Distortion Monitoring and Waveform Data Pre-Processing

Haoyuan Sun, Fangxing Li
The University of Tennessee, Knoxville

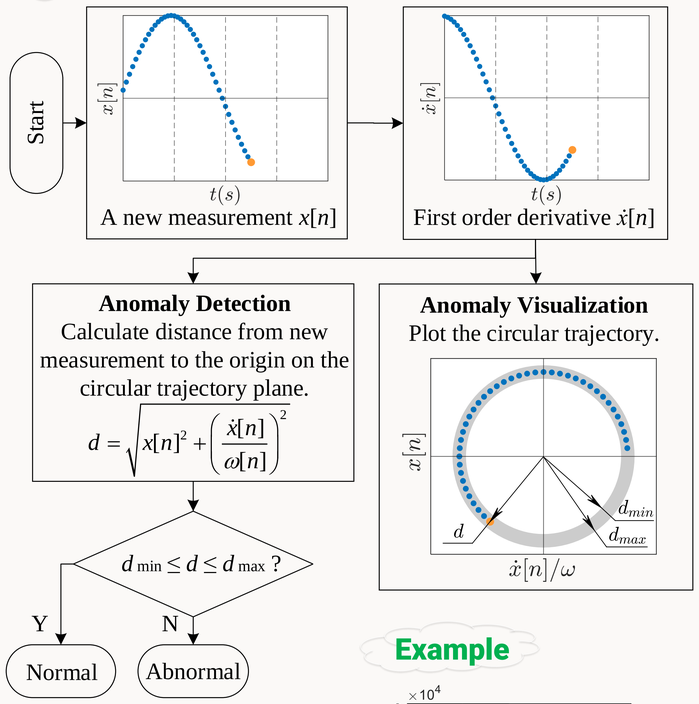
Christopher Sticht, Srijib Mukherjee
Power Systems Resilience Group, ORNL

Distortion Monitoring

Anomaly Detection and Visualization

Why? To trigger data recording and further analysis.

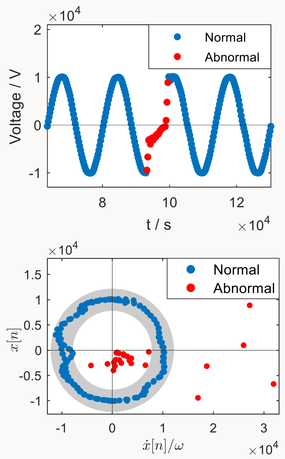
How? Circular Trajectory Approach (CTA)



Advantages

- High-resolution
- Adjustable sensitivity
- Easy computation
- Immediate detection
- Apply to all types of distortions

Example

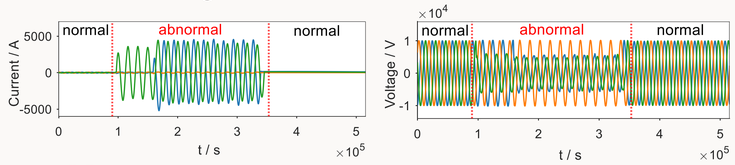


Waveform Data Pre-Processing

Waveform Truncation

Why?

To remove normal segments and thus focus on abnormal segments.

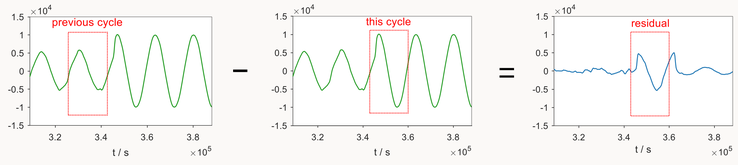


How?

(1) Circular Trajectory Approach (see left column)

(2) Residual Component Method

Take the difference of a cycle and its previous cycle.



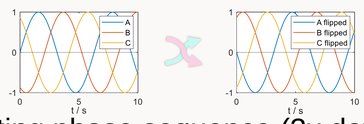
6x Data Augmentation

Why?

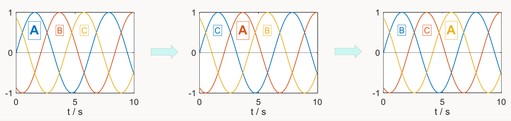
To enrich the inherently insufficient outage data.

How?

(1) Flipping (2x data)



(2) Alternating phase sequence (3x data)

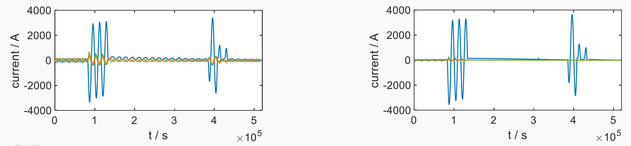


Remove Repetitive Waveforms

Why?

(1) One event could be recorded by multiple devices. Repetitive ones should be removed to allocate equal attention to each event.

(2) Two waveforms may not be perfectly aligned along the time axis.



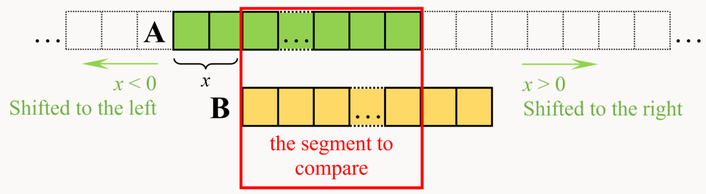
How?

(1) Euclidean Distance

To measure similarity of two waveforms.

(2) Waveform Shifting

We look for the highest similarity along the shifting.



Conclusion

- We first present a general solution for sine wave distortion monitoring and visualization — the Circular Trajectory Approach (CTA).
- We then provide three broadly applicable techniques for waveform data pre-processing. These techniques help machine learning algorithms to achieve better efficiency and better accuracy.

Interested? Check out our full paper.

22PESGM3341 Haoyuan Sun *et al.*, "Outage Cause Classification of Power Distribution Systems with Machine Learning and Real-World Data," PES General Meeting 2022.

Poster PDF