Research on Key Technologies of Power Internet of Things Based on Artificial Intelligence Technology

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Abstract. Abstract: With the development of science and technology, the power industry has combined many new technologies driven by science and technology to improve its own operating quality. The Internet of Things is a new technology that can significantly improve the power system. This article aims to study the key technologies of power Internet of Things based on artificial intelligence technology. This paper takes the research of intelligent meter reading system as an example, and conducts experimental analysis based on artificial intelligence algorithms. Using artificial algorithms in the spider web network topology, as the network increases, the communication paths that can be selected between nodes also increase, and the full-end reliability of the network topology also increases. The collection node is responsible for collecting temperature and voltage values through artificial intelligence technology, and then transmits the collected values to the coordinator node responsible for collecting information, and sends the collected information to the PC through the serial port, and uses the serial port debugging tool to display collected data. Experimental data shows that signal attenuation gradually increases with distance, and distance and obstacles make it impossible to send data accurately. So you can add routing nodes to the network, add collectors and concentrators, and then add an enhanced RF (Radio Frequency Identification) generator to the antenna design. The experimental results show that in the case of two indoor walls and D≤20m, the signal strength is in the range of -82dBm to -94dBm, which can ensure the normal communication of data. If D≥25m, data communication cannot be guaranteed. By combining power and the Internet of Things, power-based Internet of Things can be built to comprehensively enhance power operations.

1. Introduction

With the development of science and technology, the power industry has combined many new technologies under the promotion of science and technology to improve its own operating quality, and the new type of technology with a more obvious improvement effect is the Internet of Things [1-2]. The combination of electric power and the Internet of Things is currently a new field of related technology research and development. Through the construction of the Internet of Things on the basis of electricity,
the operation of power can be comprehensively strengthened. At present, people are studying the key technologies in the construction of the Internet of Things. [3-4]. Wang et al. used the Internet of Things technology to combine the two key technologies of radio frequency and sensors to create a power distribution network environment intelligent monitoring system that connects the scattered power ring network cabinets and power distribution rooms in real time [5]. The new intelligent distribution network monitoring system is based on wireless radio frequency sensing technology, which can remotely monitor the operating environment and provide instant alarms for abnormal conditions or failures, thereby effectively improving the intelligence and data level of the distribution network system. To a certain extent, ensure the safe and reliable operation of the distribution network. Jeff and others analyzed the impact of ambient temperature on safety tools and equipment, and proposed a temperature monitoring program for storing safety tools and equipment. Based on the Internet of Things technology, the temperature monitoring system is designed for real-time collection, recording and transmission and sending of target temperature data, and timely alarms and other functions [6]. The Internet of Things uses sensors to collect various required information such as sound, light, electricity, heat, chemistry, mechanics, location, and biology of objects or processes that need to be monitored in real time, and integrate it with the Internet. Realize the connection between things and people, things and things, to facilitate identification, management and control [7-8]. In addition, the Internet of Things has certain intelligent processing capabilities. It organically combines sensors and intelligent processing, makes full use of various intelligent technologies, and expands its scope of application. A large amount of data obtained from sensors is used to filter and process effective data, adapt to different user needs, and dig out new application fields and application modes [9-10].

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2.1. Introduction to Related Technologies of the Internet of Things

2.1.1. Radio frequency identification (RFID) technology. Radio frequency identification technology is a non-contact data collection technology that uses radio frequency communication to automatically identify target objects and obtain relevant data through radio frequency signals. RFID electronic tags are better than traditional barcodes, such as small size, large capacity, long life and reusable. The data processing process does not require manual intervention, and can support fast reading and writing, non-visual recognition, mobile recognition and multiple target recognition, positioning and long-term tracking management. The resulting cost, savings and efficiency improvements have promoted the development of radio frequency identification technology, making it an important entry point for all industries to achieve information.

2.1.2. Sensor technology. Sensors are the main link of automatic discovery and automatic control, and also the basic function nodes of sensor networks. Through various sensor nodes with rich functions, the sensor network can monitor and collect real-time information about different detected objects in the network distribution area to achieve complex targets within a specified range, forming an information collection platform for detection and tracking.

