Steady-state Security Assessment Based on K-Means Clustering Algorithm and Phasor Measurement Units

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Abstract

Background: The security assessment plays a crucial role in the operation of the modern interconnected power system network.

Methods: Hence, this paper addresses the application of k-means clustering algorithm equipped with Principal Component Analysis (PCA) and silhouette analysis for the classification of system security states. The proposed technique works on three principal axes; the first stage involves contingency quantification based on developed insecurity indices, the second stage includes dataset preparation to enhance the overall performance of the proposed method using PCA and silhouette analysis, and finally the application of the clustering algorithm over data.

Results: The proposed composite insecurity index uses available synchronized measurements from Phasor Measurement Units (PMUs) to assess the development of cascading outages. Considering different operational scenarios and multiple levels of contingencies (up to N-3), Fast Decoupled Power Flow (FDPF) have been used for contingency replications. The developed technique applied to IEEE 14-bus and 57-bus standard test system for steady-state security evaluation.

Conclusion: The obtained results ensure the robustness and effectiveness of the established procedure in the assessment of the system security irrespective of the network size or operating conditions.

Keywords: Blackout, contingency screening and ranking, k-means algorithm, unsupervised clustering techniques, phasor measurement units, principal components analysis, silhouette analysis, static security assessment, synchronized measurements.

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