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Compression of Power Grid Waveforms

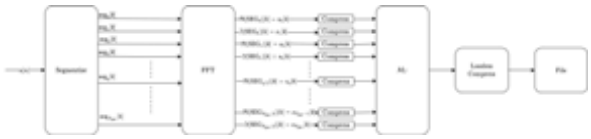

Abb. 1 Simplified schematic of Spectral Variation.

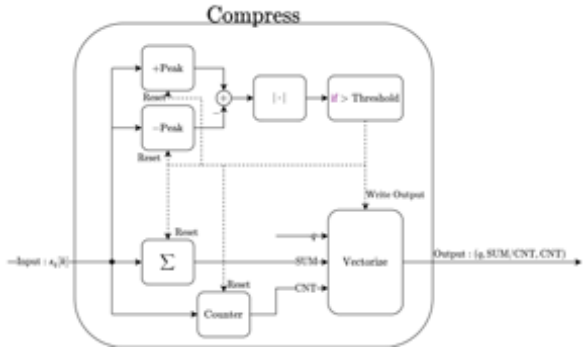

Abb. 2 Schematic of the compress block in Spectral Variation.

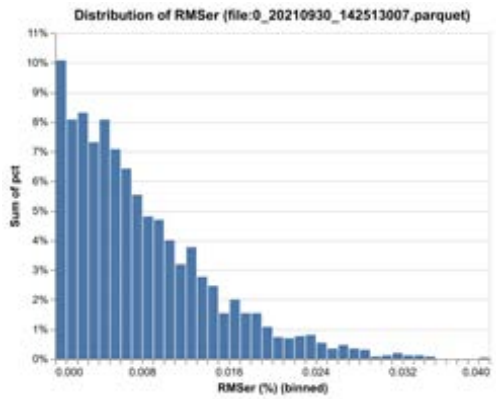

Abb. 3 Distribution of the 10 period RMS errors using Spectral Variation.

Problem

The electrical power grid is subject to non-ideal phenomena such as voltage swells and dips, transients, harmonic distortions, and unwanted phase shifts. To be able to monitor, analyze and correct these phenomena one must measure and store the grid voltages and currents. To remain independent of specific analyses the raw time domain data should be stored. Consequently, this invokes the need to store huge amounts of data. Which in turn invokes the need to sufficiently compress the data without loss of generality.

Concept

This project focuses on a summary of the tools used in data compression, it shows where one can find and create realistic test data and it gives an overview of the state of the art compression algorithms used in power grids. Furthermore, the project concludes with an implementation and comparison of two algorithms and illustrates their strengths and weaknesses.

Implementation

The project tested two algorithms: Free Lossless Audio Codec (FLAC) and an algorithm described in the paper «Spectral Variation-based Signal Compression Technique for Gapless Power Quality Waveform Recording in Smart Grids», which has a patent on it until 2024. FLAC was tested to give a comparison baseline with respect to compression ratio $\boldsymbol{CR} = \frac{\text{original size}}{\text{compressed size}}$ and computational complexity measured in floating point operations (FLOPS). A simplified schematic of Spectral Variation can be seen in figure 1 and 2.

Results

Spectral Variation is approximately 100 times better than FLAC with *CR's* in the order of 100-300. Furthermore, FLAC is approximately 70 times faster than Spectral Variation. However, one must take into account that Spectral Variation was not optimized with regard to computational complexity. Lastly, the introduced error by Spectral Variation can be kept under a certain limit by calibrating the algorithm (see figure 3).

Outlook

Seeing as the *CR* of Spectral Variation is significantly higher than FLAC, the complexity can still be optimized, the introduced error be kept under a certain threshold and that the patent expires in 2024, the suggestion is to continue with Spectral Variation.