Artificial Intelligence-Based Approach for Forced Oscillation Source Detection and Classification

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Abstract:
As power systems have expanded and evolved, via interconnections, the use of new technologies and controls have segued to new forms of system instability. For example, voltage stability, frequency stability, and inter-area oscillations have become of greater concern than in the past. This has created a need to review the definition and classification of electrical power system stability, as it has been determined that power systems can be stimulated in their characteristic eigenfrequencies by not only severe incidents, but also small disturbances. To illuminate the consequences of this phenomenon, we note that increasingly, to maximize economic benefit, power systems are typically operated extremely close to the stability boundary. Severe disturbances or even certain operating conditions may result in the involved power system segueing into rapid power oscillation conditions on a long transmission line. Traditionally, Power Oscillation Monitoring (POM) has been utilized as a signal processing approach that detects and quantifies power oscillations, which are typically small in amplitude and have poor damping. Insufficient damping of a system results in a majority of low frequency oscillations, which can usually be sufficiently suppressed by tuning the parameters of power system stabilizers (PSS) or inter-tie line controls. However, forced oscillations caused by resonance are increasingly observed within power grids. The posterior analysis shows that the affected system was well damped when the oscillation occurred; the involved resonance induced excitation, and even a small disturbance could amplify and spread rapidly throughout the power system. Thus, prototypical remediation actions, such as PSS, are not applicable for suppressing such oscillations. The most effective way to subdue such forced oscillations is to remove the source of the oscillation disturbance rapidly and accurately. This paper will review a variety of oscillatory source identification techniques ...

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