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Hierarchical Cluster Classification of Half Cycle Measurements in Low Voltage Distribution Networks for Events Discrimination

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EXTENDED ABSTRACT

1. Introduction

The paper presents a case study on half-cycle RMS voltage classification. The study is based on clustering-based elaboration of data gathered during more than one year at two different locations in a low voltage distribution network. Since the volume of available data is much higher than the amount of data possible to be analysed with classical processing tools, new algorithms are necessary to perform data analysis. For this purpose, some variants of the *hierarchical clustering* algorithm have been tested in this paper. The objective is to identify and classify abnormal events due to disturbances in the electrical network. Different definitions of distance have been used within the hierarchical clustering framework, in order to find out the most effective clustering method. The effectiveness is judged on the basis of the capability of the clustering methods tested of isolating abnormal events from the groups of recorded events.

2. Measurement System

The measurements have been carried out by using a custom designed equipment, made in Romania, called MOT-103B/BG. This equipment has been designed to meet the requirements of the SR EN 50160 standard even for long term surveys. In order to be connected to a higher processing level, MOT has factory configurable serial interfaces (RS-232 or RS-422/485) implementing a MODBUS protocol. MOT is treated as a MODBUS slave. The equipment has dedicated inputs for voltage to be monitored, time synchronization and dedicated bidirectional interfaces for communication.
Besides voltage monitoring according to SR EN50160, the MOT equipment can give on OSC output the RMS value of the voltage and the duration of the half cycle, every half cycle. This secondary function is used for the study presented in this paper. Since the equipment has no dedicated memory for half cycle RMS storage, the computer must be continuously connected during the data acquisition. Results obtained from processing data collected at two locations (Bucharest and Cluj) are illustrated and discussed in the paper.

3. Measurement Results

The measurements performed during 10-minute intervals led to gathering 60,000 half-cycle data. Specific intervals containing abnormal events were identified by processing the initial data with statistical routines. These events were analysed with further detail. The 60,000 values measured during 10-minute survey were split into 60 vectors of 1000 values each. In this way, each vector describes the measurements for 10 seconds. The clusters were formed by using hierarchical clustering with the single linkage (or "nearest neighbour") criterion. Some variants were tested depending on the notion of distance used for hierarchical clustering. These variants include the Euclidean distance, the Chebyshev distance and the Minkowski distance. In order to determine the best distance definition used for clustering with the objective of separating the events, a set of dendrograms were built. Each dendrogram represents in graphical form the evolution of the clustering process for a specific clustering variant. The most effective variant was found to be the one adopting the Chebyshev distance.
The analysis was then extended to a 30-minute interval for the two locations (Bucharest and Cluj), taking into account 18 events found in the first stage clustering. In order to discriminate local events from network events, a second clustering analysis was conducted on the 10-second vectors extracted from the measurements. Most events appearing on one site were interpreted as local, since there was no corresponding event on the other site. In some cases, possible candidates to represent system events were identified. Further information on the timing of the events and on the electrical system structure could allow for estimating the location of the events classified as system events, thus refining the conclusions drawn from the first stage of data analysis.