2.2. Artificial Intelligence Algorithm Model

2.2.1. Normalization of samples. The large true value of the power load data will affect the learning accuracy of the extreme learning machine model, and it will also increase the learning time and affect the learning efficiency of the model. Therefore, the actual power load data needs to be further standardized. The normalized formula is expressed as follows:

\[
\% = \% + \left( \frac{X - X_{\text{min}}}{X_{\text{max}} - X_{\text{min}}} \right) \left( X_{\text{max}} - X_{\text{min}} \right)
\]

(1)
Among them, X is the actual load data, Xmax is the maximum value of the actual load data, Xmin is the minimum value of the actual load data, X% is the normalized value, X%max is the normalized maximum value, and X%min is the normalized value. The minimum value after conversion.

2.2.2. Research on artificial cobweb routing algorithm for smart grid. Artificial spider web topology network topology can provide multiple routes for business and improve network reliability. The artificial spider web network topology is quantitatively calculated and analyzed, which theoretically proves the advantages of artificial spider web topology and the currently applied star, ring, Reliability and advantages of double star and double ring network structure. It is extremely important to analyze the function of smart grid communication system.

In this paper, we set the probability of link failure in the network as q, the probability of link validity as p, and the overall reliability of the system as R(G, P), where G represents a specific network topology, and Ge is obtained from the network G Delete the network obtained by e, G/e is the network obtained by merging the two nodes connected by e in the network. In this article, only the unreliable network caused by link failure is emphasized, and the factor theorem is shown in equation (2):

\[
R(G, p) = pR(G/e) + qR(G - e)
\]  
(2)

2.3. Advantages of Power Internet of Things Technology

2.3.1. Power Information Technology. Based on the intelligence and convenience of the Internet of Things, the power Internet of Things technology can share power information, and from the perspective of power users, better convenience services are obtained. Specifically, the application of the Internet of Power Different types of electricity users are managed uniformly.

For example, daily electricity consumption and enterprise electricity consumption, under the operation of the power Internet of Things, can enable both parties to receive reasonable and standard management. According to the above analysis, it can be seen that the Internet of Power Things is a two-way interaction technology between users and the platform. Based on the power Internet of Things, it can meet the individual needs of different users, which improves the diversification of the power industry.

2.3.2. Remote meter reading technology. The remote meter reading function is one of the basic functions of the power Internet of Things, and its advantages are convenience, accuracy, and efficiency. The remote meter reading function can realize remote real-time statistics of meter reading data, and when manual data collection is required, the system controls the detailed data to be transmitted to the system to complete the meter reading work.

2.3.3. Monitoring and maintenance technology. The power Internet of Things function includes two core functions: monitoring and maintenance. These two functions are a strong guarantee for protecting the quality of power operation. Power physical network technology can collect the operating parameters of power equipment, and form a workflow through storage, analysis, display and integration. In this process, the power Internet of Things technology will display all information, and can be displayed through the system.

2.4. Functions of Power Internet of Things

2.4.1. Energy saving and consumption reduction. For example, if a sensor is installed on the electric meter, the power supply department can grasp the power, realize the effective comprehensive management of the power, and achieve the purpose of energy saving and consumption reduction.
2.4.2. Improve the safety and reliability of operating equipment. By installing detection equipment in important electrical equipment and real-time monitoring of the operating status of the equipment, the operating status of the equipment can be grasped in time to improve safety and reliability.

2.4.3. Improve work efficiency and ensure personal safety. When staff perform maintenance work, each employee can be equipped with RFID equipment to track and manage employees in real time. It not only encourages the staff to work efficiently, but also avoids the risk of accidentally entering the electrified area and ensures the safety of personnel.

3. Key technology experiments of power Internet of Things based on artificial intelligence technology

3.1. Experimental Data Collection and Testing
In this experiment, all nodes are divided into two categories: coordinator nodes and collection nodes. The collection node is responsible for collecting temperature and voltage values, and passing the collected values to the coordinating node. The coordinating node is responsible for collecting information and sending the collected information to the PC through the serial port. You can use the serial port debugging tool to view the collected data.

3.2. Experimental Function
(1) Automatically establish a network.
(2) When the collection node is started, it can automatically join the existing network, and can automatically establish a binding relationship with the coordination node.
(3) The collecting node can periodically send information to the coordinating node and requires an end-to-end response.
(4) If the collecting node does not receive the response from the coordinating node, the collecting node will automatically release the binding relationship with the coordinating node, and reapply for binding with the coordinating node.

