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USING SIMULATION AND ROUGH SET LEARNING TO DETECT FAULT LOCATION IN DISTRIBUTION NETWORK

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ABSTRACT

Fault occurs owning to a variety of reasons in distribution network, such as equipment failure, overloading, tree, vehicle etc. It is very important for utility to detect the fault location as quickly as possible for helping to reduce the outage time. This paper proposed a method for distribution network fault location diagnosis which employs simulation and rough set learning. Based on the topology structure of distribution network and the probability model of equipment failure, the simulation model is firstly built for training the sample data. The rough set theory is applied to establish the rules of the relationship between outage zone and the equipment failure. And the enhanced learning process is used to improve the completeness of rules library. The numerical testing results are also presented to illustrate the method.

1 THE FAULT LOCATION MODEL IN DISTRIBUTION NETWORK

In the fault location model, we need to analyze *n* equipments and *m* user's zones. The set $D=\{d_1,d_2,\ldots,d_n\}$ denotes the equipment status. If $d_i=-1$, the equipment *i* is failure. And $d_i=1$ denotes the status of equipment *i* is fine. The set $O=\{o_1,o_2,\ldots,o_n\}$ denotes the zones may be outage. And the user's zone is corresponding to the distribution transformer. If the user's zone is outage, the corresponding transformer is uncharged. The set $T=\{t_1,t_2,\ldots,t_n\}$ denotes the transformers, which are corresponding to the user's zones set. If $t_i=-1$, the transformer *i* is uncharged. $t_i=1$ denotes the transformer *i* is charged. If $o_i=-1$, the zone *i* is outage. $o_i=1$ denotes the zone *i* is not outage. If an equipment is failure, it will result in one or more user' zone outage. The key of fault location diagnosis is how to learn the fault equipments information from the outage zone's information.

2 SIMULATION AND ENHANCED ROUGH SET LEARNING

Simulation is the effective method to build the relationship between equipment failure and the outage zones. Rough set learning is very useful tool to establish the rules library which can build the relationship between outage zones information and fault location information. We build the enhanced learning process which is used to improve the completeness of rules library. The enhanced learning framework is summarized as follows.

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1. Constructing the discrete event dynamic simulation model which is based on the structure of distribution network topology. Then, we select the equipment to be analyzed according to equipment failure curve. Finally, we obtain training datasets through simulation.
2. Training decision rules for fault location. Firstly, the rule sets are learned from sample datasets. The reinforcement process is applied to improve the learning results. If the completeness of rules library meets the requirement, we output the rules library. Through the library, customer can quickly determine the fault location with high probability.

Simulation datasets are obtained through the simulation model. Simulation input is the selected fault equipments based on equipment failure curve. Simulation output is the corresponding outage zone's information. According to the simulation datasets, we can get the training datasets. The outage zone's information is the training input. The training output is the corresponding equipment failure information. Finally, we use the Rosetta software to generate the rules library.

3 CONCLUSION

Fault location is generally extremely difficult in terms of the complicated and huge structure of the distribution network. Based equipment failure probability model and distribution topology model, simulation is the effective method to train sample datasets. A machine learning method based on rough set theory is developed to establish the relationship between outage zones information and equipment failure, including attribute reduction and rules generalization. An iterative reinforcement process is applied to improve the learning. Numerical simulating and testing show that, by using this method, we can efficiently diagnose the fault location.

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