Application of Wireless Sensor Networks in Electrical Fault Location

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Abstract: WSN (Wireless Sensor Network) was first used for military reconnaissance and has gradually been applied in the civilian field in recent years. A network composed of randomly distributed small nodes is self-organized, and with the help of various built-in sensors, various physical parameters such as temperature, humidity, pressure, and gas composition can be measured in the surrounding environment, achieving monitoring of the environment. Therefore, this article applies WSN to the location of electrical fault points, which can better meet the needs of distribution network security work in extremely harsh environments. Electrical equipment parameters are collected through wireless sensor devices, and the collected electrical equipment parameters are integrated and fused with information. The method of multi-source parameter identification and tracking is adopted, Realize the analysis of fault parameter characteristics of electrical equipment. In practical work, electrical faults are often difficult to completely avoid complex environments. In such cases, the application of wireless sensing and its network can often provide accurate information support for electrical fault troubleshooting work.

1. Introduction

The reliability of large electrical equipment operation mainly depends on the quality of its insulation. The electrical equipment is affected by many combined effects of electrical, thermal and mechanical forces and environmental factors in operation, which leads to partial discharge in the weak links of internal insulation of electrical equipment and eventually leads to insulation breakdown [1]. Once the insulation of large electrical equipment is damaged, it will not only cause accidents, but also endanger the safe and stable operation of power system and bring huge losses. WSN was first used in military reconnaissance, and has been gradually applied to civilian fields in recent years. The network is composed of randomly distributed micro-nodes through self-organization, and with the help of various sensors built in the nodes, various physical parameters such as temperature, humidity, pressure and gas composition of the surrounding environment can be measured, and the monitoring of the surrounding environment can be realized [2]. The fault location technology of low-voltage electrical equipment is still in the research stage, because high-voltage lines are generally grounded with large current, and the line structure is relatively simple. Once a fault occurs, the relevant fault information can be identified and extracted in time. [3] The component in the whole system is very heavy, which requires that when the power grid fails, it can quickly locate the location of the fault point, analyze the cause of the fault and make corresponding protection actions. The traditional distribution network operation and maintenance needs manual line patrol, but with the continuous development of China's power grid system, most remote areas have achieved power grid coverage, which makes the branches of electrical equipment more dispersed and the wiring more complicated, and also brings great obstacles to the traditional manual line patrol [4]. Therefore, in this paper, WSN is applied to the location of electrical fault points, which can better meet the needs of distribution network support in extremely harsh environment. The parameters of electrical equipment are collected by wireless sensor equipment, and the information of the collected parameters is integrated and fused, and the fault parameter characteristics of electrical equipment are analyzed by multi-source parameter identification and tracking. In practical work, it is often difficult to completely avoid the complex environment, and the application of wireless sensor network can often provide accurate information support for electrical fault removal [5].

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2. Advantages of Wireless Sensor Network Fault Location

2.1. Unique fault location mode

WSN collects fault current components for fault location, making it more accurate. During this process, less data is collected, simplifying analysis and calculation. The use of wireless communication overcomes the adverse effects of asynchronous fault data collection caused by traditional dual terminal ranging methods [6]. The location of external targets needs to be combined with the physical coordinates of the sensor node itself, Therefore, the localization of WSN nodes themselves is the foundation of external target localization. Only after the nodes themselves are correctly positioned can the specific location of the event monitored by the sensor nodes be determined. This requires cooperation among multiple sensor nodes that monitor the event and use their own localization mechanisms to determine the mechanism of the event occurrence [7]. The structure of WSN nodes is usually different in different application environments, but the basic components are composed of sensors, microprocessors, memory, A/D conversion interfaces, wireless transmitters, receiving devices, and power supplies. The WSN node structure is shown in Figure 1.

