

## Self-healing Control Algorithms for Distribution Networks

Huan-Yuan Wei<sup>1,a</sup>, Jin-Bo Lan<sup>2</sup>, Yan-Fei Ye<sup>1</sup>, Xiao-Hui Li<sup>1</sup>, Jian-Fei Yang<sup>1</sup>

<sup>1</sup>School of Electrical and Automation Engineering, Nanjing Normal University, China

<sup>2</sup>Guodian Nanjing Automation co.,LTD, Nanjing 211100, China

<sup>a</sup>e-mail:js\_weihuanyuan@163.com

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**Abstract.** Self-healing is an important feature of intelligent distribution networks. Self-healing includes the abilities of self-perception, self-diagnosis, self-decision and self-recovery. In this paper, a adjacency matrix of the distribution network is used to determine the network fault perception and make a decision. The power supply is then restored utilizing network reconfiguration. The isolated nodes in the network are identified using the node matrix of the distribution network. A new network is found according to the contact characteristics between nodes so as to restore power. Finally, the feasibility of the algorithm is verified via MATLAB simulations.

### Introduction

In recent years, there have been instances of large power failures both in China and abroad. These accidents have caused people to pay attention to the reliability of the distribution networks. The concept of self-healing of distribution networks has come into focus. "Self-healing" is source in the biomedical field, which is defined for system of a self-aware state, without manual intervention in self-judgment and taking appropriate measures to restore to the normal state. Grid self-healing means that there is no need, or only a small need, for human intervention. Instead, advanced monitoring methods for power-grid operation states are utilized in order to make continuous on-line diagnosis and assessment. This enables timely detection and quick adjustment of problems, eliminating hidden problems. Grid self-healing includes the abilities of self-perception, self-diagnosis, self-decision and self-recovery, and makes safe and reliable operation of distribution networks in different kinds of conditions possible. The process of self-healing of the smart grid can adjust the different states of the network. It leads to optimization and warning under normal conditions and fault diagnosis under faulty conditions; thereby making reconfiguration of the network and restoration of the power supply possible. Self-healing even makes separation from the main grid under extreme conditions possible. Under this condition, continued operation with a distributed power and energy storage device is achieved.

The key technologies pertaining to a distribution network's self-healing and the structure of the whole self-healing system are introduced in the paper [1]. The scheme of self-healing control for power networks includes the centralized control mode, the decentralized control mode and the centralized/decentralized coordinated control method [2]. This paper discusses the state estimation of a power network during the process of network self-healing, but there is no further study on how to do the self-healing of the power network in the paper [3]. A self-healing control framework of "2-3-6" is proposed in the paper [7], namely, the two loop control logic, the three layer control structure, and the six control links. The design focuses on the contradiction between the fast and the global response of the local dynamic process of the network. A local control with quick reaction and a global control with relatively slow reaction are made and the coordination layer is joined between the two loops control logic in order to solve the contradiction between the global control and local control. In this paper, the station of the system relying mainly on with advanced analysis and calculation function of master will collect the amount of measurement information, through the analysis of the calculation to determine fault types, fault location and formation control decision, issued to protection device. We focus on a method for centralized control through the adjacency matrix of the distribution network used to find the network reconfiguration path after a failure. Analyze the exist-





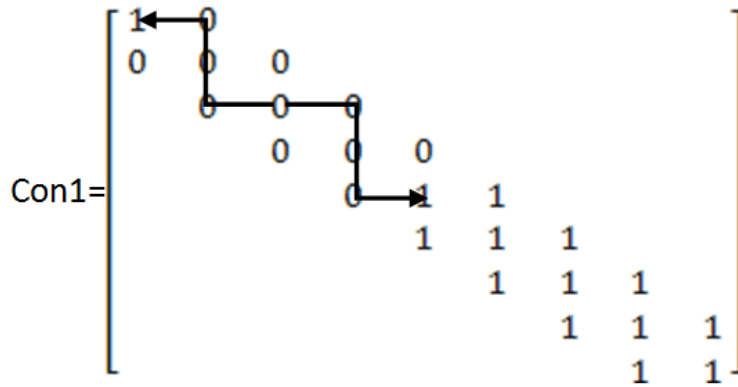


Fig.3 Searching for paths

The algorithm search following the path dictated by the state of the matrix shows two loops. One is connected with Node 1 and the other is connected with Node 5. Then, in comparison with the Con matrix: If the connection between the nodes is changed, the contact switch state is changed. For instance, Node 4 and Node 5, and Node 2 and Node 3 are not the same as before. Therefore, Node 3 can only connect with Node 4 and Node 5.

