Long Range Surveillance VTOL Design Framework Software

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1 Introduction and Initial Research

Problem

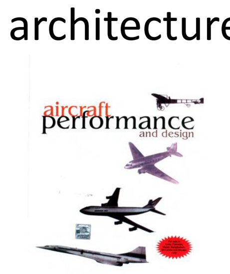
- The need for Unmanned Aerial Systems (UAS) is becoming more apparent with increasing end-use applications, including arctic surveillance, agriculture, search and rescue, wildfire monitoring, border security, etc.
- As such, there is a growing need to expand the ability to design UAS vehicles. However, it is currently an arduous endeavor with scarce software solutions.

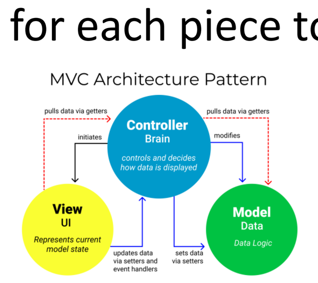
Our Solution

•Creation of a predictive performance modelling framework
  ○ Designed for low-subsonic, fixed-wing E-VTOL aircrafts.
  ○ Validate by utilizing a MakeflyEasy HERO E-VTOL UAV.
•Framework should accept key parameters such as
  ○ Wingspan, weight of the drone, and battery capacity.
•It will then generate performance metrics such as
  ○ Range, max speed, stall speed.
•Final deliverables
  ○ Predictive modelling framework.
  ○ CSV detailing flight break down.

Methods

- Derived and verified our design approach using John D. Andersons "Aircraft Performance and Design"
- Created and broke down flight profiles into various period sections. Take off, landing, climb, descent, and cruise period sections calculated using reference material formulas.
- Aimed to create easily adaptable software with a software architecture that allows for each piece to be compartmentalized.

