PhD project proposal – ***Flow control using plasma actuators for aircraft applications***

Supervisors: Prof. Pericle Zanchetta (EEE), Prof Paul Houston (Maths)

To achieve the Advisory Council for Aviation Research in Europe (ACARE) ambitious target on emissions and address key issues indicated in the report by the Intergovernmental Panel on Climate Change (IPCC), the next generation of aircraft must be based on radically different technologies. Among such innovative technologies for aircraft aerodynamics, active flow control for turbulent skin-friction reduction is most promising for a design of future green aircraft. By integrating active flow control strategies over the aircraft surface, for example, it is possible to reduce the skin-friction drag more than 10%, or 5% net aircraft drag reduction. Similar amount reduction in fuel burn and CO2 emissions from aircraft can be expected through this technology, which also brings flow noise reductions.

As yet active flow control technologies have not been adapted in commercial aircraft despite of intensive investigations currently being carried out. One of the reasons for this is due to the inherently chaotic nonlinear nature of the leading physical processes and to the difficulty in monitoring or estimating the turbulent flow status and parameters accurately, which clearly results in a very challenging optimal control problem. We propose to develop active feedback control methodology in order to reduce skin-friction drag of turbulent boundary layers, that means reduced environmental footprint of aviation and significant cost benefits reducing fuel consumption and energy usage. This will be one of the first applications of control theory to experimental aerodynamics.

This project is characterised by a multidisciplinary approach since it ranges from fluid mechanics, modelling and numerical methods for partial differential equations to control theory and power electronics. A model-based feedback control will be designed for energy optimized aircraft with the aim of achieving optimum efficiency and performance. In particular, a closed-loop control of unsteady flow separation by using plasma actuators will be developed in order to enable a full and efficient airflow regulation over an aerofoil. The plasma actuator AC voltage will be used as control input so that the generated Lorentz force would affect the turbulent flow dynamics.

The final key objective will be to optimise the plasma actuator system, including the power supply, actuator configuration and operation.

References:

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