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# DEEP REINFORCEMENT LEARNING-BASED GAIN SCHEDULING FOR ATTITUDE CONTROL OF MICROSATELLITES WITH CHANGING INERTIA

**Abstract**

Future satellite platforms will be designed to perform a variety of in-orbit tasks including debris capture, deployment of smaller satellites, assembly and manufacture, and use of appendages such as robotic arms. These activities result in time-changing inertia properties of the platform and, as a result, adaptive control techniques will be required to enable traditional attitude regulation and tracking modes. Typical control architectures implemented on microsatellites with fixed inertia matrices utilise Proportional-Derivative (PD) controllers using quaternion and body rate feedback, with attitude information provided by a suitable state estimator. These controllers are tuned to a single operating point and therefore performance will change depending on the changes to the platform configuration, whether through the use of a robotic arm or deployable appendages. Gain scheduling is a popular adaptive control technique that involves selecting operating points and generating gains that the controller can switch between based on a suitable switching parameter. This allows for performance to be tuned at each operating point for systems with unknown or changing parameters. In this paper we develop a deep reinforcement learning (DRL) agent to dynamically adjust the controller gains when performing attitude tracking and regulation of a microsatellite with a time-varying inertia matrix. A Proximal Policy Optimisation (PPO) algorithm is used to train the agent in a simulated environment, using a 6U Cubesat as the baseline spacecraft. The proposed continuous-adaptive control scheme is demonstrated on single scenarios and through Monte-Carlo analysis to demonstrate the robustness for attitude tracking and regulation. Performance of the DRL gain-scheduled PD controller is compared to a baseline PD controller tuned to a single operating point and a fuzzy logic gain-scheduled control scheme for attitude tracking and regulation scenarios for the satellite platform.