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A Study on the High Stability Control for the Integrated Aero-propulsion System under Supersonic State

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Abstract: Considering the differences among the flight operations in super maneuverability under supersonic state, a novel aero-propulsion system stability controller including a direct surge margin controller and active controller is well designed and applied in the flight of large angle of attack and aircraft acceleration process. First of all, an integrated aero-propulsion system model including inlet and engine is built to simulate the coupling problems between inlet and engine. And, an inlet controller is designed in order to modulate the inlet to satisfy the engine dynamic requirements. At the same time, simulation results indicate that the designed inlet controller could avoid the inlet super-critical working state and restrict the inlet outlet distortion. Then, based on the integrated aero-propulsion system model and the designed inlet controller, an online engine surge margin estimator is built and a direct surge margin controller is designed. Simulation results in the control of aircraft flight of large angle of attack indicate that the direct surge margin controller shows a better performance than the traditional controller. For the aero-propulsion system active controller, a compressor stall detection algorithm and a real-time compressor blade tip pressure generator are established. The simulation in the aircraft acceleration process proved that the designed high stability controller could **protect** the engine **against** stall and keep the engine in safe and **efficient** state.

Keywords: integrated aero-propulsion system model, inlet controller, HISTEC, stall detection, active controller.

Nomenclature:

AIP	:Aerodynamic Interface Plane
HISTEC	:High Stability Engine Control
ALQR	:Augmented Linear Quadratic Regulator
F_{in}	:Installed Engine Thrust
N_f	:Fan Corrected Rotational Speed
N_c	:Compressor Corrected Rotational Speed
W_{fb}	:Main Combustor Fuel Mass Flow Rate
T_{25}	:Fan Exit Temperature
RR-LSSVR	:Recursive Reduced Least Squares Support Vector Regression
H	:Flight Height
Ma	:Mach Number
E_{in}	:Inlet Control Error
σ	:Inlet Total Pressure Recovery Coefficient

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