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Nonlinear Lyapunov control improved by an extended least squares adaptive feed forward controller and enhanced Luenberger observer

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Three adaptive approaches for a non-linear feedforward controller are combined with and sinusoidal trajectory planners in a spacecraft attitude control system. Physics-based feedforward control, trajectory generation, observers, feedback control, and system stability are discussed in relation to the nonlinear dynamics under simulation. The adaptive feedforward controllers compared include an adaptive controller, a Recursive Least Square (RLS) Method, and an Extended Least Squares (ELS) Method. A novel approach to incorporate ELS in adapting an idealized feedforward controller was developed and compared to the standard RLS optimal estimator. For a large slew maneuver, the controller configuration with ELS feedforward, PID feedback, and sinusoidal trajectory outperformed the baseline adaptive controller. Mean error was decreased by 23.4%, error standard deviation by 34.0%, and maximum error by 33.0%. Mean control effort was similar for all controller configurations. This improvement is due to corrections for miss-modeled dynamics, which occur during spacecraft launch, collisions with debris, or due to fuel slosh and loose components

Biography

Matthew Cooper completed his M.S. in Electrical Engineering and M.S. in Aeronautical Engineering at the Air Force Institute of Technology and his B.S. in Electrical Engineering at Penn State. He has worked as an Electrical Systems Integration Engineer at BAE Systems, as a Geospatial Intelligence Project Engineer at the National Air and Space Intelligence Center, and is currently at the AFRL Advanced Laser Division.

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