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Design of an Autonomous Small Parafoil System, Guidance and Control

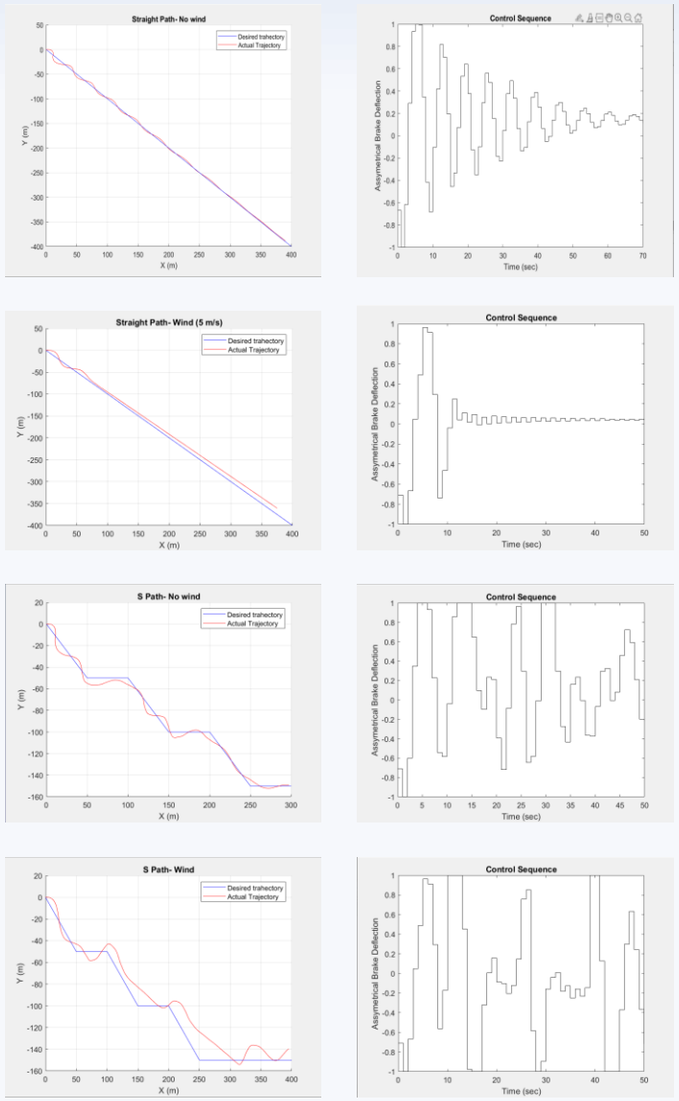
ABSTRACT

The scope of this thesis is the modelling of a six-degree of freedom parafoil/payload system and the design of the guidance and control algorithms for a controlled landing. The modelling is done based on a payload compatible with the European CanSat requirements. The parafoil system is optimized and simulated in MATLAB/Simulink environment. The guidance system consists of a waypoint path planning algorithm creating a straight and an S-shaped path for the system to follow. Model Predictive Control is chosen to produce a good path-following accuracy even in the presence of wind.

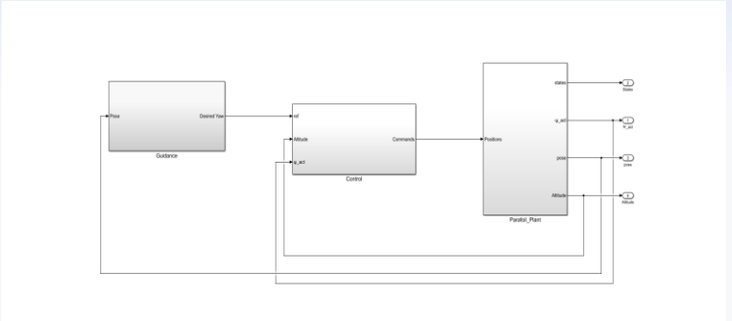
METHODOLOGY

I. The mathematical equations of the six-degree of freedom parafoil system are defined.
II. The aerodynamic coefficients and apparent mass and inertia terms are calculated.
III. The geometrical characteristics are defined via optimization of the system based on performance (L/D ratio)
IV. The system is created in Simulink and validated based on known data.
V. Simulations with no control and control input are conducted and evaluated
VI. Guidance and Control systems are developed and tested in environment with and without wind

SIMULATION RESULTS



SIMULINK MODEL



CONCLUSIONS

- The system parameters were identified based on a parametric analysis that tested different aspect ratios and their influence on lift-to-drag ratio which is a primary performance parameter for the system. Aerodynamics and Apparent mass effects were also studied and implemented in the model.
- Simulations of the system's response were carried out for no control, symmetrical and asymmetrical control input giving reasonable results.
- The lateral control via the Model Predictive Controller showed adequate path following capabilities even in windy environments.
- A simple longitudinal control was designed to command the parafoil to perform a flare manoeuvre for reducing the velocity before landing.