Research Papers on 'AERODYNAMICS'

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Paper 1:

Pitch Plane Trajectory Tracking Control for Sounding Rockets via Adaptive Feedback Linearization

Date: 2025-03-06

Time: 09:02:15

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Summary:

- This paper proposes a pitch plane trajectory tacking control solution for suborbital launch vehicles relying on adaptive feedback linearization. Initially, the 2D dynamics and kinematics for a single-engine, thrust-vector-controlled sounding rocket are obtained for control design purposes. Then, an inner-outer control strategy, which simultaneously tackles attitude and position control, is adopted, with the inner-loop comprising the altitude and pitch control and the outer-loop addressing the horizontal (downrange) position control. Feedback linearization is used to cancel out the non-linearities in both the inner and outer dynamics. Making use of Lyapunov stability theory, an adaptation law, which provides online estimates on the inner-loop aerodynamic uncertainty, is jointly designed with the output tracking controller via adaptive backstepping, ensuring global reference tracking in the region where the feedback linearization is well-defined. The zero dynamics of the inner-stabilized system are then exploited to obtain the outerloop dynamics and derive a Linear Quadratic Regulator (LQR) with integral action, which can stabilize them as well as reject external disturbances. In the outermost loop, the estimate on the correspondent aerodynamic uncertainty is indirectly obtained by using the inner loop estimates together with known aerodynamics relations. The resulting inner-outer position control solution is proven to be asymptotically stable in the region of interest. Using a single-stage sounding rocket, propelled by a liquid engine, as reference vehicle, different mission scenarios are tested in a simulation environment to verify the adaptability of the

proposed control strategy. The system is able to track the requested trajectories while rejecting external wind disturbances. Furthermore, the need to re-tune the control gains in between different mission scenarios is minimal to none.

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