Abstract No: 314 ***Physical Sciences***

DESIGN AND OPTIMIZATION OF AN ACTIVE FLOW CONTROL METHOD TO OPTIMIZE THE AERODYNAMIC PERFORMANCE OF AN AIRFOIL IN A COMPRESSIBLE FLOW

S. Khadka*, K. Steven and S.L.M.D. Rangajeeva

Department of Aeronautical Engineering, Faculty of Engineering, General Sir John Kotelawala Defence University, Ratmalana, Sri Lanka
**34-eng-5348@kdu.ac.lk*

Active flow control is being widely popular to enhance the aerodynamic performance of flight vehicles. It can effectively interfere with the boundary layer flows that can be manipulated to achieve the desired performance. In this study, the aerodynamic performance of an airfoil was optimized for the flight Reynolds number of 1.27×10^7 at compressible regime. Synthetic Jet, a type of low energy consuming active flow control method, was used to enhance the lift-to-drag ratio of the airfoil. The optimization of the active flow control was done for three design variables; velocity of the inlet jet, actuating frequency and the location of synthetic jet on the surface of the airfoil. The dataset was created by doing transient state simulations for NACA 0015 airfoil with different combination of design variables. Box–Behnken design was considered for experimental design. For the optimization process, Response Surface Methodology was implemented to analyse the response of design variables on lift-to-drag ratio, which was further optimized using Genetic Algorithm. Locating the synthetic jet at the optimized location showed 8.44% increase in the aerodynamic performance of the airfoil. Furthermore, comparison between applicability of synthetic jets in incompressible and compressible flow was done. The application of synthetic jets for any suitable range of design variables showed a definite increase in aerodynamic performance for incompressible flow, while only certain input combinations simulated favorable performance in compressible flow. The flow visualization also confirmed the reduction of wake size when synthetic jet was actuated at the range of 0.4 to 0.5 chord locations. Aerodynamic buffeting, which causes adverse effect in the control, stability and the structure of the aircraft parts during high speed flights could be reduced by the application of synthetic jets at the optimized location.

Keywords: Active flow control, CFD, Compressible flow, Optimization, Synthetic jets