Paper No: 22PESGM3341

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Anomaly Monitoring and Outage Data Pre-processing

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Background

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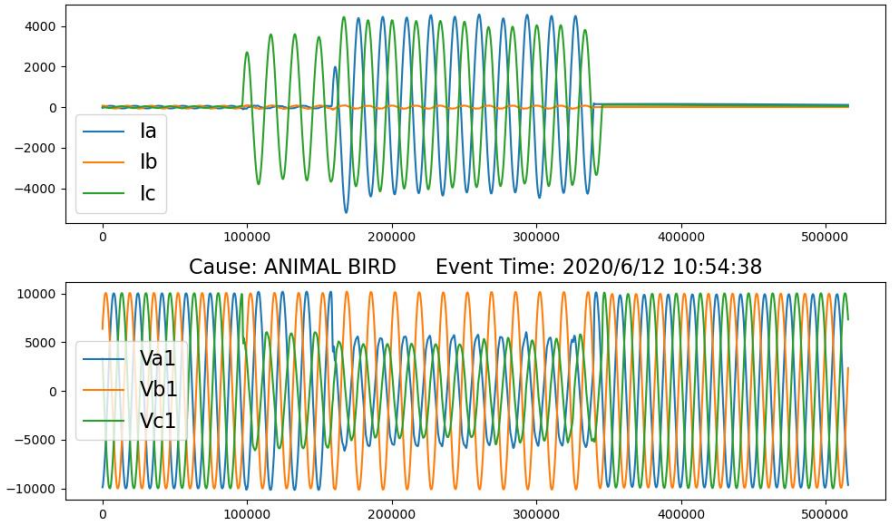
- Waveform Data
  - Distortion Monitoring
  - Pre-processing



- Help machine learning algorithms to better classify outage causes. E.g. tree, animal, lightning…

Distortion Monitoring

Anomaly Detection and Visualization

Why? To trigger data recording and further analysis.

How? Circular Trajectory Approach (CTA)

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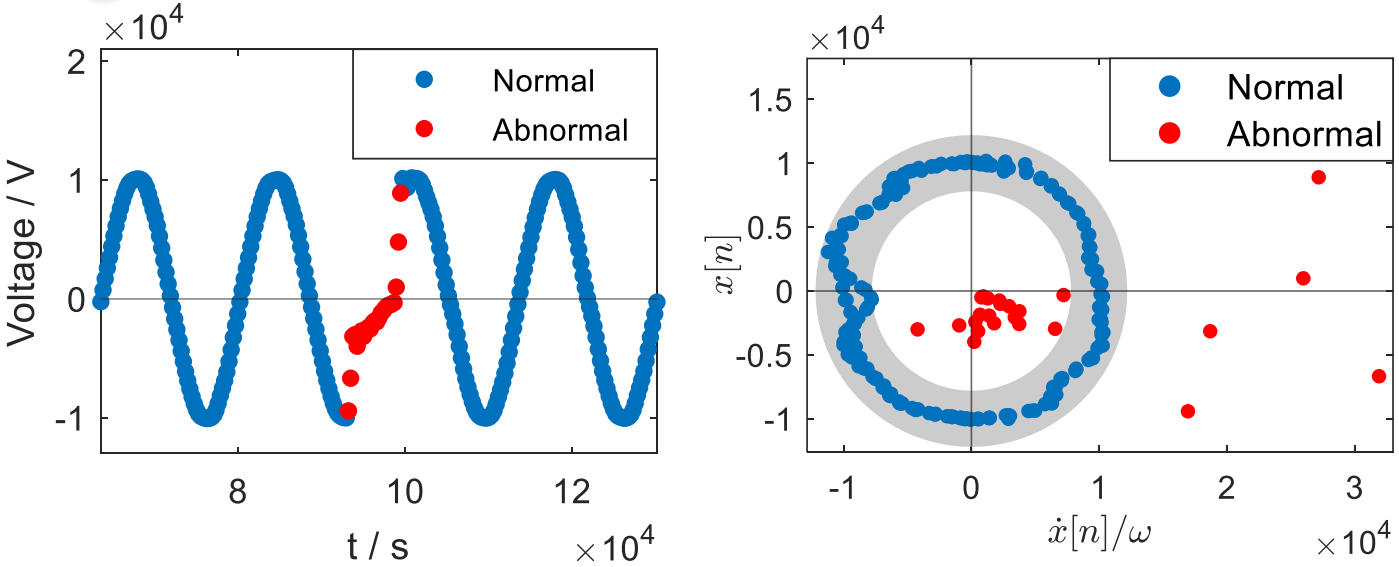

