Research Group Introduction

研究グループ紹介

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Abstract— Our research mission is to develop new insights into the principles that govern the interaction between the Cybernetic world and Power Electronic Systems in the context of modern power grids. Based on the understanding of these principles, we combine analysis and experimental techniques to develop a general system-level methodology and tools that can predict potential instability in power electronics systems in the field.

1. Laboratory Introduction

At the Department of Engineering Cybernetics of NTNU we work in close collaboration with the group in autonomous systems and automatic control to devise new system oriented solutions for power electronic control. We develop stability analysis methods and tools for estimating and improving the stability margins of Microgrid systems like those found in marine vessels, remote regions, offshore wind farms and PV parks.

2. Research Topics

〈2·1〉 **Harmonics and Oscillatory Phenomena:** We focus on the development of signal analysis tools for non-stationary non-linear signals originating from non-linear elements in the power system. We develop instantaneous frequency detection algorithms and combine them with our stability analysis tools to assess the impact of distortions and oscillatory phenomena on stability margins of power systems dominated by Power Electronics. We develop instrumentation that contains these algorithms offering beyond state-of-the-art capabilities in measurement of electrical distortions.

〈2·2〉 **Power Electronics Systems & Microgrids:** In this topic we design and develop software tools for the design and deployment of Microgrids. A multidisciplinary group of students study the Microgrid from the energy resource assessment to the electricity production. The software tool includes two layers of analysis: the energy mix optimization and the detail electrical

system simulation. Elements of the two layers include resource data acquisition, optimal energy mix, load profile estimation and validation, budget constraints, sizing of components, power quality and stability analysis. The work is carried out in collaboration with selected Microgrid field projects in the world and the analysis is combined with field measurements for validation purposes and assessment of power quality and stability.

3. Collaborations

We have established collaborations with the Kingdom of Bhutan, Columbia University and several countries in Africa and Latin America in "Microgrids in Developing and Remote Regions". In stability of power electronics systems we collaborate with Tsukuba University, Tokyo Institute of Technology, Nagaoka University of Technology, University of Lorraine, Supélec, The NTNU Center for Autonomous Marine Operations and Systems, Shanghai Jiao-Tong University, SINTEF Energy and the NTNU Department of Electric Power Engineering. Industry is a priority partner in our applied research projects, and ongoing projects involve The ULSTEIN Group, Fred Olsen Renewables, and The Kongsberg Group.

4. Exploring Cybernetics beyond Power Systems

Starting in 2014, the group has expanded the research in non-stationary signal analysis from the domain of harmonics in power systems into the domain of biological systems, specifically brain signals. For that purpose, the group is now developing Brain Computer Interfaces (BCI) with the long-term goal of understanding the electrical properties of brain signals and its relations to well-known human ability and cognitive dysfunctions with the idea to introduce real-time feedback to ameliorate them.

Fig. 1. Research Team Photo: PhD and Master Students 2015

Fig. 2. Laboratory for Impedance Processing

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