In this paper, the distribution network model was built using MATLAB. The state of the circuit breaker is simulated by the S-function, and the state of the circuit breaker is transmitted to the control function. Then a power supply network is found by controlling the function. The feasibility of the scheme is verified by the S-function, and the model is shown in Figure 4.

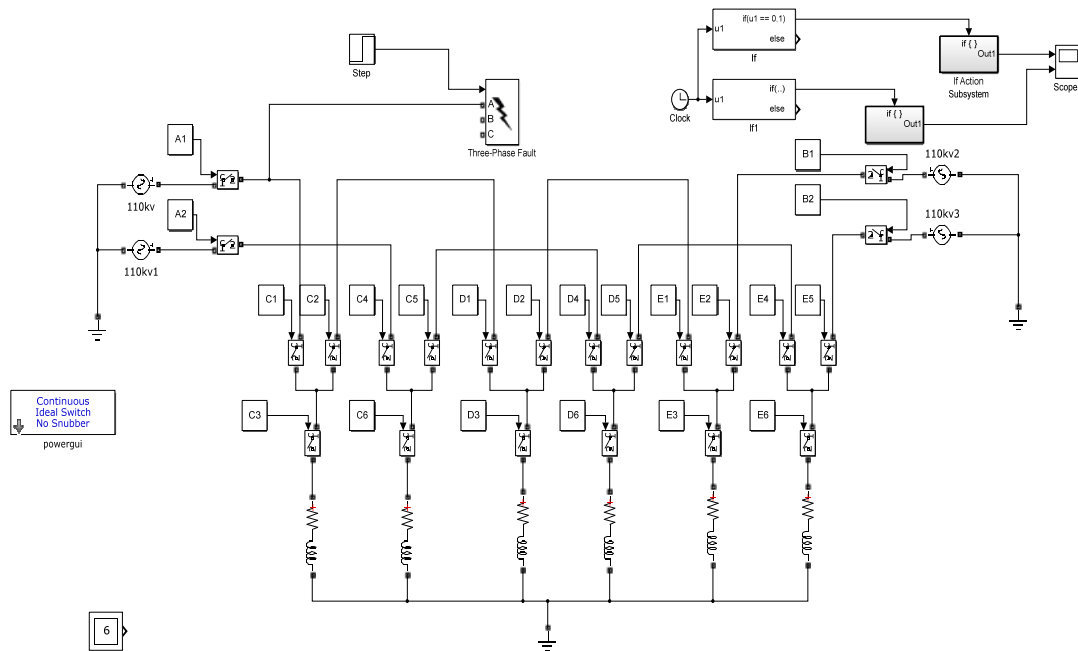


Fig.4 MATLAB simulation chart

Through the construction of the distribution network in Figure 1, a short circuit is simulated. It is verified by simulation that the network can recover the power supply. Through simulation of 4 normal operation modes, the circuit breaker action in Table 1 is obtained. We can find that the algorithm can reconstruct the network and restore the power supply through the closing circuit breaker.

Table 1 Simulation results

	The closed circuit breaker under normal operation	The closed circuit breaker for simulation of short circuit
1	A1,C1,D2,E1,E2,B1	A1,C1,C2,D1,E2,B1 (Node 6 short circuit)
2	A1,C1,D2,E1,E2,B1	C2,D1,D2,E1,E2,B1 (Node 2 short circuit)
3	A1,C1,C2,D1,E2,B1	A1,C1,D2,E1,E2,B1 (Node 4 short circuit)
4	A1,C1,C2,D1,E2,B1	A1,C1,C2,D1,D2,E1 (Node 8 short circuit)

## Summary

In this paper, a self-healing scheme is developed by utilizing a node matrix in order to complete the distribution network's self-decision and self-diagnosis. The path of the distribution network self-healing can be found and the current state of the distribution network can be known through the adjacency matrix. Searching process is simple and do not need to search every line. Because the distribution network is simple, no other constraints are needed. When the distribution network structure is complex, it is recommended to choose and optimize according to the power network voltage constraints and power loss constraints from the multiple networks of recovery power supply that are found. Thereby, a more reliable recovery power supply can be established. Under the background of the construction of the intelligent distribution network in China, the research is gradually deepened. It is the key problem in the future to find out the best solution in the process of power network self-healing.

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