3.3. GPRS Module Chip Selection
The communication control unit is the core part of the data acquisition and transmission subsystem. It realizes the control of the SMS transceiver module through AT commands, sends the power data to the management terminal in the form of short messages, and takes corresponding control through the received control characters. At present, there are many GPRS data transmission modules used in industrial systems, including MC series from Siemens, G18 and G20 from Motorola, products from Wavecom, and SIM series from SIMCOM. Let's compare these products:

| Module | Advantage | Disadvantage |
|--------|-----------|--------------|
| MC35i  | Small size, widely used | Does not integrate TCP/IP protocol G20 |
| G20    | High applicability, a variety of configurations are available | Slightly larger and higher price |
| Q2406  | Widely used and affordable | Does not integrate TCP/IP protocol |
| SIM100 | Agreement, low price, perfect function | Good technical support for domestic students |
4. Discussion on key technologies of power Internet of Things based on artificial intelligence technology

(1) When there is one wall indoor, when \( D \leq 25 \text{m} \), the signal strength is in the range of 79dBm to -95dBm, which can ensure the normal communication of data, and the communication between the gateway node and the node can be considered stable and reliable. When \( D \geq 30 \text{m} \), the signal strength is extremely reduced, which can no longer meet the communication requirements between the gateway node and the node. \( D \) represents the communication distance between the gateway node and the node, \( S \) represents the data sent by the node, \( R \) represents the gateway node successfully receives the data sent by the node, and \( P \) signal strength. Table 2 and Figure 1 are the test results when there is one wall indoors.

**Table 2.** Test results when one wall indoors.

| D(m) | S   | R   | P(dBm) |
|------|-----|-----|--------|
| 5    | 23.7| 25.1| -79    |
| 10   | 24.2| 24.6| -83    |
| 15   | 25.0| 25.9| -87    |
| 20   | 24.4| 24.9| -91    |
| 25   | 24.5| 23.5| -95    |
| 30   | 23.4|   - | -108   |
| 35   | 23.2|   - | -117   |
| 40   | 22.9|   - | -125   |

**Figure 1.** Test results when one wall indoors.

(2) Table 3 and Figure 2 show the results of the communication distance test when the room is separated by two walls. If there are two walls indoors, when \( D \leq 20 \text{m} \), the signal strength is in the range of -82dBm to -94dBm, which can ensure the normal communication of data. If \( D \geq 25 \text{m} \), data communication cannot be guaranteed. Comparing the data in these two tables, it can be seen that the signal attenuation on gradually increases as the distance increases, and the signal attenuation gradually increases as the number of obstacles increases at the same distance. Therefore, the distance and obstacles prevent the generated data from being sent accurately. So you can add routing nodes to the network, and add an enhanced RF generator to the collector and concentrator antenna design to solve this problem. During equipment installation, corridors, walls, corners, etc. should be avoided to ensure normal data transmission.
Table 3. Communication distance test result when indoor separated by two walls.

| D (m) | S   | R   | P (dBm) |
|-------|-----|-----|---------|
| 5     | 23.7| 25.1| -82     |
| 10    | 24.2| 24.6| -86     |
| 15    | 25.0| 25.9| -89     |
| 20    | 24.4| 24.9| -94     |
| 25    | 24.5| 23.5| -99     |
| 30    | 23.4| -   | -111    |
| 35    | 23.2| -   | -134    |
| 40    | 22.9| -   | -142    |

Figure 2. Communication distance test result when indoor separated by two walls.

5. Conclusion

The power Internet of Things technology system is a new field of current power intelligent development. Through the application of power Internet of Things technology, it can bring overall quality improvement to power operation. The implementation of power Internet of Things technology can improve the convenience, accuracy, diversity, effectiveness, and stability of power work. As the distance increases, the signal attenuation of the intelligent meter reading system gradually increases. The reason why the data cannot be accurately transmitted is the distance and obstacles. Therefore, routing nodes can be added to the network and connected to the collector and concentrator. An enhanced RF generator is added to the antenna design. The experimental results show that when there are two walls indoors, when D≤20m, the signal strength is in the range of -82dBm to -94dBm, which can ensure normal data communication. When D≥25m, data communication cannot be guaranteed.

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