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Enhanced High Impedance Fault Detection and Location Accuracy via μ-PMUs

Background

High impedance faults (HIFs) normally exist in power distribution systems with voltages ranging from 4 kilovolts (kV) to 34.5 kV. Upon the occurrence of a HIF, its immediate vicinity is imposed with potential danger, which is hazardous to public safety. For such reasons, researchers and engineers have been exploring novel ways to detect HIFs since the 1970s. Many algorithms aim at enhancing conventional relays at the early stage. They propose methods such as the proportional relaying algorithm, impedance-based method, and the PC-based fault location and diagnosis algorithm. However, two critical issues hinder HIF detection performance: measurement accuracy and information extraction capability. In fact, it was revealed in one case study that conventional protection cleared only 17.5% of staged HIFs. Specifically, existing commercial microprocessor-based relays rely on threshold constructed by direct physical measurements which degrades detection logic performance.

Invention Description

Researchers at Arizona State University have developed a stochastic HIF monitoring and location scheme using high-resolution time-synchronized data in micro Phasor Measurement Units (μ-PMUs) for distribution network protection. Specifically, the process is based on feature selections, semi-supervised learning (SSL), and probabilistic learning for fault detection and location. For example, a wrapper method is proposed to leverage output data in feature selection to avoid overfitting and reduce communication demand. To utilize unlabeled data and quantify uncertainties, an SSL-based method is proposed using the information theory for fault detection. For location, a probabilistic analysis is proposed via moving window total least square based on the probability distribution of the fault impedance.

Potential Applications

- Power distribution systems
- High impedance fault detection

Benefits and Advantages

- Improved fault detection reduces duration of power loss
- Feature pool and a feature selection method avoids overfitting and reduces communication bandwidth
- Semi-supervised learning (SSL) method increase data availability for HIF learning

Related Publication: Enhance High Impedance Fault Detection and Location Accuracy via μ-PMUs

Faculty Profile of Professor Yang Weng