

# COLLOQUIUM

Group: Engineering Fluid Dynamics

As part of his MSc thesis assignment

**D.J.M. Wirtz**

will give a presentation, entitled:

## **Experimental Study into Flow Separation Control using Synthetic Jet Actuators in NACA0018 Wing**

**Date:** Thursday June 18, 2015

**Time:** 13:00

**Room:** Horst Building Room N.109

### **Summary:**

The flow over a deployed flap segment of an airplane wing should remain attached to the surface; otherwise its aerodynamic performance will decrease drastically. Flow separation occurs when the boundary layer due to lack of momentum is no longer capable of coping with the adverse pressure gradient that is present on the suction side of the wing.

Flow separation control aims at affecting the flow by actively delaying flow separation and thus improving the aerodynamic performance of the wing. In the present study synthetic jet actuators (SJA's) have been applied for flow separation control for a NACA0018 wing. The SJA's employed feature a piezo-electric disk inside a cavity and an exit slot of a span of 30 mm and a width of 0.25 mm.

In the initial part of the present study a stand-alone SJA has been investigated in order to replicate the promising results found by the University of Florida for the SJA design also used in the present study. In the next part of the investigation, a configuration with ten of these SJA's integrated in a NACA0018 airfoil, with a chord length of 0.165 m, was considered. These SJA's are tangentially directed with respect to the surface of the airfoil. During the in-stroke of the actuator, air from the surroundings is ingested through the slot into the cavity, while during the out-stroke air is blown through the slot out of the cavity. The maximum peak velocity generated for a range of actuation frequencies of the integrated synthetic jets, have been measured using a hot-wire anemometry (HWA) setup, first in quiescent air. These HWA results for the velocity field induced by the SJA's have been compared with analytical results for a wall jet.

Subsequently the ten-SJA configuration has been investigated for its aerodynamic performance inside a wind-tunnel at a free-stream velocity of 25 m/s, corresponding to a Reynolds number of 273,000. These measurements of the lift have been performed using different actuation frequencies and ratios of jet velocity and free-stream velocity.

Finally, HWA measurements have been performed for the ten-SJA configuration at a number of different chord-wise positions, for a number of angles of attack, at a free-stream velocity of 25 m/s. These data sets have been investigated on their spectral power density and correlated to the results of the measurement of the lift. In the spectral density results various phenomena can be identified, like actuation frequency and its higher harmonics, the occurrence of attached or separated flow and energy addition to the flow by the actuators.

### **Assessment committee:**

Prof.dr.ir. C.H. Venner (chairman)  
Prof.dr.ir. H.W.M. Hoeijmakers (mentor)  
Dr.ir. G.R.B.E. Römer  
Ir. J.H.M. Gooden

**Chairman,**

d.d. \_\_\_\_\_