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Corresponding author: Amsha S
e-mail of corresponding author: amshas@iisc.ac.in
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For student corresponding author: student member of one of the following:

Title
BUBBLE SUPPRESSION ON A HIGH LIFT WING SECTION USING SYNTHETIC JET

Authors
Amsha S [1], O N Ramesh [2], N Balakrishnan [3]*

** Corresponding author*
[1] PhD student, Aerospace Engineering, Indian Institute of Science, Bangalore, 560012, India, amshas@iisc.ac.in
[2] Professor, Aerospace Engineering, Indian Institute of Science, Bangalore, 560012, India, onr@iisc.ac.in
[3] Professor, Aerospace Engineering, Indian Institute of Science, Bangalore, 560012, India, nbalak@iisc.ac.in

Abstract
Short distance Take Off and Landing (STOL) aircrafts can be the future of urban air mobility, enabling us to take off from roads and under prepared runways. To achieve high lift at low velocities, we require multi element high lift sections, that require complex mechanisms. The objective of this work is to replace such a system with a high cambered fixed wing configuration with the assistance of an active control device that suppresses any separations over the wing curvature. A flow control device called synthetic jet is being incorporated. Synthetic jets are simple in design, constitutes a cavity with an opening to the receding boundary layer over the wing, and a piston as one of its interior walls which pumps the air in and out of the cavity, thus energizing the external flow. Establishing a design by testing various configurations and fine tuning the control parameters are to be done using CFD.
A novel dynamic mesh approach to mimic the piston motion has been adapted into the solver for the study. For the validation of the CFD model, the benchmark experimental data of test cases from the workshop on CFD Validation on Synthetic Jets and Turbulent Separation Control, has been used. Unsteady flow simulations have been carried out using Spalart Allmaras turbulence model. For the second test case from the workshop, the round synthetic jet in a cross-flow, the phase evolution of the velocity at the orifice exit shows better match with the experiment compared to literature [1]. The time and phase averaged velocity profiles at various locations downstream of the orifice match well with the experiments. The horseshoe vortex and the high velocity streaks inside the boundary layer during suction characterizing the flow has been captured correctly. A high-fidelity tool, DES (Detached Eddy Simulation) has been used to capture finer details of the flow. The model has been applied to the third test case, a wall mounted hump with a concave step resulting in a separation bubble downstream, for studying the effect of jet momentum and frequency in suppressing the bubble. The momentum coefficient C_μ and non-dimensional frequency F^+ has been used to characterize the jet as defined in [2]. The averaged profiles of pressure and skin friction coefficients over the hump in the unforced condition from unsteady simulations have better match with experiments. As characterized in the experimental work, the drop in pressure just after the jet position, before the recovery starts, has not been picked up by the simulations except in cases where $F^+ < 0.5$. The change in pressure recovery rate is only evident in jet with $C_\mu > O(1)$ and the $F^+ < O(1)$ with a reduced reattachment length; therefore, the same order has been adapted for the bubble suppression in the new airfoil. Simulations are being carried out in the new configuration and better aerodynamic efficiency of the wing is expected.

References
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