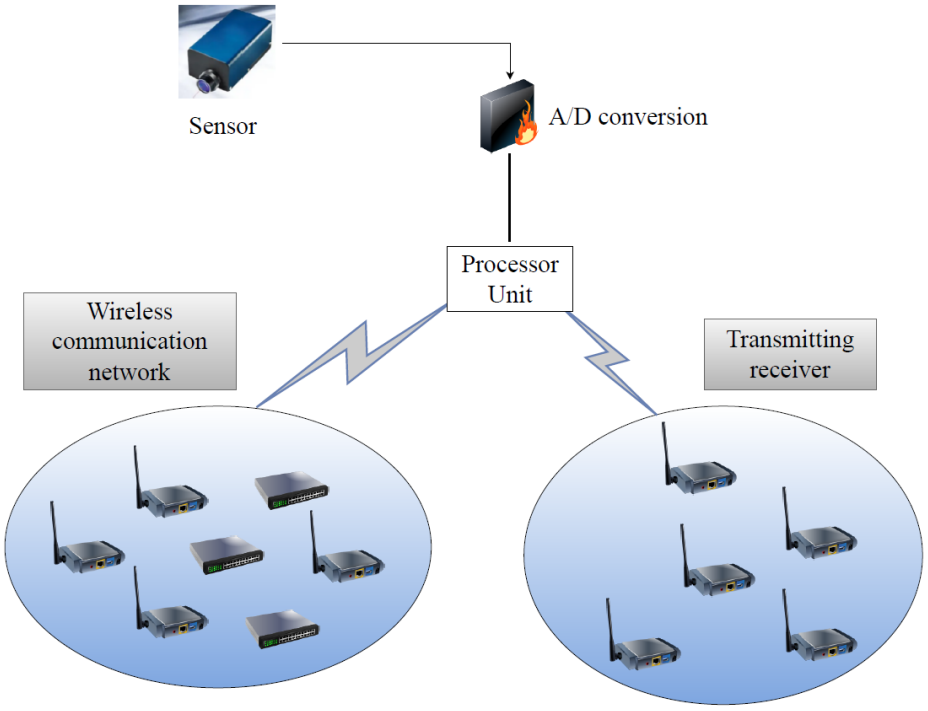

Figure 1 WSN Node Structure

Generally, the fault current component is used as the collection object to avoid measurement accuracy issues caused by excessive resistance. At the same time, the collected data information is relatively limited, and more steps such as calculation, analysis, and data processing are also omitted. The monitoring center is responsible for processing the collected data and sending the command to collect signals again. The analysis, processing, and fault diagnosis of the collected data are all handled by the monitoring center, avoiding the influence of other factors in fault detection and ensuring the accuracy and accuracy of the positioning results of the system [8]. More importantly, it adopts a wireless communication mode, which eliminates the problem of misaligned and asynchronous fault data collection caused by the previous dual ended distance measurement method.

2.2. Wide application range

As an emerging research hotspot in the field of information, sensor networks involve interdisciplinary research fields, with key technologies including network topology control, network protocols, time synchronization, data fusion and management, and positioning technology [9]. Among them, positioning technology plays a very important role in the effectiveness of sensor

network applications. Wireless sensor networks are actually a large-scale network with widely distributed and densely arranged nodes. They can obtain signals from different spatial perspectives, making the target information more comprehensive and accurate. In the fault location work of distribution routes, wireless sensor networks can achieve large-scale, fast, and accurate positioning, greatly saving manpower and material resources, and improving the efficiency of fault location [10]. They can collect signals from various dimensions, With a high signal-to-noise ratio, it can ensure the accuracy of ranging, effectively expand the ranging range, and avoid blind spots in ranging.

