Advanced Design Approaches for Additively Manufactured Electrical Machines

Summary

Additive manufacturing (AM) is evolving rapidly and it has been seen in the world as important step towards the next industrial revolution, being one of the key features of decentralization the production of high complex structures. The flexibility of the technology also allows the production of electromechanical components and even electrical machines, which can have significantly better properties compared to conventional technologies. However, it is an innovative industry and lacks the knowledge and skills to take advantage of this technology. AM opens the possibility to introduce unconventional three-dimensional complex structures and constructional elements, which allow the production of electrical machines with novel magnetic circuit design solution. Yet there is not existing well developed design methodology how to take these advantages into account. The project focus on the development of the design methodology for switched reluctance machine considering the AM advantages. The objective of the project is selection and definition of innovative electrical machine design and working out the calculation methodology most beneficial for using AM technology. Practical part of the work will be printing the developed machine and validating the developed methodology in the lab.

Research field:	Electrical power engineering and mechatronics
Supervisor:	Prof. Dr. Ants Kallaste
Availability:	This position is available.
Offered by:	School of Engineering Department of Electrical Power Engineering and Mechatronics
Application deadline:	Applications are accepted between June 01, 2024 00:00 and June 30, 2024 23:59 (Europe/Zurich)

Description

Within this thesis, the PhD candidate will learn about the design and optimization of switched reluctance machine. The main emphasis will be on the development of reluctance machine design methodology what will consider additively manufacturing machine advantages. We will provide the necessary software for the numerical analysis of the machine but the candidate will be responsible for developing and implementing the design procedure. A working demonstrator will be built and tested at the end of the thesis. The candidate will present his/her work at international conferences and publish journal papers required to complete the thesis within the PhD studies.

Responsibilities and tasks

- Selection the topology of the machine benefiting most from the AM
  - There are several different switched reluctance machine design solutions. The task of the work is to select the most suitable machine topology that would benefit the most from AM technology.
- Design methodology for electrical machine core
  - The possibilities of asymmetry and 3-dimensional freedom of building the machine core will be studied and most beneficial solution will be selected. The task is to work out the design principles for core and develop the design methodology.
- Design methodology for electrical machine winding configuration
  - The possibility of producing winding with different shape, uneven distribution and cross-section will be studied. The task is to work out the design principles for winding and develop the design methodology.
- Novel design methodology for switched reluctance machine considering the advantages provided by AM
  - Asymmetry used in the magnetic circuit of the electrical machine in order to improve power density and performance characteristics and novel winding configuration, reducing losses and improving performance of electrical machines, considering the advantages provided by AM, are developed.
- Practical tests on the test bench
  - Based on the developed design methodology machine will be constructed and tested. Research goals will be verifying the developed methodology.

Applicants should fulfil the following requirements:

- a master's degree in electrical engineering (preferably with focus on electrical machines)
- a clear interest in the topic of the position
- excellent command of English
- strong and demonstrable writing and analytical skills
- capacity to work both as an independent researcher and as part of an international team
- capacity and willingness to help in organizational tasks relevant to the project

The following experience is beneficial:

- Theoretical and experimental basics of electrical machines
- Knowledge of advanced electrical machine design theory
- Knowledge in FEM modelling
- Programming in C++/ MATLAB

The candidate should submit a research plan for the topic, including the overall research strategy. The candidate can expand on the listed research questions and tasks, and propose theoretical lenses to be used.

We offer:

- 4-year PhD position in the leading electrical machines research group in Estonia with a large portfolio of dedicated research, industrial and study-oriented projects
- The chance to do high-level research in one of the most dynamic Universities and research groups in the region
- Opportunities for conference visits, research stays and networking with globally leading universities and research centers in the fields of electrical machines and diagnostics

About the department

The Department of Electrical Power Engineering and Mechatronics of Tallinn University of Technology is an interdisciplinary research center that focuses on socially relevant and future-oriented research and teaching issues related to power engineering and mechatronics. The mission of the Department is to be a leader in electrical engineering and technical studies and development projects in Estonia, known and valued in society, and a respected partner in both national and international cooperation networks and organizations.

The department educates future energy leaders and engineers at the bachelor's, master's and doctoral level. Through training courses, the department ensures lifelong learning and continuous development.

The department carries out large-scale interdisciplinary scientific research, development and professional projects, thanks to which the competence in the field of electrical energy and mechatronics continues to grow. With research, application and development services, the department increases the competitiveness of companies in both the domestic and international markets, keeping knowledge in Estonia. The department has coordinated or been a partner in numerous international projects, such as Horizon 2020, INTERREG, 7FP, Nordic Energy Research, etc.

The Department of Electrical Power Engineering and Mechatronics conducts research within seven research groups and operates state of the art laboratories with high end equipment, offering also accredited services in the fields of lighting and different electrical measurements.

The departments' focus areas are related to both domestic and global developments, such as increasing digitalization and decarbonization, decentralization and decentralization of electricity generation, and the increasing use of renewable energy sources. The department conducts research in the following relevant areas tackling the energy transition:

- optimization of electrical systems and system analysis to find possibilities for electrification and decarbonization
- diagnostics and monitoring of equipment and systems
- cyber security, 5G data communications and artificial intelligence
- energy networks and research on hydrogen technologies, including energy storage, renewable energy, low carbon technologies, consumption management, IoT applications in energy
- implementation of smart industry, including industrial robotics, automation, 3D printing, machine vision
- implementation of energy and resource efficiency, including digitization of supply chains, mapping of opportunities to optimize systems and reduce energy consumption

- development of smart city solutions, including environmentally friendly and self-driving vehicles / drones, digital twin applications.

Additional information

For further information, please contact Prof. Ants Kallaste ants.kallaste@taltech.ee or visit https://taltech.ee/en/electrical-machine-group

To get more information or to apply online, visit https://taltech.glowbase.com/positions/769 or scan the the code on the left with your smartphone.