MECHANICAL ENGINEERING

MUR DM 117/Microtecnica - Fly-by-wire flight control system for commercial rotorcrafts

Funded By	MINISTERO DELL'UNIVERSITA' E DELLA RICERCA [P.iva/CF:97429780584] Politecnico di TORINO [P.iva/CF:00518460019] MICROTECNICA S.R.L. [P.iva/CF:05635550014]
Supervisor	SORLI MASSIMO - massimo.sorli@polito.it
Contact	
Context of the research activity	The doctorate research project will be focused on developing the architecture of a fly-by-wire flight control system for the main rotor of a commercial helicopter. Progetto finanziato nell'ambito del PNRR - DM 117/2023 - CUP E14D23002030004
Objectives	Fly-by-wire flight control systems are commonly used in flight controls of modern commercial and military fixed wing aircraft. Fly-by-wire flight controls have also been developed recently on new versions of military helicopters, but helicopters for civil applications still rely on mechanical commands, possibly assisted by electrical commands with limited authority, for the control of the blade pitch of the main and tail rotors. The issue related to the main and tail rotors control is that any failure leading to the loss of control of the rotors entails a loss of control of the helicopter with a catastrophic consequence. Fly-by-wire flight control systems offer several advantages: ¿ Esaier installation: mechanical systems have installation constraints, while the electrical harness can be freely routed through the aircraft, that entails more flexibility in the aircraft design, more space available, esaier installation of other aircraft equipment ¿ Reduction of maintenance tasks: regular maintenance items such as components lubrication and setting of the cables tension are eliminated ¿ Self-diagnosing capability ¿ Active control: control laws can be scheduled with flight conditions To be used on a helicopter, fly-by-wire flight control systems must however have the same integrity and minimum probability of loss of control as mechanical systems. This implies to develop systems with: ¿ Multiple signal sources ¿ Multiple independent computing lanes

Objectives	¿ Built-in diagnosing capability ¿ System modeling capability to perform continuous in-flight monitor in order to isolate failed equipment ensuring safe operation and to detect progressive degradations allowing the development of an effective prognostics and health management system The doctorate research project will be focused on developing the architecture of a fly-by-wire flight control system for the main rotor of a commercial helicopter addressing the following points: ¿ Identify alternative system architectures with discussion of the relative merits and eventually select the optimal one based on the evaluation of all design, performance, reliability and safety factors ¿ Perform a safety hazard analysis, determining the probaility of occurrence of the failures and their effect on the helicopter flight condition ¿ Define the characteristics of all components of the fly-by-wire flight control system and perform a sizing of the most critical components ¿ Estimate the reliability of the defined system ¿ Define the system control law ¿ Create a high-fidelity mathematical model of the system and perform simulations of the system behavior for conditions representative of the flight envelope ¿ Develop a prognostics and health management system (PHM) capable of detecing failures and ,progressive degradations and assess its effectiveness by performing simulations for the representative fault cases

Skills and competencies for the development of the activity	Simulation, modeling, dynamic analysis of servoactuators, servo systems, regulation laws, mechatronic systems