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Load Frequency Control of Power Systems with Communication Delays

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Abstract:

Load Frequency Control (LFC) is a technique used to maintain balance between generation and demand by regulating the power system's frequency, an indicator of that balance. A decrease in frequency indicates that power demand exceeds current generation, while an increase in frequency indicates that generation exceeds demand. If the frequency is not kept in an acceptable range, it can cause power outages, equipment damage, etc. In this respect, LFC is essential for power system stability and reliability. On the other hand, it is well known that each control system has time delays that can degrade system performance or even cause instability. Therefore, time delays must be accounted for in the analysis and design of LFC to achieve reliable and efficient power delivery. However, due to such delays, the design and analysis require advanced techniques. In this regard, optimal control methods based on nonsmooth, nonconvex optimization of the spectral abscissa and H2/Hinf norms of the closed-loop system are intended to be utilized. Though these methods have been successfully applied to many control systems with time delays, no one has ever used them in LFC. By employing such techniques, one can achieve the maximum exponential decay rate, leading to the fastest rejection of frequency deviations in the power system, at the expense of a trade-off between performance and robustness. To illustrate the design and analysis phases of the study, numerical examples of the LFC of a multi-area power system with electric vehicles are intended to be employed. It should be shown that the designed systems are not only stable under inevitable communication delays but also quickly and reliably reject the effects of frequency deviations. Thus, the reliability and efficiency of the power system must be guaranteed.

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