Flying Vehicles Loss-Of-Control Autonomous Recovery Using Nonlinear Smooth Regulators and Neural Network with Exponential Observers

Future Aerospace vehicles will become extremely complex and expensive that advanced level of automation should be a viable tool not just for safety of their crew but also for their reusability where smart systems should enhance their flight control systems especially throughout In flight Loss - Of - Control (LOC). A variety of facts is at the core of In - flight LOC problem from failures of critical components, exogenous disturbances, forced departure due to maneuverability near upset trim points or at the boundaries of the flight envelope and also near the boundary of different regular operating trim points due to the limits of affine models used as benchmark of most design. In general, LOC events contribute to destabilize internal dynamics (zero dynamic / sliding dynamic) that most flight control design techniques failed to fully capture its nature especially leaving upset flight vehicles trajectories unstable and unpredictable. This work focus on the design of compact autonomous intelligent recovery controllers where nonlinear exponential observers is added to estimate states critical for their accuracy when enabling post LOC flight recovery regimes. The resulting compact flight recovery controller would assist pilots during post LOC flight recovery regimes to steer flight vehicles to the nominal flight regimes where safety requirements and flying qualities are satisfied. The longitudinal dynamic of the Generic Transport Model (GTM) model is used for illustration of the post LOC flight recovery regimes.