スマートグリッドのための風力発電システムの設計と制御

Form 3

論　文　要　旨

Abstract

論 文 題 目

Title:

Design and Control of the Wind Energy Conversion System for the Modern Smart Grid

（和訳：スマートグリッドのための風力発電システムの設計と制御）

Because of the large amount of renewable energy, the renewable power system (wind, solar, biofuel, hydro, tidal, etc.) will be the major sources of the energy system in future. If we are to integrate a large amount of renewable energy into the power system and an efficient socio-economic way, we must rethink and reconfigure our energy systems. The intelligent power grid or smart grid is the key to realize this transformation. Among the several renewable sources, multi-megawatt wind energy conversion systems (WECSs), often organized in a wind farm, are the back-bone of the modern smart grid. However, wind energy is a fluctuating resource which can diverge quickly. Due to the wind speed variations, the output power of wind turbines is fluctuated. It causes frequency deviation from the rated value and creates voltage flicker at the buses of the power grid. Frequency deviation and voltage flicker provide poor power quality and originate instability problems in the power system, when there are loads sensitive to accept high voltage and frequency variations. Therefore from the perspective of smart grid, WECS should ensure to control the frequency deviation, power fluctuating and robust control abilities. Firstly, in this thesis, to achieve the maximum output power from the wind turbine a maximum power point tracking control (MPPT) method with parameter identification has been analyses. Secondly, To reduce the power fluctuation for a wind turbine, the power smoothing methods composed of the controlling kinetic energy with fuzzy control systems which provides a cost effective power smoothing for a WECS. A simple shunt circuit is included to the DC-link circuit, and it can ensure the stable operation of the WECS during the system fault condition. Thirdly, a new approach to design and implement a digital H_∞ controller for a permanent magnet synchronous generator (PMSG) based wind energy conversion system (WECS) is proposed. Due to wind energy is an uncertain fluctuating resource, requires tight control management. Therefore, the proposed model-based digital H∞ controller scheme comprises for both generator and grid interactive power converters, and the control performance is compared with the conventional PI controller. Simulation results confirm the efficacy of the proposed method which is ensured the WECS stability, mitigate shaft stress, and improving the DC-link voltage and output power qualities. Fourthly, a frequency control scheme for a small power system by a coordinated control strategy of a wind turbine generator and a battery energy storage system. A minimal order observer is utilized as a disturbance observer to estimate the load of the power system.

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