Defence Seminar

Seminar Title	: Optimal Load Frequency and Voltage Control in Interconnected Power Systems: A Model Predictive Control Approach
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Venue	: EE-205 (Seminar Room)
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Abstract	:

Modern electric power systems are exceptionally complex human-engineered systems, constantly evolving in scale and complexity. Ensuring the smooth flow of electricity to consumers remains paramount. To achieve this, the power system must maintain a state of continuous stability. This dissertation explores the intricate dynamics of power system stability, focusing primarily on two crucial aspects: frequency stability and voltage stability. The work introduces innovative control methods to keep the power grid steady, guaranteeing users a continuous supply of dependable electricity. A disturbance in a power system causes the frequency to deviate from its nominal value. The load and generation of the system are strategically adjusted to restore the synchronous frequency. This work introduces a novel shrinking-horizon Model Predictive Control (MPC) technique, which employs a centralized controller for managing the load frequency of a single-area power system and distributed controllers for multi-area systems.

In contrast to existing approaches that use an approximate first-order transfer function model, this work presents a structure-preserving linear state-space model for power systems. In this work, a novel MPC based Stochastic Load Frequency Control (SLFC) technique is proposed, that enables high amounts of RESs to be integrated while maintaining reliable and stable operation. A structure-preserving linear state-space model for power systems is derived which more precisely represents a practical power system behaviour. To model the stochastic nature of RES power outputs, frequency deviation is added as a chance constraint in the optimization problem, transforming it into a chance-constrained optimization problem. Voltage instability in power systems arises due to the shortage of reactive power and may cause abnormally low bus voltages, leading to a partial or complete blackout. In this dissertation, a novel receding-horizon MPC-based voltage controller is proposed, which maintains the voltage stability of a power system by optimally controlling generator reactive power and SVC output. For this, a sensitivity-based analysis is performed to design a state-space model of the power system. The voltage control is done step-wise, and the optimal control action in each step is calculated by minimizing a cost function subject to a set of relevant constraints. The performance of the proposed controller is evaluated on the standard IEEE 9, 39 and 118 bus test systems to prove the efficacy of the proposed control techniques under different operating conditions and in the presence of different contingencies.