

Analytical and simulation-based V&V techniques applied to hypersonic vehicles

This paper addresses the applicability of analytical and optimization-guided simulation-based Worst-Case Condition (WCC) search techniques for advanced V&V, to variable geometry hypersonic aircrafts. The baseline analytical WCC search methodology adopted uses the structured singular value and an LFT model, formed from a subset of the uncertain parameters defined for the nonlinear dynamics. This analysis is complementary to traditional Monte-Carlo campaigns in that it provides an analytically guaranteed existence of WCCs. However, it tends to provide overly conservative results when the system depends on time-varying parameters, such as morphing. Hence, a novel method using SVO-based LPV model invalidation techniques is proposed to directly exploit performance degradation arising from those time-variations. The simulation-based WCC evaluation is performed by minimizing certain cost functions intrinsically aligned with the vehicle performance, using global optimization algorithms and a high-fidelity nonlinear simulator. The different adopted techniques are compared in terms of successfully identified WCCs and computational requirements.