AEROSPACE ENGINEERING

MUR DM 118 - Novel control strategies for drag reduction in wall-bounded turbulence

Funded By	MINISTERO DELL'UNIVERSITA' E DELLA RICERCA [P.iva/CF:97429780584] Dipartimento DIMEAS
Supervisor	DI CICCA GAETANO MARIA - gaetano.dicicca@polito.it
Contact	
Context of the research activity	The topic is related to the development of wall turbulent flow control techniques in order to reduce skin-friction drag. Despite significant progress in the knowledge of turbulence, many difficulties remain in controlling turbulence under conditions relevant to transportation and energy applications. The skin-friction drag generated by turbulence affects, for example, speed and fuel efficiency of airplanes, ships, wind turbines, and pipelines. Even modest reductions in drag could yield significant economic and environmental benefits and in the recent years, a huge effort has been devoted to develop new strategies for wall turbulent flow control with the aim to reduce the energy losses induced by turbulence. Progetto finanziato nell'ambito del PNRR – DM 118/2023 - CUP E14D23001660006
Objectives	The aim of the present research is to develop an integrate active feedback control system for drag reduction in wall bounded turbulent flows. Turbulent flows are ubiquitous both in nature and in engineering applications, from climate and weather dynamics to wind-turbine engineering, and from turbulent streams in pipelines to flows around aircraft wings. Since near-wall turbulence is responsible for the increase in wall skin friction, in the recent years huge efforts have been devoted to reducing the skin friction drag. Among these, passive control devices (such as riblets, vortex generators, etc) have long been studied. However, passive control strategies can not be considered for optimal solutions in a context where varying initial conditions may cause significant changes of the flow behaviour. In contrast, active control devices offer potential to adjust a wide range of input parameters according to the initial conditions in such a way the examined system operates at its best performance. To properly drive control actuators different strategies can be employed and model-based and data-driven/machine-learning approaches can be used to design control laws. The candidate will contribute to the development of turbulence control

	scheme based on the optimal/suboptimal control theory and adaptive algorithms. Reinforcement learning will be also applied to the development of control strategies in order to reduce skin friction drag. Moreover, the activity will include the analysis of large data-sets, the development codes for data processing and the use of advanced measurement techniques such as particle image velocimetry.

Skills and competencies for the development of the activity	The candidate should be familiar with the following subjects: - turbulent flows - Matlab and Python languages - dynamical system theory - Machine Learning algorithms applied to fluid dynamics