別紙様式８

研　究　主　論　文　抄　録

論文題目　Robust Control Application for Wind Power Generation in Power Systems
（電力システムにおける風力発電のためのロバスト制御）

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主論文要旨

A robust control approach to enhance the participation of Variable Speed Wind Turbines (VSWTs) in the primary frequency regulation during network disturbances is presented in Chapter 2. The proposed control system utilizes an H∞ Linear Matrix Inequality (LMI) based scheme to improve the closed-loop performance. It is compared with two classical control systems: the Inertial Control and the Modified Inertial Control. The H∞ LMI controller optimizes the trade-off between frequency deviation smoothing and wind turbine (WT) speed deviation after the disturbance. Results show a considerable improvement in frequency deviation smoothing and optimal speed recovery during a sudden variation in the system load. A desirable robust performance was also obtained.

In Chapter 3, a new methodology to improve the WT fault ride-through capability and the transient stability of a power system including a DFIG-based wind farm is presented. A small-sized Energy Capacitor System (ECS) with a fuzzy-based control scheme was utilized. A four-machine infinite bus system was considered in which one of the units was an aggregated model of DFIG-based WTs. A three-phase to ground fault was applied in a nearby line and the WTs were protected by crowbar with converter fast reconnection system. According to the results, the ECS not only improves the stability level of the system, by reducing the oscillations in the synchronous units, but also shows positive performance effects in the WTs such as reduction in the mechanical stress.

A comparative study about the application of robust pitch angle control in different types of WTs, including onshore and offshore types, is presented in Chapter 4. The main objectives are the reduction of turbine component fatigue loads and platform motions in case of floating wind turbines, taking into account the shaft oscillations damping, rotational speed control and optimal power absorption objectives. A three-blade 5 MW upwind wind turbine, with different types of platforms, was utilized for simulation. A H∞ LMI controller is proposed. A gain-scheduled proportional-integral (GSPI) controller was selected as baseline controller. Simulation result shows the advantage of using a robust controller over a GSPI controller showing very good trade-off between different conflicting objectives.