Research on Real-time Application of Ubiquitous Power Internet of Things Information Based on Smart Sensor Technology

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Abstract. In view of the current situation that it is difficult for the power control centre to take into account the multi-source information to conduct effective risk assessment on the dynamic process of the power grid, the challenges and opportunities faced by the power grid risk assessment under the background of the ubiquitous power Internet of Things are pointed out. The framework of the dynamic risk assessment system for the grid of the Internet of Things. At the same time, in view of the monitoring and fault diagnosis functions of sensor technology, especially gas sensor in transformer oil chromatographic monitoring, the application of ubiquitous power Internet of Things sensor technology in online monitoring of power equipment is discussed. First, the application of online monitoring of power equipment is analysed. The inevitable trend will then discuss in detail the monitoring and fault diagnosis functions of gas sensor technology in transformer oil chromatographic monitoring from sensor technology, gas sensor, transformer oil chromatographic device, and gas analysis method.

1. Introduction
The ubiquitous power Internet of Things realizes real-time perception and data access of various power equipment status through IoT terminals, and at the same time, through the system connection, integrates the existing scheduling, operation inspection, marketing, meteorological and other multi-system data to realize the status of the power grid. Comprehensive and real-time perception. By introducing multi-source data from the ubiquitous power Internet of Things, the traditional static grid risk assessment can be upgraded to a dynamic risk assessment, thereby revealing the risks faced by the system more comprehensively, accurately and in a timely manner. The sensor is an electronic device that can convert physical quantities, chemical quantities, biomass, etc. into measurement signals. It can output signals in various forms such as voltage, current, and frequency, and meet the functional requirements of information transmission, processing, recording, display, and control [1]. It has the advantages of compact structure, small size, good linearity, high sensitivity, etc. It is widely used in the fields of electronic and electrical, industrial automation, computer, etc., and has formed a set of mature theories and technologies, such as strain sensors, inductive sensors, gas Sensitive sensors and so on. This article mainly discusses the monitoring and fault diagnosis functions of gas sensors in transformer oil chromatographic monitoring.
2. Design of sensor information model

2.1. Modelling method
According to the method established by IEC61850, the application functions of the equipment to be modelled are decomposed into the smallest entities that exchange information with them, and these entities are called LNs [2]. Several LNs form an LD. Based on their functions, LN contains data tables with specialized data attributes. The data object (DO) has a complete structure and well-defined semantics. According to the service performance of the defined rules, the information represented by the data and their attributes is exchanged, and finally the service is realized by the specific communication service mapping (SCSM) and the specific communication means (such as MMS). The specific modelling ideas are as follows: 1) The convergence controller is used as a logical device. 2) The communication state of the monitoring device is used as the state quantity in LN0 (logical node 0). 3) Each type of sensor serves as a logical node class. 4) Each sensor serves as a data object under the corresponding logical node class. 5) The monitored value of the sensor is used as an attribute of the data object. The modelling idea of sensor information model is shown in Figure 1.

Figure 1. Modelling ideas of sensor information model

The modelling process is shown in Figure 2. The modelling steps are as follows: 1) Establish the decomposed functional unit, that is, the logical node LN. Decompose application functions into logical node classes that can be found. For example, some existing logical nodes and extended logical nodes are defined in IEC61850-7-4. 2) For the established logical node LN, determine the data object DO. 3) Observe the system and determine whether other functional modelling is required [3]. If not, then the modelling ends. If necessary, return to step 1).
2.2. Modelling examples

The convergence controller is used as an LD, a type of sensor is used as an LN, a measured value of the sensor is used as a DO, the type, quality, time, and description of the measured value are used as the data attribute (DA), and the sensor's constant value (coordinate, manufacturer, Information such as accuracy) is placed in the configuration file. Take temperature and humidity sensor (abbreviated as ZSNR) as an example to explain in detail the modelling method of unified information model. To solve the above problems, a sensor information model is constructed in the convergence controller, which mainly realizes the standardization and unification of the semantics and data expression format of the sensing device. Among them, the unified semantics guarantees the uniqueness, readability, and scalability of the attributes of the sensing device, and standardizes and unifies the keywords, expression methods, and data description languages; the unified data expression format is mainly in abstract definitions, parameter descriptions, etc. The data expression format is unified, including the equipment model, the abstract definition of the equipment, and the specific parameters of the equipment model [4]. By establishing a sensor information model, it supports the plug-and-play and interconnection of sensors of different manufacturers, and improves the information interaction efficiency of various application systems of the power Internet of Things. The sensor information model application deployment is shown in Figure 3.
3. Calculation of failure probability of smart sensors based on ubiquitous power Internet of Things

The acquisition of system failure probability is the basic work of system risk assessment, but the system failure probability is not static. It is not only affected by the service life and load rate of the component itself, but also by the external environment. The failure probability of the component under different operating conditions is generally different. The component failure probability formula is

\[ P = P_m(t)e^{\sum \lambda_i Z_i(s, d_e) + \beta \lambda Z(d_e)} \]  

