Masterarbeit/Forschungspraxis/Research Internship Projects: Predictive/encoderless control of two- and three-level back-to-back power converter driven PMSM/Induction Motor system using Labview FPGA

Background

Figure 1: Simplified structure of two- and three-level back-to-back power converter driven PMSM/ACM system.

Voltage source back-to-back power converters allow for the true four-quadrant operation, i.e., the direction of the active power flow is allowed to be reverse at any instant. It is an important property for modern advanced variable speed drives, grid connected distributed energy applications and High Voltage AC/DC (HVAC/DC) transmission systems. With a full-scale power capacity voltage source back-to-back power converter, it is possible to fully control the power extracted from the load/generator, and also provide ancillary services (frequency and voltage supports) to the grid. This topology is especially attractive for renewable energy systems such as PMSG/DFIG wind energy applications.

Model predictive control, which incorporates the system model and the discrete nature of a power converter into controller design, is one of the most promising alternatives to classical control techniques for power electronics and drives. Encoderless control reduces the system complexity and may increase the system robustness against encoder failure. In many applications it can be used not only as a backup but also a wide speed range standalone control strategy.

Using FPGA as the controller implementation target for power electronics / drives is becoming the trend for both industrial and academia. Due to its parallel computational capability, it is in particular attractive for cases where fast computational power is required. Labview-FPGA
techniques provide a modern solution for developing FPGA designs, and make the whole controller implementation procedure more efficient than coding with VDHL/Verilog.

**Within these topics, the tasks for a master thesis include:**
1) Perform a literature survey of model based encoderless control, or signal injection based encoderless control for PMSG/ACM, and predictive control schemes for machine side or grid side control of two-/or three-level back-to-back power converter driven PMSM/ACM systems;
2) Do a simulation verification/comparison (in Matlab or Labview) of the most effective 1) encoderless control methods for PMSM or ACM control or 2) predictive control for both machine and grid side;
3) Labview FPGA coding and experimental verifications with an NI-CRIO controlled PMSM/ACM system setup;

**The tasks for a Hauptseminar/Forschungspraxis/Research internship include:**
1) Perform a literature survey of model based encoderless control, or signal injection based encoderless control for PMSG/ACM, or perform a literature survey of predictive control schemes for machine side or grid side control of two-/or three-level back-to-back power converter driven PMSM/ACM systems;
2) Do a simulation verification/comparison (in Matlab or Labview) of the most effective model based encoderless control for PMSM or ACM; or do a simulation verification/comparison (in Matlab or Labview) of the most effective predictive control schemes for machine side or grid side control.
3) Labview FPGA coding and experimental verifications with an NI-CRIO controlled back-to-back converter PMSM/ACM system setup;

**Requirements**

1) Basic knowledge and great interests in power electronics & drives and renewable energy systems;
2) Familiar with Matlab/Simulink, have experiences doing PMSM or ACM control, and/or grid side power converter/active front end power converter control;
3) Preferred to those who have experiences using Labview; or those who have great interests in learning Labview / Labview FPGA.

**Contact**

Please send your CV (including the projects you have performed) and the list of the courses you have attended through email to Mr. James-Zhenbin Zhang (james.cheung@tum.de).