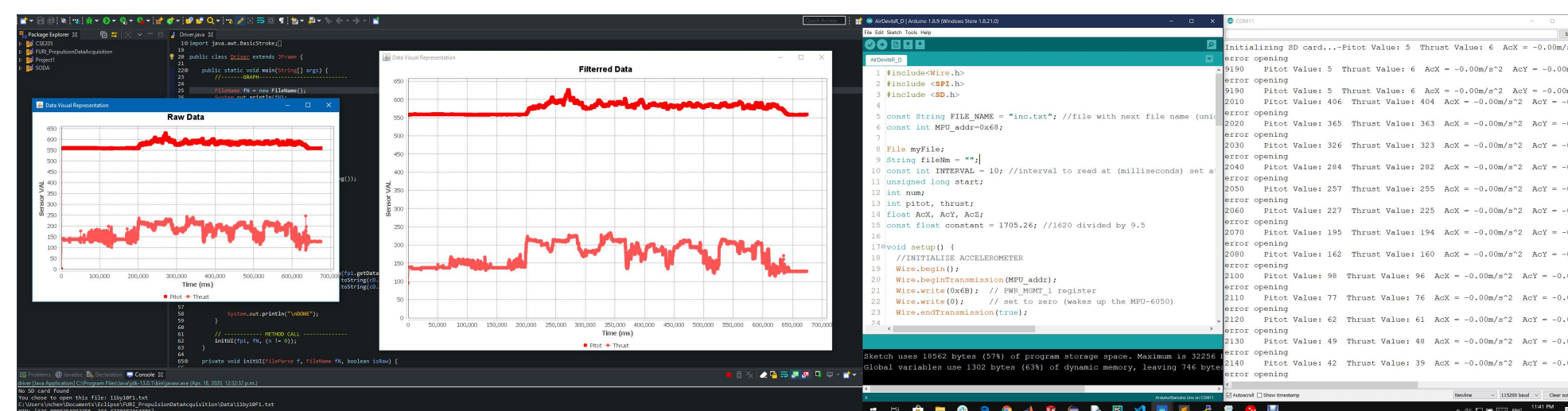

Fig 2. Filtered Data Sample
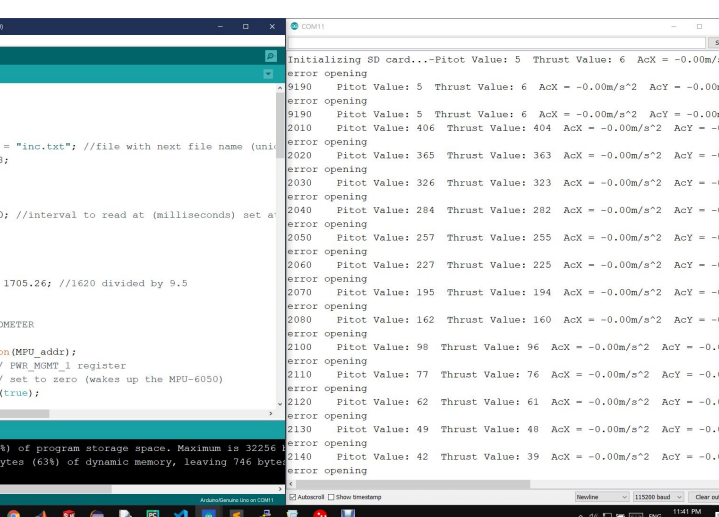

Fig 3. Java FIltration Program Running

Fig 4. Arduino Programming

Summary

Considering the applications and popularity of electric fixed-wing UAVs are growing, it is critical to quickly obtain performance data on different aircraft platforms to verify and optimize design by application requirements. Consequently, the development of modular instruments, software (*Fig 3,4*), and data logger (*Fig 1*) are essential.

The test article used to test this experimental system was the Kadet Trainer RC plane (*Fig 6*). The Kadet is a 3 channel electric model aircraft with a swappable propulsion system and two external sensors: load cell (to measure thrust) and a pitot tube (to measure airspeed). Along with the external sensors, the brushless motor electronic speed controller also logs basic power information useful for aircraft power consumption data.

For simplicity, this system is initially being analyzed solely based on the two external sensor data. Although minimal, these two sensors still provide a number of essential aircraft performance characteristics including: projected top speed (level flight), airframe drag, takeoff speed, thrust lapse data, and acceleration data.

