Title - Intelligent Controllers Design for Optical Fine Pointing Systems

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The work reported in this thesis is primarily addressed two challenges of the Pointing and Stabilization system i.e., Jitter attenuation and Input command dynamic response.

Initially, Kinematic equations based relationship is developed between LOS (Line of Sight) angle and applied torque. The conventional control design methodology based on the frequency domain approach is adopted, and the obtained results are verified experimentally. The first level validation is done with numerical simulation runs and then the developed controller configuration has been implemented on high-end DSP hardware and interfaced with the designed gimballed sensor system. Furthermore, Fuzzy logic control (FLC) configuration is also designed for the proposed stabilization model. The comprehensive comparative suggests that the designed gimballed sensor system can achieve jitter attenuation performance in the range of 30-50 μradian.

This thesis also investigated the FSM dynamics with different controller configurations to increase the limit of precision pointing, jitter attenuation, and desired bandwidth as per applications. In this, PI lag compensation approach is initially used for parametric validation. Then PID controller configuration is developed and optimized using GA, PSO, and GWO algorithms. Furthermore, intelligent controller configuration (FLC, ANFIS, GA tuned FLC) are developed for FSM electro-optical pointing and stabilization assembly to overcome the pointing error associated with inaccurate dynamic modelling, saturation, and non-linearity.

The comprehensive comparative analysis suggests that the intelligent controllers provide more robust and optimal performance with less computational efforts than conventional controllers in terms of both time responses and disturbance rejection.

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