Temasek Defence Systems Institute

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Missile Autopilot Design for Pseudo Linear High Manoeuvring Air Targets

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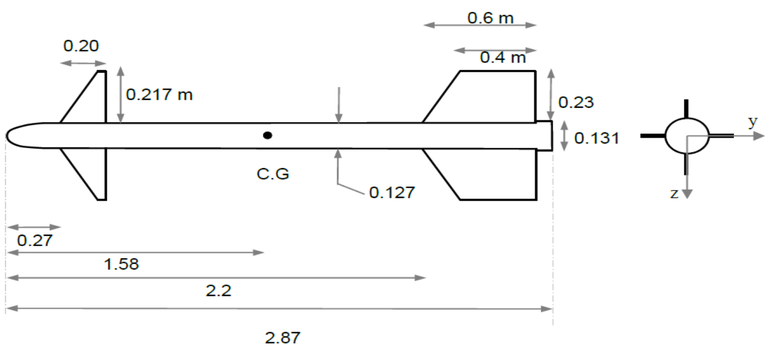
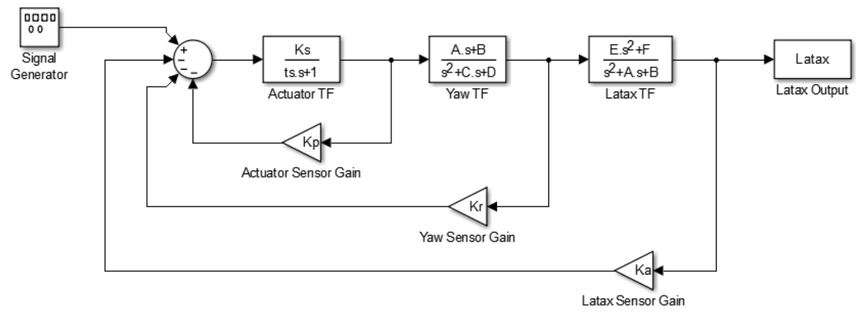
Objective

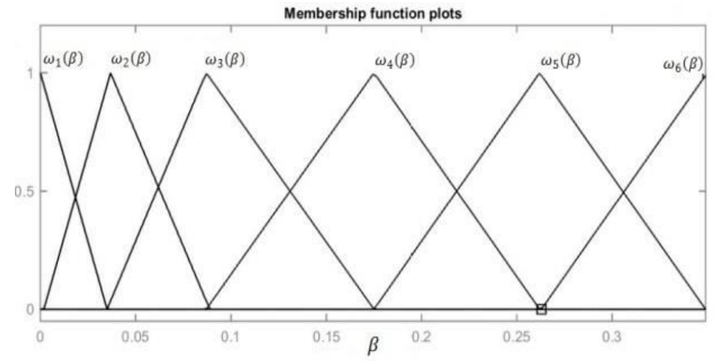
This thesis discusses the design and analysis of classical and fuzzy control techniques on a non-linear missile autopilot control system. The concept of hybrid fuzzy logic based modelling of the missile parameters whereby physical system modelling blends with Sugeno fuzzy modelling is introduced. The thesis also investigates the design of state-space observers to evaluate its effectiveness in replacing sensors in the event of a sensor failure. Lastly, a model Kalman filter was explored to detect yaw or latax sensor failures.

