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ACTIVE FLOW CONTROL OF AN OVER-EXPANDED NOZZLE BY SHOCK VECTOR CONTROL

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Active flow control in supersonic nozzle mainly concerns strategies for Fluidic Thrust Vectoring (FTV). Actual thrust vectoring technology is based on movable nozzles but approaches based on active flow control are under investigation. FTV does not need the complex adjustable hardware of variable geometry devices. FTV in fixed symmetric nozzles is obtained, for instance, by a local blowing at wall that causes flow separations and asymmetric pressure distributions, thus allowing the vectoring of primary jet thrust. Thrust vectoring offers many advantage in terms of safety, maneuverability and effectiveness of aircraft controls. It helps the vehicle to meet take-off and landing requirements and it is also a valuable control effector at low dynamic pressures, where aerodynamic controls are less effective[1]. The key point for the fluidic approach is the identification of a manipulation technique that can gradually modulate the symmetry-breaking effect within an acceptable range of deterioration of the nozzle performances. In present work we focused on the controllability of a fixed nozzle for space launchers. It is well-known that at ground level the nozzle is over-expanded and a complex shock structure appears in order to match the flowfield with the ambient discharge pressure. The application of the shock vector control is investigated here numerically with the aim of testing the control effectiveness of the rocket nozzle and the system sensitivity to different forcing actions. URANS analyses are used for computing the unsteady nozzle performances[2], with the aim of investigating the nonlinear dynamics of the shock structures under forcing and their controllability. Where available, the numerical results are compared with experimental data found in the open literature.

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