Sensor networks are generally deployed in harsh environments or areas that are difficult for humans to reach. Due to the large range of deployment areas and the large number of nodes, the state of each node cannot be taken into account, requiring nodes to be sturdy and consume less energy. So when nodes transmit data, it is required that the network has strong fault tolerance and robustness. Sensor nodes are widely distributed in the monitoring area, and they communicate and connect through multi hop self-organization and wireless routing. Compared to wired distribution, it saves the trouble of manual wiring and is suitable for application in distributed systems. For example, collecting and processing information data, data transmission, etc., a sensor network system plays a multi-party role, controlling the use of other devices, and because it is wireless communication, there is no need for overly complex wiring. Overall, its cost is relatively low and its cost-effectiveness is high.

3. Application of Wireless Sensor Network in Electrical Fault Location

3.1. Accuracy and speed of fault location

The most critical and core provision of Cable fault location is to ensure the accuracy of fault location, which means successful fault location. Therefore, the first step in determining the effectiveness of WSN is to ensure that it can accurately locate the fault location. Specifically, when a distribution network fault occurs, the node immediately puts into operation, and the fault signal is transmitted within 4ms. The fault location of distribution networks based on WSN usually introduces synchronous triggering devices. When a fault occurs, nodes can quickly enter operation, thereby clearing the fault as quickly as possible. Detect and repeat the prediction process that belongs to a normal state, and for prediction decisions that belong to an abnormal state, it is necessary to identify the cause of the fault. To analyze the potential development trend of the fault in the future, it is necessary to estimate the future development and operating time, and make effective control methods and maintenance plans for the causes of the fault.

The main hardware for extracting fault features in the entire WSN is the wireless current sensor node. Its functions include collecting, monitoring, and sending current data. Its core component is the CC 2530 chip in the communication module, which processes the voltage signal collected by the current sensor and sends the data to the coordination node through the wireless network. For WSN, when applied to distribution network lines, after statistical calculation of risk, the convergence demonstration can meet the specified requirements in a state of 15% network volume, with only 3.34ms. This demonstrates the special function and role of the WSN system

3.2. Reliability Analysis of Fault Location

After electrical equipment malfunctions, wireless sensor nodes can timely and effectively monitor the fault signal; At the same time, the relevant information of the middle and lower level nodes can be safely and reasonably transmitted to different nodes, and ultimately transmitted to the control center. In order to achieve wireless network-based parameter collection and fault diagnosis of electrical equipment, it is necessary to first construct a model for parameter collection and fault feature extraction of electrical equipment. The method of multi-dimensional sensor information recognition and parameter fusion is used to sample electrical equipment parameters, and the structure diagram of parameter collection of electrical equipment is shown in Figure 2.