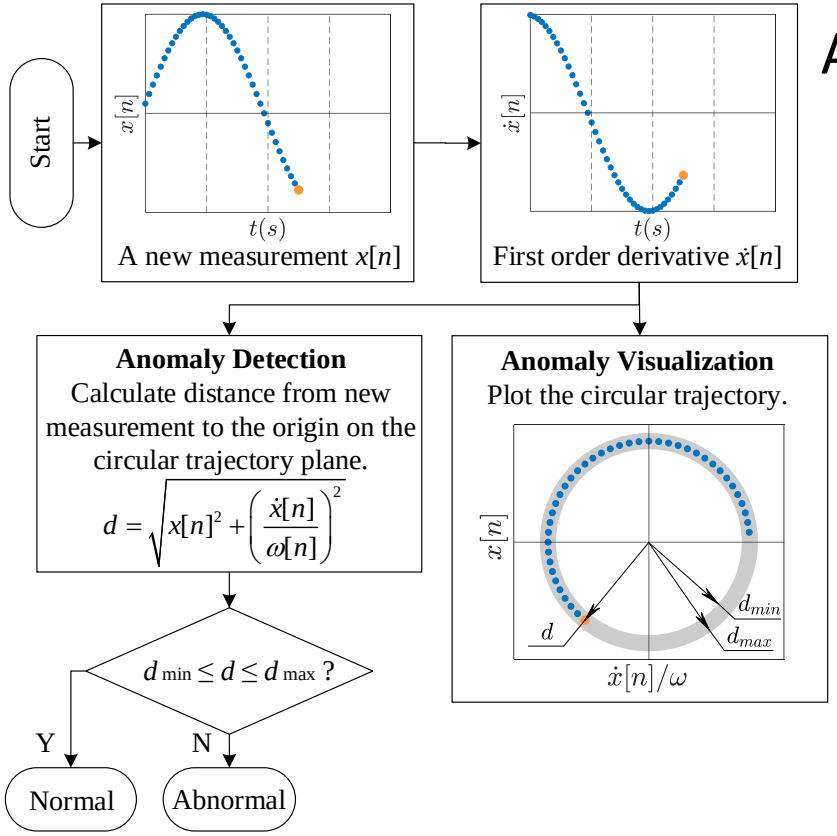

Haoyuan Sun *et al*., "Circular Trajectory Approach for Online Sinusoidal Signal Distortion Monitoring and Visualization," IEEE Trans. on Smart Grid (PES letter), July 2022.

Waveform Data Pre-processing

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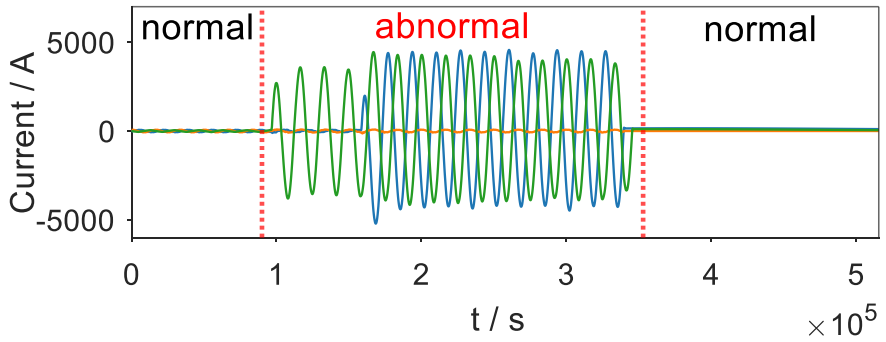
Waveform Truncation

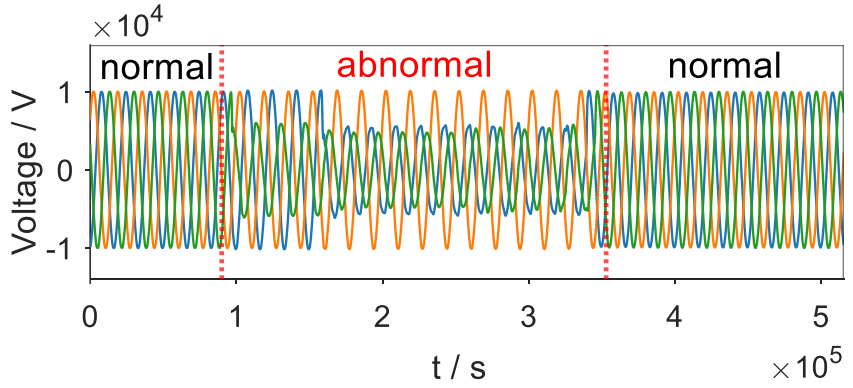
Why? To remove normal segments and thus focus on abnormal segments.

How? (1) Circular Trajectory Approach (CTA)

(2) Residual Component Method

Take the difference of a cycle and its previous cycle.





Waveform Data Pre-processing

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Remove Repetitive Waveforms

Why?

