Control of growth of perturbation in airfoil boundary layers

Harvansh Dandelia[1], Vinod Narayanan[2], and Ravi Kant[3]

The aim of this study is to reduce the non-modal growth of small magnitude perturbation in the spatially developing boundary layer flow over an airfoil, by the incorporation of a linear quadratic regulator (LQR) control loop, through the means of wall transpiration. NACA 2512 is the chosen subject for the analysis. The Orr-Sommerfeld equations are solved as an initial value problem. We used variational method to obtain the optimal growth. Application of accurately computed wall control brings about the change in kinetic energy of the perturbations by reducing it. In order to calculate the wall control, the LQR controller minimizes the well developed cost function *J*, which is usually the integral sum of the perturbation kinetic energy. The optimized control feedback is given back to the system to obtain an attenuated growth. We look at this growth at various locations (denoted by the slope ***m*** of its tangent) on the airfoil for a range of streamwise (α) and spanwise (β) wavenumbers. It is well known that the mode corresponding to α=0 is the most unstable one. After applying the controls, the peak value of growth (G_{max}) reduces. A maximum reduction of 56% is observed. Further we could increase the Reynolds number (***Re***) by 30% so that the flow can remain stable.

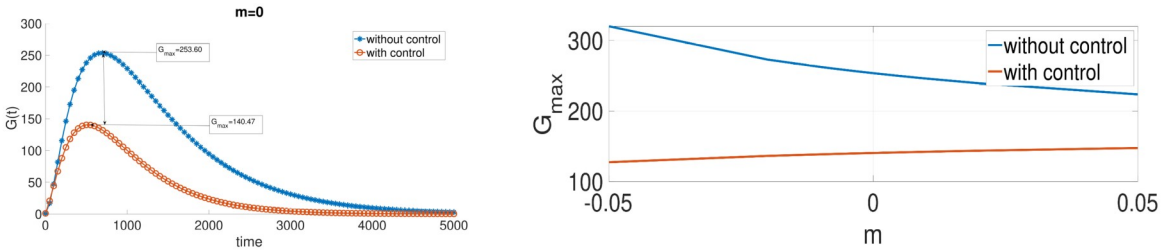

Figure: The above results were plotted for *Re* = 160, α=0, β=0.3

1 Mechanical Engineering, IIT Gandhinagar, India
2 Associate Professor, Mechanical Engineering, IIT Gandhinagar, India
3 Assistant professor, Mechanical engineering, School of technology, PDEU Gandhinagar, India