Conclusion

The following research project has touched upon several methods of data collection and analysis, but the overall goal of this project is to automate the process of optimizing electric fixed wing aircrafts as much as possible while performing this task better and faster than by hand. This is possible due to the stable architecture of the following optimization system. The Optimization System is comprised of 3 main components:
- Data Collection Unit
- Post-flight filtration program
- Data Analysis Plotter/Helper Functions

Data Collection Unit: Logs sensor data raw as a .txt file onto ejectable storage unit (micro-sd card)

Post-flight filtration program: Digital filter designed to reduce inherent noise from sensor data. Incorporates several types of filters which can be selected/manipulated by the user based on data quality.

Data Analysis Plotter/Helper Functions: Even with data filtration, portions of data may still need to be isolated for further analysis. An example of this going wrong is illustrated in *Figure 8*. The error resulted in a **37% overestimation error** of theoretical top speed (*Fig 7* - corrected/filtered data).

Propulsion Configs + Pics

Motors		Prop Size	
1)	770kv	1)	10 x 6
2)	--- kv	2)	14 x 8
3)	750kv	3)	9 x 7.5

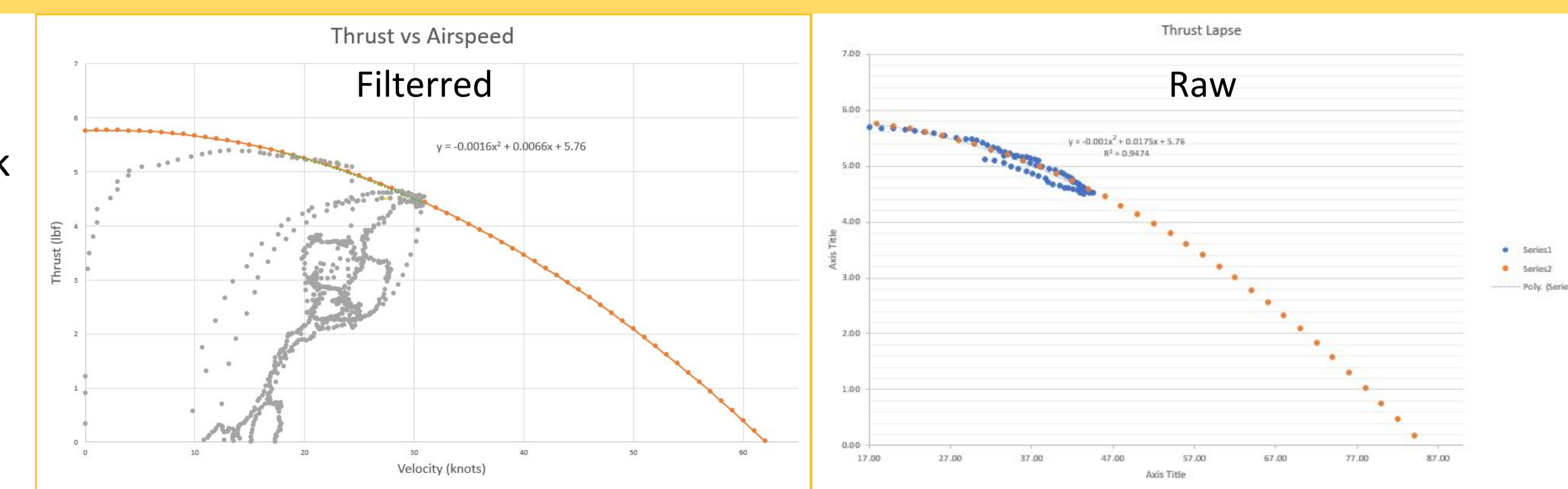Fig 5. Thrust Sensor / Prop+Motor

Fig 6. Kadet Trainer

Fig 7. Filtered Thrust Lapse: 10x6 770kv 6s

Fig 8. Raw Thrust Lapse: 10x6 770kv 6s

Improvements

Although this project has achieved its fundamental goal, there are still improvements which could be made to make the process of data collection more efficient:
- implementation of electrical RC filter
- flying with all sensors + sensor fusion
- throttle position to thrust data mapping