(1) One event could be recorded by multiple devices.

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

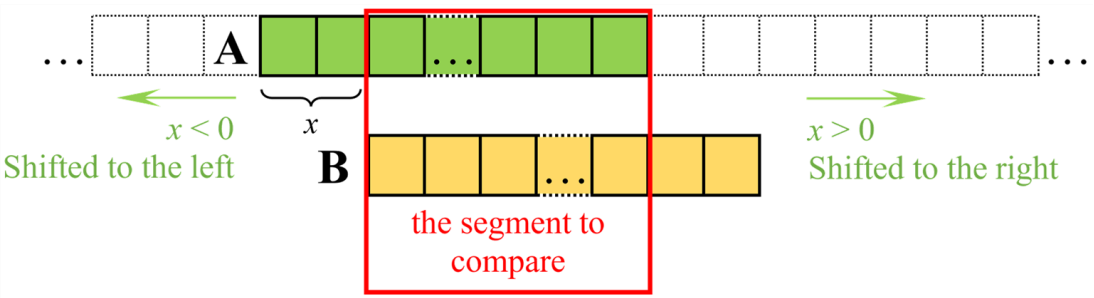
How?

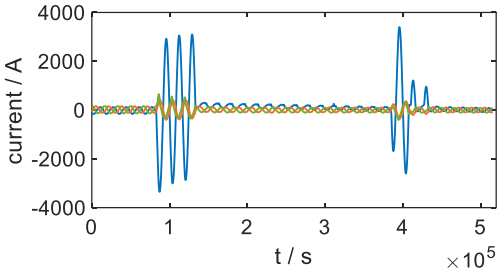
(1) Euclidean Distance

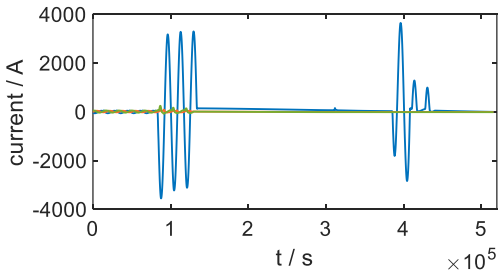
To measure similarity of two waveforms.

(2) Waveform Shifting

We look for the highest similarity along the shifting.







Waveform Data Pre-processing

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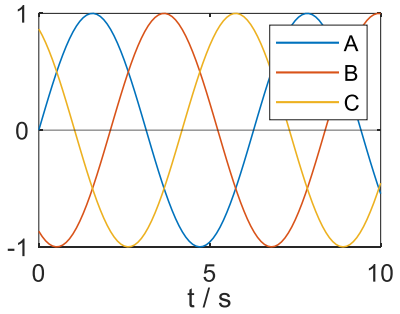
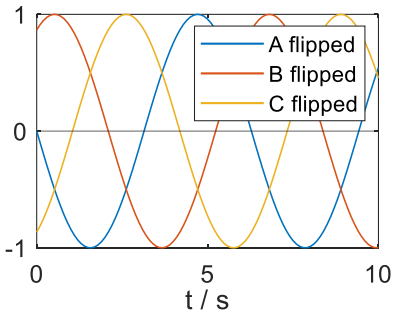
6x Data Augmentation

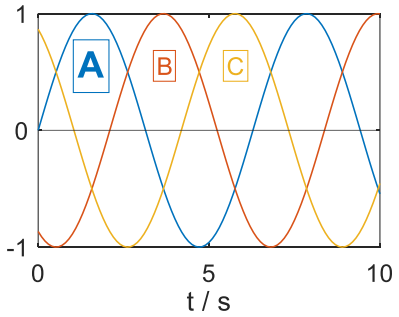
Why? To enrich the inherently insufficient outage data.

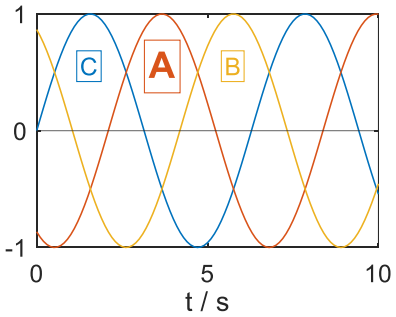
How? (1) Flipping (2x data)

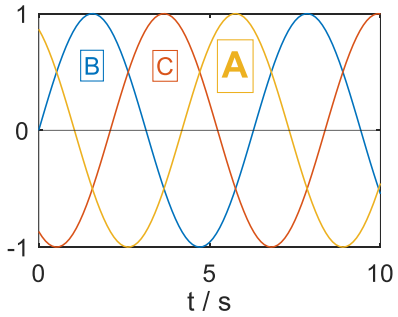




(2) Alternating phase sequence (3x data)







Conclusions

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- 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.