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Analysis of Event Sequences in Power Distribution Systems [Extended Abstract]

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Abstract. In this paper, events registered in power distribution systems are analyzed to recognize sequences of events associated to faults occurred in the network. The events considered in this study are basically voltage sags generated by homopolar faults and registered by power quality monitors installed in the secondary of transformers in distribution substations. The events registered in a measuring point have associated the time of occurrence, and the list of increasing-time ordered events corresponds to a sequence. The aim of this work is to discover the collection of events associated with failures in the network that can be viewed as sequences of events related with the actuation of the protection system. Two algorithms are proposed to recognize these sequences. The methodology is tested with data gathered in different substations which have been manual grouped by the utility[1].

Key words

Power quality, sequence pattern discovery, voltage sag, event sequence, frequent episodes.

1. Statement Problem

The main goal is the identification of event sequences related with the occurrence of faults in network components for future applications in prognosis of faults.
If D is a set of events registeres in the same substation of the system as, D can be written as: $\boldsymbol{D} = \langle(\boldsymbol{A_1}, \mathbf{t_1}), (\mathbf{A_2}, \mathbf{t_2}), \ldots, (\mathbf{A_n}, \mathbf{t_n})\rangle$, where an event is a pair (A_i, t_i), A_i is the type of event (an event can have different attributes) and t_i is the instant of occurrence. A_1 is the first event and A_n is the last event. Given that at the same point of fault can pertain several events, then D can be viewed as $\boldsymbol{D} = \langle(\boldsymbol{S_1}, [\boldsymbol{t_{s1}}, \boldsymbol{t_{e1}}]), (\boldsymbol{S_2}, [\boldsymbol{t_{s2}}, \boldsymbol{t_{e2}}]), \ldots, (\boldsymbol{S_k}, [\,\boldsymbol{t_{sn}}, \boldsymbol{t_{en}}])\rangle$ where S_i is a subset of events related whit the same point of fault, t_{si} is the star time of the subsequence i and t_{ei} is the end time of the subsequence i. The discovery of these subsequences is based on a criteria of similarities between attributes of events and considering also the temporal proximity of occurrence.

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2. Proposed Solution

A first solution is based on the recognition of the nearest events beginning from the date of occurrence of the event The assumption is that a permanent fault will have successive near events by the actuation of the protection system. A second solution is based on the similarities of the duration, depth and faulted phases, since the assumptions are that for a particular fault the events will be similar too.
The proposed solution to recognize the events sequences related whit individual point of failure was tested with a database that contains about of 3000 events classified manually by the utility.

3. Main Results and Conclusions

The analysis of registered events and the proposed solution has shown that useful information about the behavior and evolution of the faults in the electrical system may be extracted, as a first step in the exploitation of events recorded in power distribution systems for the recognition of future failures.
The test of the proposed solution showed that the assumptions of the problem are not performed in all the cases because the events monitored in a measurement point are associated to the lines that are feeded in that point. Then, a overlapping of sequences may occur.
Future work should continue with the search of similarities between different sequences of events associated to faults of specific elements of the network, in order to discover patterns or mine frequent episodes and exploit other information contained in the events recorded.

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