

SPACE LAUNCH SYSTEM ASCENT FLIGHT CONTROL DESIGN

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A robust and flexible autopilot architecture for NASA's Space Launch System (SLS) family of launch vehicles is presented. As the SLS configurations represent a potentially significant increase in complexity and performance capability of the integrated flight vehicle, it was recognized early in the program that a new, generalized autopilot design should be formulated to fulfill the needs of this new space launch architecture. The present design concept is intended to leverage existing NASA and industry launch vehicle design experience and maintain the extensibility and modularity necessary to accommodate multiple vehicle configurations while relying on proven and flight-tested control design principles for large boost vehicles.

The SLS flight control architecture combines a digital three-axis autopilot with traditional bending filters to support robust active or passive stabilization of the vehicle's bending and sloshing dynamics using optimally blended measurements from multiple rate gyros on the vehicle structure. The algorithm also relies on a pseudo-optimal control allocation scheme to maximize the performance capability of multiple vectored engines while accommodating throttling and engine failure contingencies in real time with negligible impact to stability characteristics. The architecture supports active in-flight load relief through the use of a nonlinear observer driven by acceleration measurements, and envelope expansion and robustness enhancement is obtained through the use of a multiplicative forward gain modulation law based upon a simple model reference adaptive control scheme.

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