Real-Time Condition Monitoring of Instrument Transformers using Modern Power System Monitoring Data

Summary

The main objective of this research project is to develop methods to assess the actual condition of substation instrument transformers using modern power system monitoring data, e.g., PMUs, PQ meters, TFR, etc. It is of interest to determine which of the available measurement data and how can be used considering the data availability and cost limitations. Within the research it is possible to participate in activities performed in high-voltage laboratory and using RTDS. The research is financed by Estonian TSO. This research project is part of the wider project which objective is to develop methods to assess the condition of Transmission Network substations and determine the optimal approach for equipment maintenance principles.

Research field:	Electrical power engineering and mechatronics
Supervisor:	Prof. Dr. Jako Kilter
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, 2025 00:00 and June 30, 2025 23:59 (Europe/Zurich)

Description

The research

Transmission Network Operators (TSO) around the world are looking various ways to optimize their costs related to maintenance activities. The most implemented approach is to use manufacturers suggestions which indicate the appropriate time interval after what the maintenance should be made. This approach however may lead to use of funds in not so optimal was as the equipment may not need to be maintained after certain time interval. The approach that it is observed in this project is related to risk assessment and probabilities with the objective to determine the probable or actual condition of different substation equipment. For this various existing measurement data can be used or some additional measurements could be implemented if seen viable.

In this research project the main emphasis is on instrument transformers and specifically on their condition monitoring in real-time using all available and appropriate measurement data. This will include various existing measurement solutions, e.g., PMUs, PQ meters, SCADA measurements, partial discharges, etc. If seen appropriate also new approaches are to be developed and checked in actual substations levels.

The thesis should address the following questions: 1) Which online and offline approaches are used for instrument transformers condition monitoring around the world? 2) How condition of instrument transformers can be determined? 3) What measurement solutions are appropriate in general and in actual substation environment 4) How different instrument transformers should be assessed and what parameters should be monitored? 5) What recommendations should be given to TSOs when planning actual condition-based instrument transformers maintenance?

Responsibilities and (foreseen) tasks

- Literature overview on online and offline methods for instrument transformer condition monitoring
- Instrument transformer modelling principles
- Instrument transformer laboratory testing
- Methodology development for instrument transformer condition monitoring
- Framework development for instrument transformer condition monitoring in actual TSO substation

Applicants should fulfil the following requirements:

- a master’s degree in electrical engineering or power systems or physics
- a clear interest in the topic of the position
- excellent understanding and speaking skills 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 provide assistance in organizational tasks relevant to the project
- modelling skills related to Matlab or Python

The following experience is beneficial:

- working knowledge of statistics
- working knowledge of stochastic processes
- working in international environment
- publishing academic papers

The candidate should submit a research plan for the topic, including the overall research and data collection 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 one of the largest, most internationalized and leading engineering science research centers in Estonia with a large portfolio of ongoing pan-European and national R&D projects in the field of electrical engineering;
- The chance to do high-level research and directly participate in industrial related activities;
- Opportunities for conference visits, research stays and networking with globally leading universities and research centers in the fields of electrical engineering.

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 electrical and power engineering 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)

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For further information, please contact Prof Jako Kilter, jako.kilter@taltech.ee

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