ELECTRICAL, ELECTRONICS AND COMMUNICATIONS ENGINEERING

CRT/DENERG - Cloud-Computing Based, Multi-Physics Design of Electric Motors

Funded By	Dipartimento DENERG FONDAZIONE CRT CASSA DI RISPARMIO DI TORINO [P.iva/CF:06655250014]

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Context of the research activity	The rapid transformation of the mobility and industrial sectors is driving unprecedented demand for high-efficiency, high-performance electric motors. Such electric motors must be designed to meet increasingly stringent requirements for efficiency, reliability, compactness, and noise-vibration-harshness. Achieving these targets requires a holistic approach that integrates multiple physical domains—electromagnetic, thermal, structural, and acoustic—into the design and optimization process. Traditional design workflows, often limited by computational resources and sequential analysis, struggle to capture the complex interactions between these domains, especially when rapid prototyping and iterative optimization are needed. Recent advances in cloud and high-performance computing enable large-scale, multi-physics, and multi-objective optimization of electric motors, leveraging parallelized simulations and automated workflows. This PhD project addresses these challenges by developing advanced tools and methodologies for the cloud-based, multi-physics design of electric motors. The research will focus on integrating state-of-the-art modeling environments (e.g., Matlab and SyR-e by PEIC/PoliTo), reduced-order and finite element models, and evolutionary optimization algorithms within scalable HPC frameworks. The ultimate goal is to deliver a comprehensive design and optimization platform capable of producing detailed motor designs—including CAD models, efficiency maps, and performance curves—suitable for both virtual validation and hardware prototyping. The outcomes will support the next generation of electric drive modules for a wide range of applications, from automotive to industrial automation.

	• Implement and validate reduced-order and finite element models for rapid

Objectives	and accurate simulation across multiple physical domains. • Develop a modular software architecture for multi-physics modeling of electric motors, integrating electromagnetic, thermal, structural, and NVH analyses. Such SW architecture is meant for multi-core parallel computing, and compatible with cloud computing. • Establish automated workflows for multi-objective optimization, balancing efficiency, performance, cost, and NVH constraints • Deliver comprehensive design outputs, including CAD models, efficiency maps, and torque-speed curves for use in system-level simulations and prototyping. • Demonstrate the effectiveness of the multi-core simulation tool on selected design benchmark/benchmarks. • Facilitate virtual calibration and system integration, supporting advanced control strategies and hardware-in-the-loop testing

Skills and competencies for the development of the activity	Key requirements for this PhD project are: - Solid background in electrical engineering, with a focus on electromagnetic principles and electric machine design. - Experience in modeling and simulation of electromechanical systems, preferably using Matlab and finite element analysis tools. - Familiarity with multi-physics simulation environments and multi-objective optimization algorithms. - Proficiency in scientific programming and software development for engineering applications. - Ability to work in multidisciplinary teams and address complex engineering challenges using rigorous scientific methodologies