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FLOW CONTROL – PRELIMINARY DESIGN OF SYNTHETIC JET ACTUATOR

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Synthetic jet - alternating blowing and suction is a well-known shear layer active flow control technique. By means of the synthetic jet is possible to lower drag, to increase lift or to intensify heat transfer in wide range of different applications like airplanes, cars, compressors, turbines, etc. One of the first who showed that turbulent boundary layer separation can be controlled by alternating blowing and suction was Seifert et al. (1993). Chen et al. (1999) focused on the increase of mixing and Smith & Glezer (2002) demonstrated the possibility to use synthetic jet for jet vectoring. An important advantage of the synthetic jet, comparing to a conventional blowing or suction, is a significantly lower value of the supplied momentum needed for the same effect, Seifert et al. (1993).

The efficiency of the flow control by means of a synthetic jet depends on a correct design of the synthetic jet generator. The design of the synthetic jet generator must be made regarding the character of the flow field. The frequency of the synthetic jet should correspond to the natural vortex shedding frequency to influence separation or mixing process in the right way. This can be described like a change of the rate of vortex structures splicing. Several approaches can be used to influence the rate of vortex's structures splicing by synthetic jet. The first case is when the exciting frequency of the jet corresponds to the natural vortex shedding frequency. Another possibility is the application of high frequency synthetic jet with amplitude modulation, Matejka et al. (2009). Amplitude modulation is used to generate lower frequencies, which agrees with the natural vortex shedding frequency. Many authors used exciting frequency of the synthetic jet much higher comparing to frequency of the natural vortex shedding frequency. This case was explained by Dandois et al. (2007).

The synthetic jet is creating vortex structures. These vortex structures originate due to the interaction of the boundary layer (main flow) with pulsating stream from output orifice of the synthetic jet generator. The flow control should be done with minimum input power, so the synthetic jet generator should be operated on its resonant frequency. In case of resonant frequency the velocity of the synthetic jet is maximized. Preliminary design of the synthetic jet can be done using Lumped Element Modeling (LEM), Gallas et al. (2002). LEM is based on analogy between electrical and acoustic domain, which corresponds to the synthetic jet actuator. The main assumption of LEM is that the characteristic length scales of the governing physical phenomena are larger than the geometric dimension. In this case the acoustic wavelength must be much greater than the size of the synthetic jet generator.

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