Design of Self-Healing Control Method for Photo Voltaic Distribution Network of Internet of Things

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Abstract: During the construction of photo voltaic grid-connected distribution network, the self-healing control system is generally composed of monitoring computer, communication cable, communication interface, photoelectric converter, bus connector and multi-film optical cable. The remote centralized monitoring is realized by communicating with the local controller of the unit. Its network mode model for industrial Ethernet, communication system and implementation of the need for large-scale but photo voltaic (pv) grid power distribution network with single purpose of large number, wide distribution of the region, and the communication of capital concentration is much higher than power generation capacity of thermal power, hydro power, nuclear power or if based on Internet technology and network, not only can reduce the communication equipment of the implementation of the capital, can also provide follow-up self-healing control rising space.

1. Introduction
In the construction process of photo voltaic grid-connected distribution network, the establishment of self-healing control system is generally composed of monitoring computer, communication cable, communication interface, photoelectric converter, bus connector, and multi-film optical cable. Through communication with the local controller (lower computer) of the unit to obtain data, in order to achieve the purpose of remote centralized monitoring. Its networking mode is the industrial Ethernet mode, which requires large-scale communication system implementation, but the photo voltaic grid-connected distribution network has a large number of stand-alone, widely distributed areas, and the cost of communication is much higher than the concentration of power generation capacity. If the networking of thermal power, nuclear power or hydro power is based on the Internet of Things technology, it can not only reduce the implementation cost of communication equipment, but also provide room for future self-healing control[1-2].

This paper is based on the sensing layer is the basic network of the Internet of Things to achieve "the connection of things and interaction of characters", the perception control sub-layer and the communication extension sublayer. Among them, the perception control sub-layer can realize intelligent perception and identification, information collection and processing and automatic control of the physical world; the communication extension sub-layer connects the physical entity to its upper layer through the communication terminal module or its extension network. The structure of the Internet of Things selects an embedded system as the core and designs a system for centralized monitoring of several inverters.
2. Connection between self-healing control of photovoltaic grid-connected distribution network and Internet of Things

2.1 Overall architecture of the system

As the photovoltaic grid-connected distribution system is too large, different quality problems such as voltage, harmonic and frequency will often occur in the grid-connected operation of photovoltaic power generation. Therefore, the self-healing control of distribution network is very important for the normal operation of photovoltaic power generation grid connection. Therefore, this paper focuses on the self-healing control system of photovoltaic grid-connected distribution network based on the Internet of Things. Before this, it is necessary to master the principle and composition of photovoltaic inverter[3-4].

![Figure 1. Overall architecture of the system](image)

As shown in Figure 1, the ARM-based collection terminal is used to collect data from the photovoltaic inverter subsystem at regular intervals. At the same time, each terminal interacts with the host computer (terminal) via network equipment, and the terminal analyzes and manages the data. That is, each collection terminal regularly reports the collected data to the host computer, and other subsystems can query the host computer for the data of all photovoltaic inverter subsystems, including itself[5-6].

Storage, network transmission, touch screen man-machine interface functions, as the collection terminal of the subsystem. The monitoring system in the general control room uses a 32-bit PC to display, and every collection terminal sends data collected on the subsystem to the upper computer at regular intervals. Each subsystem is relatively independent, and all data of all other subsystems can be queried at the respective terminal. At the same time, the data transmitted to the host computer is stored in the database, and the data can be analyzed at any time. Self-awareness of the occurrence of the fault, then diagnose, control and recover. And the frequency of collecting data can be set.

2.2 Prevention and Control

The $d_4$ indicates the early warning state. Under the $d_4 \leq d(\cdot) \leq d_4$ condition, although the voltage and frequency parameters in the photovoltaic grid-connected distribution network are within the standard range, they have reached the limit state, and the reserve factor has been significantly reduced. Under this condition, the PV grid-connected distribution network enters an early warning state. It is necessary to set protection thresholds for the structure of the PV grid-connected distribution network operation mode and perform proofreading. At the same time, it is necessary to predict failures and implement load changes on the predicted results. In the case of changing conditions, the network structure control program is used to adjust reactive power compensation and operation mode to ensure that the photovoltaic grid-connected distribution network reaches the normal operating state[7-10]. The prevention and control judgment model is shown in Figure 2.
3. Optimized control test analysis

Under the $d(\cdot) \leq d_4$ conditions, the photovoltaic grid-connected distribution network maintains a normal operation state, and all parameters in the operation process meet the operation constraint standards. On this condition to decrease network loss, improve power quality, can use photovoltaic (pv) grid power distribution network reconfiguration and capacitor switching and improve the security and economy of power distribution network operation optimization control process is under normal condition, for the reconstruction of the photovoltaic (pv) grid power capacitor, reduce the loss to a minimum, until to improve power quality.

Early due to the interconnection of unit does not need the minimum load when the load changes, distribution network power will also change, power is along with the change of load changing, therefore in the process of running in low load and high load range 220 V as the critical point, higher than 220 V to high load the electricity enterprise, is less than or 220 V for low load the electricity that occupy the home, with branch medallion and contact with the switch to determine the distribution network using type, set the switch in the starting position of every line.

The power supply recovery scheme for self-healing of the photovoltaic grid-connected distribution network by this method is shown in Table 1, and the results before and after self-healing of the distribution network by this method are shown in Table 2 and Figure 3.

| Table 1 Self-healing scheme of distribution network |
|---------------------------------|-----------------|
| plan                           | details         |
| Action switch                  | Switch (20) disconnects, switch (25) closes |
| Switching times                | 2               |
| Number of islands              | 0               |
Table 2 Results analysis of distribution network before and after self-healing

|                          | Before adopting the method in this paper | After adopting the method in this paper |
|--------------------------|------------------------------------------|-----------------------------------------|
| Excised load             | 4-13, 12-25                               | -                                       |
| Overall load loss /kW    | 2004                                     | 0                                       |
| Class I composite loss /kW | 690                                      | 0                                       |
| Network loss/kW          | 13.37                                    | 16.4                                    |

Figure 3 Results after adopting the method in this paper

By analyzing Table 1, Table 2 and Figure 3, it can be seen that after the self-healing control of the photovoltaic grid-connected distribution network is carried out by the method in this paper, all loads are restored to power supply. In the case of failure between node 3 and node 4, the method in this paper disconnects and closes the switch (20) and the switch (25) respectively, so as to make the distribution network reconstitute the distribution network running in parallel with the main network. The contents in Table 2 show that in the process of self-healing using the method presented in this paper, there are not only fewer switching actions, but also no island network with poor stability in the distribution network.

The self-healing control method and the original method proposed in this paper are introduced into the photovoltaic grid-connected distribution network model to carry out the self-healing test after fault respectively. The simulation results show that this method can meet the service demand of self-healing.
control of photo voltaic grid-connected distribution network, achieve the expected research purpose to
the greatest extent, and improve the self-healing control quality of photo voltaic grid-connected
distribution network.

4. Conclusion
The self-healing control of the distribution network is to monitor its own state during the operation of
the distribution network and restore its normal operation to normal operation through appropriate
adjustments without human intervention. The current self-healing technology of photovoltaic
grid-connected distribution automation does not take into account the particularity of multi-source
feeders in its design. Therefore, the study of self-healing control methods for photovoltaic
grid-connected distribution networks is of great significance.

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