Preface

A power system network is a complex nonlinear system that is built with many other interconnected subsystems to meet the power demand requirement. Due to power system complexities and mismatches, power system stability is widely affected even under small system perturbations. Various disturbances like subsystem uncertainties, the interaction of noise in the signals, parametric uncertainties, unmodeled nonlinearities, and environmental influences may cause instability in the system. The stable and reliable performance of the power system network is the main objective of current research in the context of global economic and industrialization development. Modernization of power system networks must equip with advanced topologies, which enhance the operation regime through their strong robustness and performance. It can be achieved by voltage regulation and maintaining accuracy through the excitation control of the synchronous generators in multimachine power networks, similarly, in microgrid power networks the controller performance can be enhanced by voltage/frequency regulation, providing suitable current sharing among converters, and adequate power flow in the network. The penetration of renewable power sources, severe faults, and parametric uncertainty in the load demand may produce mechanical power perturbations and instability in the system to power blackouts and economic losses. Uncertainties in the power system parameters directly affect the generator states and perturb global performance for interconnected power system networks.

In this thesis, a study of the power system networks is carried out using different control approaches by analyzing various perturbations in the system and the integration of renewable sources. The main aim of the thesis work is to improve the control performance by minimizing control complexity in the network, reducing the control efforts, providing resiliency towards uncertainties, estimating the system nonlinearities, and designing the adaptive laws for unknown power system parameters. These mentioned objectives are focused on designing and implementing the control scheme on the multimachine and microgrid power networks. In the first part of the thesis, multimachine power networks are considered for the implementation of the control objectives. The multimachine power system networks are configured by interconnected generators. These networks are operated through field excitation control.

To achieve the objective of the work, in the second part of the thesis, similar robust control schemes are implemented on microgrid power networks. In microgrid power networks, the control effort is minimized by the event trigger control scheme, and further, the resiliency of the microgrid network against the denial-of-service attack (DOS) is examined. The first part of the thesis is explained in the starting three chapters of the thesis, whereas the fourth and fifth chapters are respectively dedicated to the control effort minimization and DOS-based cyber resiliency in the microgrid power networks.

The control schemes for multimachine power system networks are examined on the New England IEEE standard 10 Machine 39 Bus model whereas the control schemes for microgrid power networks are verified in ac/dc microgrid systems and multi-DG-based autonomous microgrid systems. These schemes are simulated in MATLAB/Simulink environment, Also, these schemes are verified in real-time environments. To examine the controller's efficacy for multimachine power system networks, a real-time digital simulator (RTDS) is employed. The controller's verification for the microgrid power networks in a real-time environment is achieved by a Typhoon-based real-time simulator.