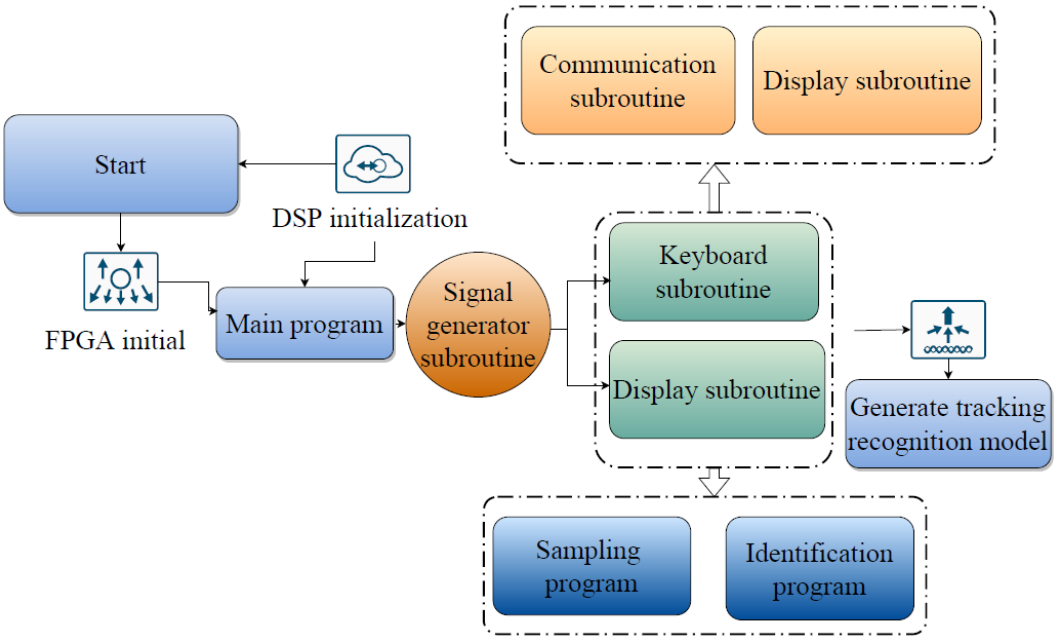

Figure 2 Structure diagram of parameter acquisition for electrical equipment

After the network cable of electrical equipment fails, the result of automatically generating the initial report of line fault is obtained, and the fault parameters of electrical equipment are obtained according to the specific business scenario of fault handling. The sensor will transmit the obtained current information to the coordinator node, and then the coordinator node will transmit it to the monitoring center. The monitoring center will summarize and analyze the current information transmitted by each node in WSN, and determine the location of the fault through multiple collection and analysis. Therefore, the node can view the fault-related data and information in a timely manner. Moreover, the sensor network system can also transmit the collected information in time and receive it by the control center, thus ensuring the efficiency, timeliness and accuracy of distribution network fault location.

3.3. Wireless Sensor Network Energy Optimization Analysis

Currently, due to the development and optimization of integrated circuit technology, the power consumption of sensor modules has gradually decreased, and more energy is concentrated and lost in wireless communication modules. This has brought a new topic to the research of sensor network systems, focusing on how to minimize the energy consumption of wireless communication modules, thereby optimizing energy consumption as a whole. The overall performance of wireless current sensors in this article can meet the needs of line zero sequence current sensor data collection. When the coordinator node establishes a wireless network, it begins to listen for the presence of current sensor nodes within the communication range. The joining process is as follows: the current sensor node sends data packets to the core coordinator of the network. If the information matches correctly and correctly between nodes, the sensor node is allowed to join the network established by the coordinator node.

The WSN based fault location technology for distribution new circuits is being applied to different tasks, and its application in environmental detection has attracted widespread attention. The environmental monitoring system for a certain area collects node position current information through a large number of sensors, and wireless sensors effectively monitor the environment. When the environment changes, the current information at the node position will also change accordingly. The state mode after new fault signal detection and feature extraction is called the undetermined detection mode. By comparing with the reference mode, you can determine whether the equipment is normal or abnormal. Due to the diversity of fault types, there are multiple fault vector modes, and the process of establishing a fault vector mode is to create a fault file. Based on the model, further analyze the fault symptoms and status to identify the nature, type, and cause of the fault.

4. Conclusions

At present, the fault monitoring data of large electrical equipment are collected by wired sensors and transmitted by communication cables. The installation and maintenance cost of this kind of sensor is often very high, even exceeding the cost of the sensor itself. In view of the above situation, this paper began to discuss the introduction of WSN technology. Because the fault current is small, the location analysis of single-phase grounding fault depends more on the measurement accuracy of the sensor. The measurement accuracy of the sensor depends on various components of the sensor and the measurement algorithm. The reliability and stability of the wireless sensor in the application of fault detection and location of electrical equipment need to be tested many times in practice. Only by timely and accurately locating the fault and solving the fault problem can the safe operation of the electrical equipment system be truly supported and its due functions and functions be played. The internal environment of large-scale electrical equipment is complex, and it increases the complexity and time of network installation to know the location of each node by manual deployment. In some places, it is even impossible to obtain the accurate location of nodes by manual deployment, but the cost of WSN will be greatly increased by equipping each node with GPS devices. Because the application of WSN has just started, some problems such as the rationality of network topology design, routing algorithm and electromagnetic interference characteristics of wireless sensors need further study.

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