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To whom it may concern,

Review of the Ph.D. dissertation of Mr. Yerkin Orazaly
Thesis: Development of a stability analysis method for a nonlinear satellite attitude control system based on its mathematical model in linear form.

The dissertation addresses a problem of analyzing the stability of a satellite attitude control system with reaction wheels. A satellite rotational dynamics and its interactions with the total angular momentum of the satellite and reaction wheels show non-linear dynamics, which are usually difficult to handle cleanly with off-the-shelf linear methods.

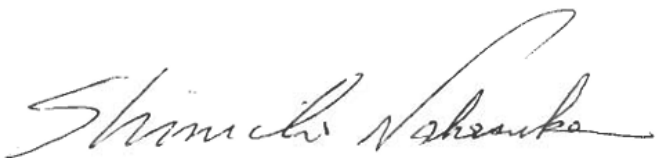
The central idea of the dissertation is to avoid the usual shortcut of replacing the nonlinear system with a local linearization. Instead, the author represents the nonlinear dynamics directly in linear form with time-varying coefficients. This keeps the analysis tied to the actual equations of motion and opens the door to applying linear control theory without discarding the structure of the problem. The treatment of the asymptotic behavior of the angular momentum, and how the initial angular momentum feeds into the coefficients of the limiting linear system, is the core of the work.

The model is built on Euler equations, quaternion kinematics, and a PD control law, which are reasonable and well-grounded choices. From them, the author derives the linear-form representation, establishes a limiting system with constant coefficients, and maps out stability conditions in the controller parameter space. The stability regions are analyzed using the coefficient method and then cross-checked against the Hurwitz and Mikhailov criteria. Having two independent verification paths adds real confidence to the results.

The author also developed a prototype attitude control system with reaction-wheel actuators and tested across yaw, roll, and pitch channels, including the case when disturbance is introduced. The experiments confirm that the selected control structure works also in practical s

The scope of the dissertation is appropriate for a Ph.D, as the problem is clearly stated, the mathematical treatment is coherent, and the experimental work ties the theory back to hardware. The results have been published in refereed venues.

From these observations, I recommend this dissertation for defense for the degree of Doctor of Philosophy (Ph.D.).



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