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ASCENT FLIGHT CONTROL OF LAUNCH VEHICLE USING ANGLE OF ATTACK ESTIMATOR

Abstract

A launch vehicle with a long slender body is an aerodynamically unstable structure that needs to be stabilized in order to fulfill its mission to deliver payload into outer space. Due to many factors such as a high order of the system, a harsh environment that it is exposed to, various uncertainties in parameters, and disturbances, the launch vehicle is difficult to control. The atmospheric ascent phase is critical in launch vehicle flight because of the high dynamic pressure and wind disturbance imposed on the vehicle at that phase.

One method that can be used to reduce the load on the vehicle is by utilizing the angle of attack as a feedback input for the attitude control system. While using angle of attack feedback is interesting for its dual feature of both drift and load relief, direct measurement of angle of attack in a real launch vehicle is difficult due to the combined factors of harsh environment and reliability of measurement. In this study, we propose an angle of attack estimator based on attitude angle and lateral acceleration. This estimator is integrated into an attitude control system to stabilize and control the launch vehicle. The controller attempts to stabilize the system, achieve desirable attitude response, and provide load relief effort against wind disturbances.

Attitude control system is designed for typical standard vehicle model, including actuator dynamics and body bending filter to degrade the system performance. Several simulations using classical method incorporated with drift-minimum and load-minimum control scheme are done as comparisons and to see the benefits and weaknesses of each scheme. Time simulation shows that the control system designed is able to stabilize the vehicle and provides robustness under wind disturbance, while achieving improvements on its attitude response.