Master Thesis

Design, Implementation and Validation of a Sliding Mode Observer for predictive control of electric Motors using STM32-MCU and Real-Time Systems

Background and preface:

Sensor- und sensorless control of electric machines play nowadays very important roles in the different automation areas, in the industry as well as in the automotive fields. Purpose the improvement of the whole control concept of a modern control strategy an adaptive observer must be designed and implemented, this observer is nonlinear and of an adaptive behavior and is utilized to estimate the different states of the motor under test. In addition, interface- and control-circuits have to be fully designed and fabricated, these electronic circuits have to be first simulated and the PCBs’ layouts have to be implemented purpose utilizing them in the control loop of the motor, additionally and according to the desired requirements and simulation results some drafts must be validated and enhanced. Within this scope and to validate the proposed algorithms different models have to be implemented using Matlab/Simulink, simulated and prepared for the automatic code generation using Simulink embedded coder. The proposed algorithm has to be verified in the test bench, for which the load motor must be coupled and integrated to the whole test bench, this must be done through the validation of current and voltage measurements’ circuits within the IGBT-based two level inverter and interfacing them to Trigger ports and ADCs of the STM32 microcontroller.

Keywords:

Duties and tasks:

- Test, validation and operation of the already implemented 2L-PCB (Version II); a complete validation process must be done and the board has to be tested and integrated into the test bench,
- Test and validation of the hardware-components using 3-phase star/delta connected RL-Load,
- Literature research on the topic observability and sensorless control of nonlinear motors focusing on Model Predictive Control for three phase induction and PMSM motors,
- Finalization, validation and operation of the Interface-PCBs and the connections needed for the test bench for PMSM, 2L-VSI-Inverter and STM32-MCU. The hardware components are available but not yet wired and the components of the 2L-Inverter are available but not yet completely soldered in the PCBs in addition, an interface PCB for measurement and signal conditioning should also be manufactured and implemented,
- Design and implementation of SMO-Speed, -Position, -Flux and -Torque observer and integration in the control loop; the needed parameters of the electric motor and the mechanical system for the observer functionalities must be identified,
• Simulation of the whole scheme is not only needed for the validation of the designed observer and whole control scheme but also for the code generation, that will be deployed on the STM32-MCU,
• Preparation of the Load Motor and including the step load’s behavior into the control loop and finalizing any needed PCBs or interface circuits,
• Test and Validation of the whole system while accessing the currents and voltages measurement channels through interfacing them to the Microcontroller-Board,
• Experimental Surveys for improving the different hardware components of the test bench.

Qualifications and prerequisites:

• Good Knowledge of design and simulation using MATLAB/SIMULINK.
• Good knowledge of or rather experience in the topic control of electric machines using power electronics.
• Good knowledge of or rather experience in microcontroller applications and embedded programming using c-language.
• Good Knowledge of or rather experience in PCB-Design.
• Good Knowledge of or rather experience in simulation of electric/electronic circuits using Matlab/Simulink/Pspice.
• Good Knowledge of design of driver-, interface- and measurement-circuits.

Start and duration:

October or November 2021 for six months.

Contact and additional information:

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Sensorless-MPC-Lab on researchgate:

Related IEEE Publications:

• Direct Sensorless Model Predictive Control of Induction Motor Based on Extended Kalman Filter for Three-Level NPC Inverter.
  https://ieeexplore.ieee.org/document/9008024

• Flexible Test Bench Arrangement and Particular Implementation of Three Level IGBT Based VSI for Self-sensing Model Predictive Control of Induction Motor
  https://ieeexplore.ieee.org/document/9265822