Point-On-Wave-based Anomaly Detection and Categorization in Low Inertia Power Systems

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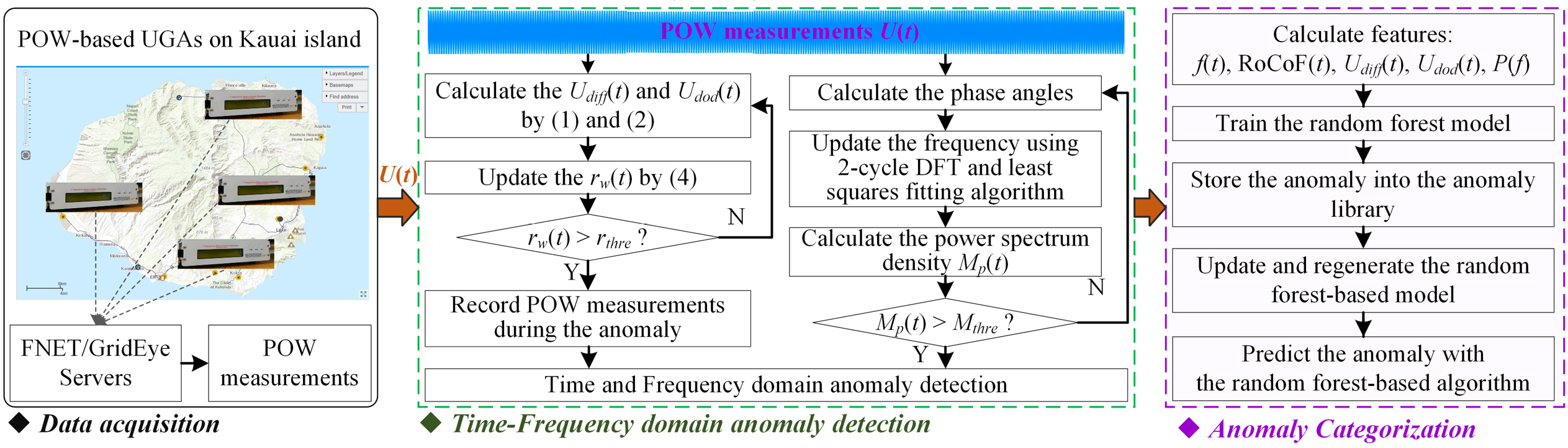
Background

- Anomaly widely existed in low inertia power systems, e.g., an island power grid;
- The low power system inertia has resulted in a high dynamic during anomalies and thus brought challenges to their detection and categorization;
- Synchronized Point-on-Wave (POW) streamed from Universal Grid Analyzers (UGAs) can provide real-time waveform measurements and thus lead to innovative anomaly detection and categorization algorithms.

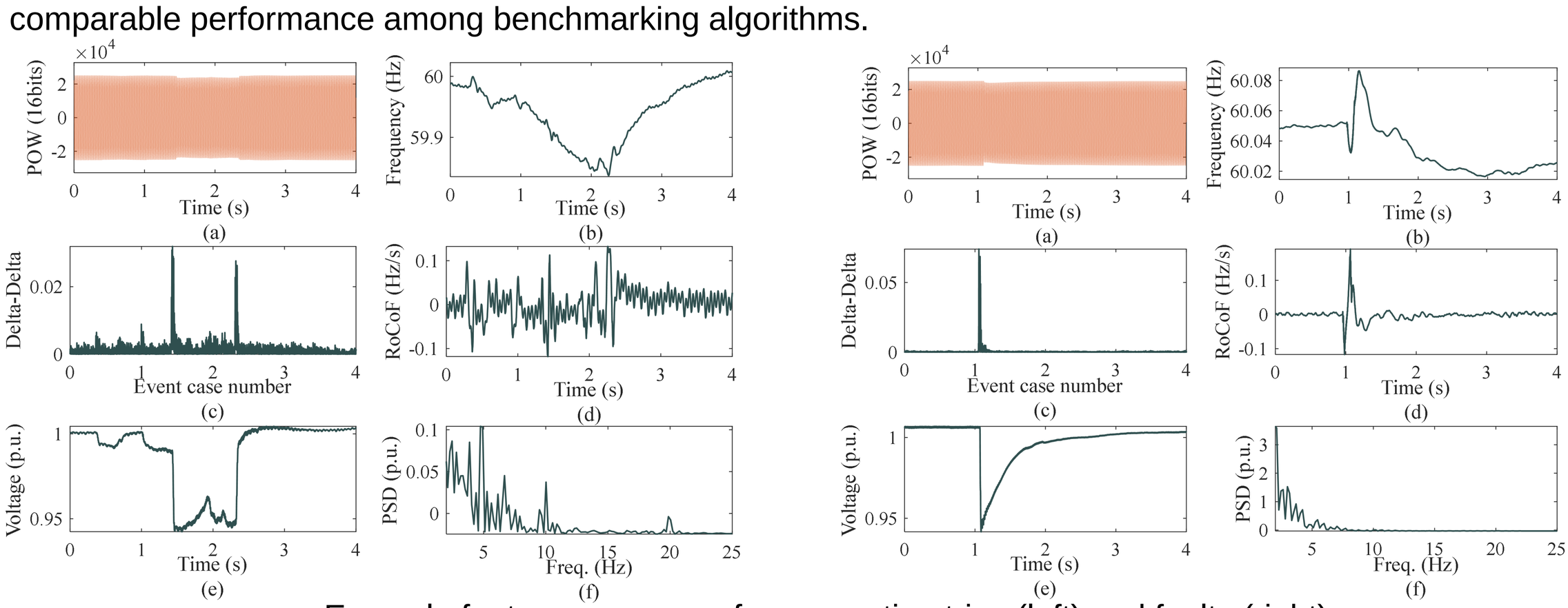
Contributions

- A real-time POW-based anomaly detection algorithm is proposed to capture waveform distortions. The algorithm is implemented based on the recursive form to reduce the calculation burden. Importantly, the proposed algorithm has been deployed on the FNET/GridEye system for real-time anomaly detection purposes.
- Four POW-based SMUs are deployed in Hawaii islands and one-year POW measurements are collected for anomaly categorization in a low inertia power system. An anomaly categorization algorithm based on random forest and the Bayesian optimization are designed considering POW, frequency, RMS values of voltage magnitudes, and power spectral densities.
- A POW-based anomaly library has been built up targeting low-inertia and high PV-penetration power grids. The anomalies have been confirmed with local utility companies on Hawaii islands.



Anomaly detection and categorization results

- Multiple experiments have been carried out to verify the performance of the proposed anomaly categorization algorithm, where the results demonstrate its profound performance compared with other advanced algorithms.
- The result demonstrates that the performance of the proposed POW-based anomaly categorization algorithm has comparable performance among benchmarking algorithms.



Example feature responses for generation trips (left) and faults (right).