Flight Control of Modern Shaped wings Using Vortex and Flapping Actuators

Lift force on modern shaped wings at a high angle of attack relies on complex set of vortices that are formed at the leading edges, flaps, and tips of the wing. At high angle of attack these vortices loose gradually their coherence due to intrinsic flow instabilities. At these conditions, the lift produced by the vortices is reduced and the aerodynamic moments derivatives change from stable to unstable conditions causing loss of controllability and stall. Tests showed that small continuous, pulsating, or flapping that are injected into the separated regions from certain locations on the wing sufface could control the behavior of the flow over the wing. Depending on the orientation of the injected the flow pattern over the wing can be altered to achieve the desired controllability. The injection can therefore be used for flight control without the conventional control suffaces_ Controlled actuation of different combinations of based on feedback from sensors distributed over the wing sufface can yield the desired pitch, yaw, and roll moments. Moreover, this method incurs little or no drag penalty.

The control system relies on rational activation of pulsating jets. Static and dynamic coggeJjog. of the flow topology, aerodynamic responses and actuator characteristics are required for closed-loop control system design. Advanced external flow control and aircraft attitude control architectures and algorithms are needed to cope with the highly coupled, time-varying, uncertain and complex nonlinear that are dynamically and structurally unstable. The present concept is applicable to attitude control of tailless fighters, vehicles and UAVs, especially micro IJAVs, without requiring control suffaces such as ailerons, rudder, elevator, or flaps. This type of controlled lift can also be used to enhance pefformance of lifting bodies. The advantage of such a system lies in its aerodynamic simplicity, reduced radar cross-section and ease of miniaturization.