Comparative study of different Kalman filter implementations in power system stability

Abstract

Voltage stability and voltage collapse issues have in recent years begun to constitute an unpleasant warning to the operational security of power systems. Many techniques have been investigated in order to predict the point of voltage collapse. However, there are still several restrictions due to the insufficiency of current system state information. Accompanied by the commencement of the Phasor Measurement Units (PMUs) evolving technology, it donates a solution to enhance the existing power system state estimation. In consequence, the significances to develop preferable methods that would provide a preliminary warning before the voltage collapse had grabbed the attention. This study covers the forming of real-time system monitoring methods that able to provide a timely warning in the power system. The algorithms used to estimate the points of collapse are according to the theory that voltage instability is approximately linked to the maximum load ability of a transmission network. As a result, the critical operating conditions (peak of maximum deliverable power) come when the system Thevenin impedance is equal to the load impedance. This study focuses specifically on research about the motivation and the application of different Kalman filter implementations such as Discrete Kalman Filter (DKF), Extended Kalman Filter (EKF) and Unscented Kalman Filter (UKF) are used to track the Thevenin parameters. Therefore, the implications of this research paper are to determine the robustness and reliability of the proposed tracking methods. As compared to previous studies, the tracking process is just mainly focused on DKF method only, while the novelty throughout this study is to compare the performances and efficiencies of different Kalman filters in determining the maximum load ability on the 2 different types of test systems. Accompanying, the parameters are utilized in real-time voltage instability estimator to discover the current system's condition. In this study, the effectiveness of the proposed algorithms is assessed under a large number of random operating conditions on the Malaysia's power system 132 kV, 2-bus and 10-bus systems.

Eventually, the results are differentiated by using the early-warning index of voltage collapse. All through the test cases, EKF method shows the best ability to track the Thevenin parameters as compared to DKF and UKF. Last but not least, the early-warning index acted as a pioneer implication in estimating the maximum load power ability of the power system right before load shedding methods are being executed.