(1)

In the formula: \( P \) is the component dynamic failure probability; \( P_m \) is the reference failure probability; \( Z_i \) is the dynamic influence factor of the failure probability, and \( \lambda_i \) is the co-efficient, which can be obtained according to the maximum likelihood estimation method [5]. The relationship between the reference failure probability \( P_m \) and the operating time of the equipment conforms to the bathtub curve, and the probability density can be expressed by the Weibull distribution, as shown in equation (2).

\[ P_m(t) = \left( \frac{\beta}{\hat{\beta}} \right) \left( \frac{t}{\hat{\beta}} \right)^{\beta-1} \]  

(2)

In the formula: \( t \) is the service time of the equipment; \( \hat{\beta}, \beta \) is the scale parameter and shape parameter of the Weibull distribution, respectively.

\[ Z_1(s, d_e) = e^s / d_e \]  

(3)

The disaster state correction factor is shown in formula (3), which is related to the disaster level and the geographic distance \( d_e \) between the current component and the disaster centre.

\[ Z_2(d_e) = 1 / d_e \]  

(4)
The scheduling state correction factor $Z_3$ is related to the topological distance $d_i(e_j)$ between the component and the component involved in the scheduling operation, as shown in equation (4).

$$Z_3 = \frac{1}{\min\left(d_i(e_1), d_i(e_2), ..., d_i(e_n)\right)}$$ (5)

The fault state correction factor is shown in equation (5), which is related to the topological distance $d_i$ between the current component and the faulty component.

$$Z_4 = \frac{1}{d_i}$$ (6)

4. System Design

4.1. Overall design

According to the design function requirements of the system, the host is composed of STC89S52 single-chip microcomputer module, LCD1602 liquid crystal display, wireless transmission module, display module, sound and light alarm, and the node is composed of single-chip microcomputer module, wireless transmission module, temperature collector, alcohol sensor detector, and circuit system. The block diagram is shown in Figure 4:

![Figure 4. Block diagram of the circuit system](image)

4.2. Related module design

4.2.1. Selection of controller module. The controller is mainly used for data reception and processing. STC89S52 single-chip microcomputer is used here, which is a low-power, high-performance 8-bit microcontroller with 8K in-system programmable Flash memory. The on-chip Flash allows the program memory to be programmable in the system and is also suitable for conventional programmers. On a
single chip, with a smart 8-bit CPU and in-system programmable Flash, the STC89S52 microcontroller is selected as the controller of this collector [6].

4.2.2. Selection of wireless transmission module. The APC200A-43 module is a highly integrated half-duplex micropower wireless data transmission module, which is embedded in a high-speed single-chip microcomputer and high-performance radio frequency chip. Innovative use of highly efficient cyclic interleaving error detection and error code, greatly improved anti-interference and sensitivity, can correct up to 24bits continuous burst error, reaching the leading level in the industry. The APC200A-43 module provides multiple channel options and can transparently transmit data of any size, without the user having to write complicated settings and transmission programs. The APC200A-43 module is a new generation of multi-channel embedded wireless data transmission module, which can be set with many channels, the transmission power is up to 20mW, and still has low power consumption, which can transmit 0-1000 meters.

4.2.3. Selection of temperature detection module. The temperature sensor DS18B20 is an improved intelligent temperature sensor newly launched by DALLAS Semiconductor Corporation in the United States. It can directly read the measured temperature and can realize 9-12 digits of digital value reading through simple programming according to actual requirements. There is a structure of 8-byte high-speed temporary RAM memory for more accurate measurement accuracy [7].

4.3. System Test

According to the system requirements, the temperature measurement range is 30-70℃, so it is set in the microcontroller to start an alarm when the temperature is not 30-70℃. The multiple test data are shown in Table 1 below:

| Ambient temperature °C | 32.2 | 33.7 | 33.2 | 33.5 | 33.4 | 34 |
|------------------------|------|------|------|------|------|----|
| Measuring temperature °C| 32.3 | 32.8 | 33.3 | 33.7 | 33.3 | 33.8 |
| Constant temperature time | 8:00 | 8:30 | 8:45 | 9:00 | 9:20 | 9:40 |

Adjust the wireless transmission module so that the transmission distance between the node and the host is not less than 5 meters: debug the node control module again, so that the data of the three nodes are periodically and cyclically transmitted to the host, and the display screen and sound and light alarms will display and process the nodes cyclically. The collected data, and the three nodes all have separate power supplies to provide power, which realizes the data collection, processing and display of the Internet of Things.

5. Conclusion

The use of sensors can greatly reduce the demand for personnel. In the past, electric power personnel were required to solve power problems, and it was difficult to repair power equipment, which would consume a lot of time. With the application of sensors, because the fault can be confirmed in a short time, the demand for personnel will be greatly reduced. The feedback reception currently used in the Internet of Things is mainly realized through the network. Therefore, compared with the traditional way, the network can have a wider range of use conditions. When in use, real-time feedback can be used to make the power network more coordinated and coordinated.

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