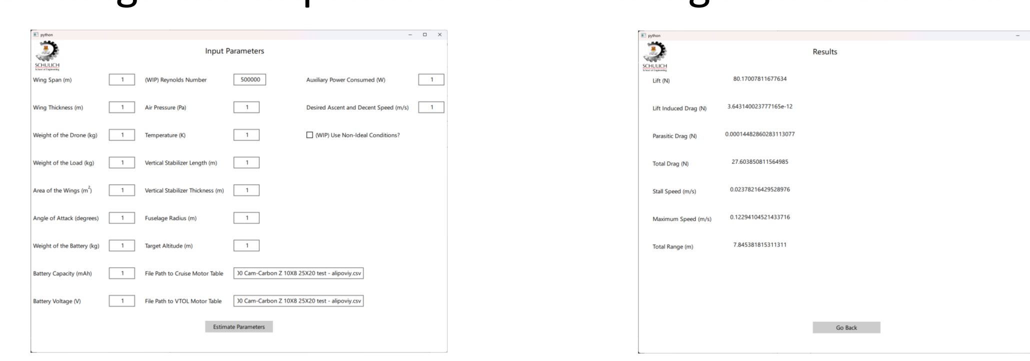




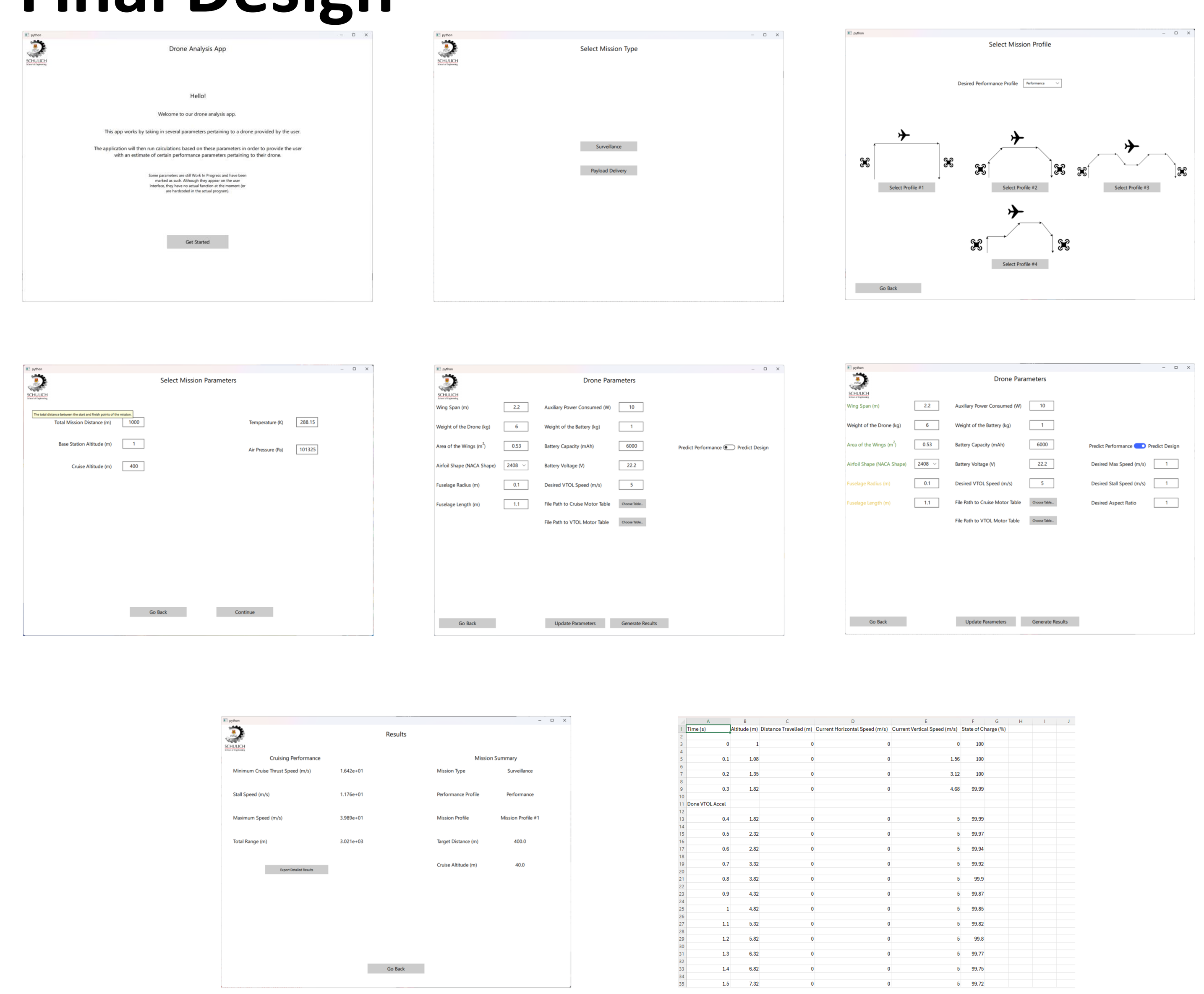
2 Protoyping and Final Design

Initial Design

- Our first prototype implemented all the different parameters related to drone design in one place
- Employed an iterative design approach to ensure the code scalability and future enhancements
- Implemented a user input and output page to display results
- This approach was cluttered and made it hard to navigate and too open ended
- With the help of our sponsors, we were able to identify our shortcomings and implement those changes into our final design



Final Design

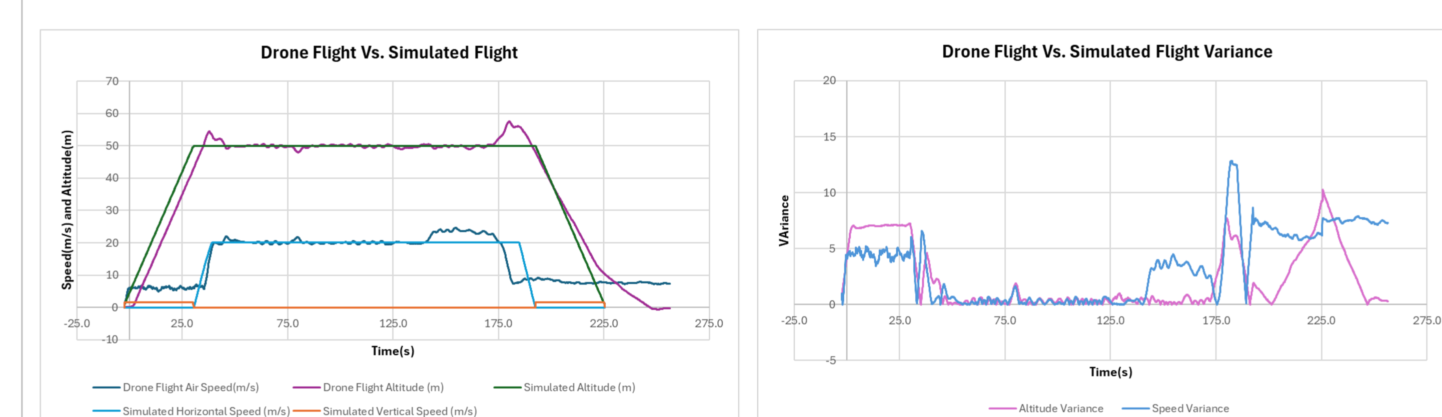


3 Results and Validation

Validation Flight Tests

- Executed a flight plan following the first mission profile to perform the following test procedures to validate our model utilizing the MakeflyEasy HERO E-VTOL UAV
  ○ Max speed test
  ○ Battery endurance test
  ○ Max takeoff weight test

Results



Analysis

- Comparing the drone flight data to the simulated flight data we find the results from our program closely follow the flight data from the tests
- Pros:
  ○ The takeoff, acceleration and cruise periods matched up very closely with the drone flight data, with little variance in these phases of flight
  ○ The variance that was found was due to slight mismatching in times. Otherwise, it is evident the slopes and general shape of the plots are very closely matching
- Cons:
  ○ The data diverges in the deceleration and landing segments beyond simple mismatches in time.
  ○ This divergance is due to the simulation's neglect to consider the air brake procedure done to prepare for landing
- Potential Improvements and Next steps
  ○ Adding additional period sections to account for moments when the VTOL and fixed-wing flight modes are active simultaneously
  ○ Add custom mission design using the predefined period sections