The parameters estimation-based condition monitoring of electrical machines

Summary

Electrical machines are the workhorses of modern industry. Yet, they are prone to different faults, meaning the condition monitoring and diagnostics of the electrical machines is a highly important task in order to ensure prolonged lifetime of the systems, continuous undisturbed work and minimizing economical losses. The electrical systems are becoming ever more complex, leading to the necessity of novel and more advanced approaches of diagnostics and condition monitoring. The overall goal of the project is to examine the opportunities and pitfalls involved predicting the faults in machines, leading to dealing with the roots of faults at early stages rather than eliminating the results of failures. The project focuses on selection of suitable diagnostic methods, modelling and simulation of faults, diagnostic and prognostic algorithms, extensive laboratory testing of fault case scenarios and validating the methodology through analysis of all the mentioned steps.

Research field:	Electrical power engineering and mechatronics
Supervisors:	Dr. Toomas Vaimann Dr. Bilal Asad
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, 2022 00:00 and June 30, 2022 23:59 (Europe/Zurich)

Description

Within the thesis, the PhD candidate will learn the diagnostics methods and signal processing techniques used for the predictive maintenance of electrical machines. The main emphasis will be on the development of diagnostic algorithms that can estimate various design parameters of electrical machines using machine models and the measured global signals. By comparing the estimated parameters with the originally designed ones, the possible cause of the fault will be predicted. We will provide the necessary hardware and software for the simulation and testing of the diagnostics tools. The candidate is responsible for developing and implementing the diagnostics procedures. 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

- The mathematical models for simulations and parameters estimation
  - Different methods suitable for fault simulations of electrical machines will be studied and implemented. The most suitable model for the fault simulations will be selected during the study. Moreover, state observers based on the selected simulation model will be created.
- Different diagnostic and prognostic methods
  - Different signal processing techniques in addition to adoptive or matching filters will be studied. The most suitable technique for parameter estimation shall be implemented.
- Combining simulation models and diagnostics methods
  - The simulation models and diagnostic methods will be merged to build the electrical machine's diagnostic and prognostic algorithm. MATLAB environment will be selected for this purpose.
- Building the system
  - An experimental setup with adequate sensors will be built in the lab based on the selected methods.
- Testing and validation
  - Finally, the system will be tested and validated through exhaustive measurement and analyses.

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
- Programming in C++/ MATLAB
- Signal processing and digital filter design
- Working knowledge of optimization theory
- Basic knowledge of stochastic processes and probability theory
- Basics of vector calculus and linear algebra

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 Dr. Toomas Vaimann toomas.vaimann@taltech.ee and Dr. Bilal Asad bilal.asad@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/496 or scan the the code on the left with your smartphone.