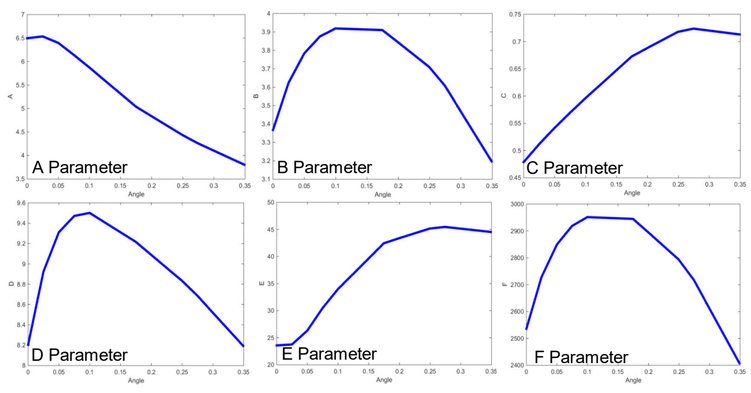
Main Research Ideas

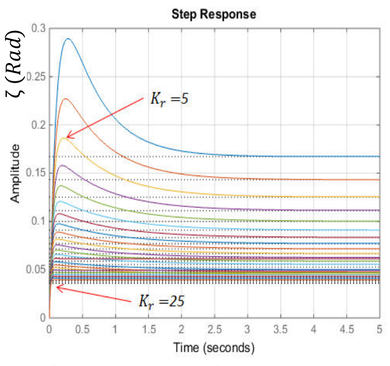
A missile model has varying aerodynamic coefficients throughout its flight as it changes with the speed and angle of attack (AOA) of the missile. To accurately model a missile, the coefficients must be varied parametrically and the autopilot control gain scheduled to ensure the missile's performance throughout flight.



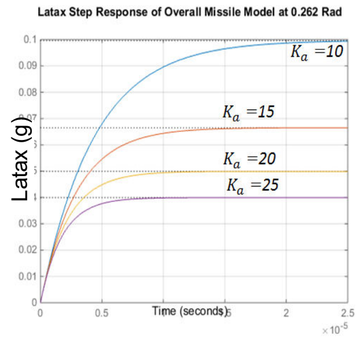




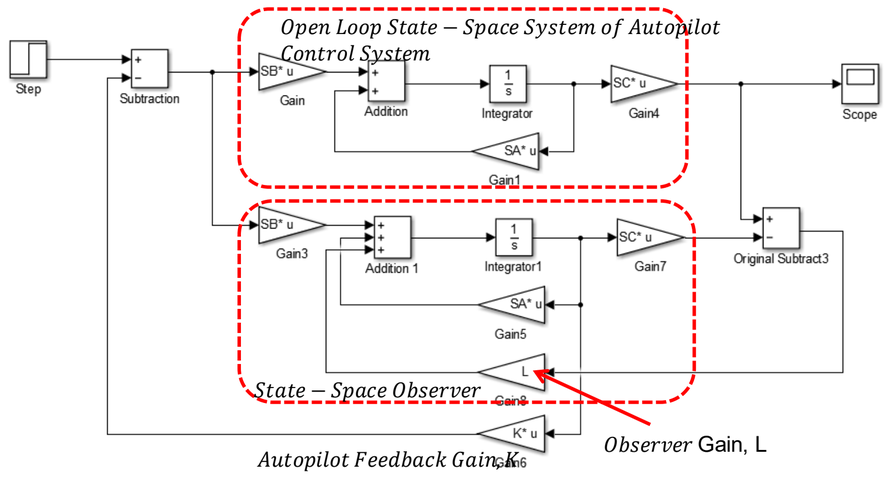




Step Response of Yaw Block at β=0.262 rad with varying K_r Gain between 3 and 25.



Step Response of Latax Block at β=0.262 rad with K_r=25



Findings

The thesis has showed that Sugeno based fuzzy expressions are suitable to model the non-linear missile autopilot control system. The use of different types of membership functions for the Sugeno based fuzzy expressions may be explored in future. It could also include the investigation of fuzzy clustering for missile autopilots. Lastly, this thesis assumed that the sensors utilised were perfect sensors when in reality, it may not be the case. The sensors themselves may also be affected by transfer functions and they could have an effect on the performance of the autopilot control system. Therefore the dynamics and implications of sensors on the system could be studied further in detail. Part of this thesis has been submitted as a paper to the 2016 American Control Conference (currently under review).

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