Design of a Combined Substation Operation Monitoring System Based on Internet of Things

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Abstract. Aiming at the lack of reliability and timeliness of traditional manual supervision of combined substation, this paper proposes a state monitoring system for combined substation based on Internet of Things (IoT) and industrial cloud. Via the IoT, the sensing, transmission, and storage of real-time data of combined substation operation are realized. Combining the industrial cloud and monitoring system, and using the micro-service architecture, the friendly service of the combined substation supervision can be realized, the automation level and safe operation level of the combined substation can be improved greatly, and which satisfied the users.

1. Introduction

Combined substation is a line connection point in the power network, which is used for switching voltage and power, collecting and distributing power [1]. It contains high-voltage switches, transformers, low-voltage switches, and other compact power distribution devices [2]. Traditional operation state of the combined substation mainly relied on the regular inspection and recording by the workers, and the inspection results are recorded in paper for analysis. In this way, it has many shortcomings, such as large workload, large and complex data, long detection and recording time, and the accuracy and timeliness of fault diagnosis of the combined substation can't be guaranteed, which seriously affect the reliable power supply of power distribution equipment [3].

At present, in terms of reliability and timeliness of traditional manual monitoring of combined substation, this paper proposes a state monitoring system for combined substation with the new technology of the IoT and industrial cloud. Firstly, the operating parameters and environmental parameters of the combined substation through Intelligent Instrument and sensors, which are collected into the intelligent data collection terminal. Then the data is transmitted to the industrial cloud server by GPRS and wireless transmission, the operation data is stored and processed through the cloud computing technology. At length, the online operation, maintenance and supervision of the combined substation can be realized, the input of human resources is reduced, and the reliability of the combined substation work is effectively improved.

2. Architecture Analysis of Combined substation Status Monitoring System

2.1. Combined substation status monitoring system architecture

The architecture of the combined substation states monitoring system based on IoT and industrial cloud is composed of three parts: data collection layer, data transmission layer and data application service layer, as is shown in the Figure 1,.

(1) The data collection layer constructs a “wired+wireless” data collection platform by installing sensors and accessing smart meters, and installing corresponding cameras at the video image collection location, combining the management of distribution equipment with video surveillance, the variable operating parameters of intelligent instrument cabinet are collected to the intelligent data collection terminal through Modbus protocol.

(2) An efficient and reliable data transmission system is established in data transmission layer. The operational data acquired in the intelligent collection terminal is transmitted to the real-time data collection cluster of the industrial cloud computing center in real time through appropriate transmission methods, and stored in the cloud database.

(3) The data application layer mainly implemented the combined substation management system on the industrial cloud. By analyzing and processing the information from the perception and transmission, the friendly service of the combined substation status monitoring system can be realized. Therefore, by providing real-time condition monitoring service, operation statistical analysis service, fault condition alarm service, real-time video surveillance service, and other application services, the threshold and cost of using the system can be reduced.

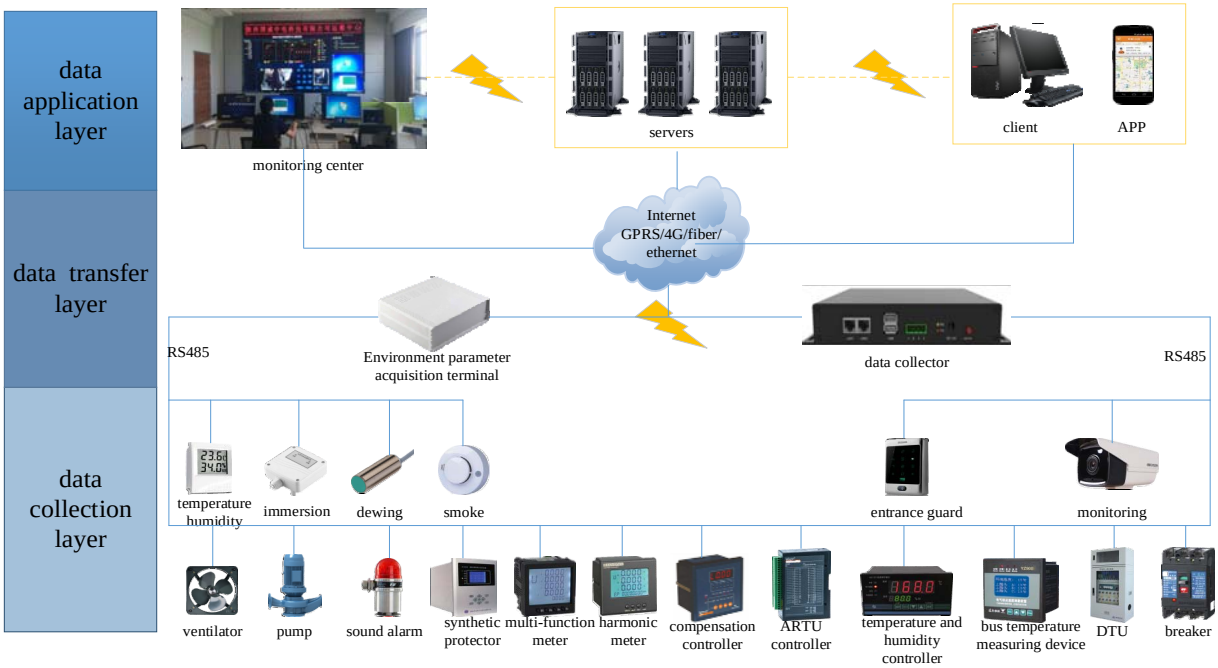

Figure 1. Architecture of combined substation state monitoring system.

2.2. Combined substation status monitoring system software architecture

In order to support the use of application services in different factories and subscription of users, the design of combined substation monitoring system based on IoT and industrial cloud adopts the design mode of micro-service software architecture, as shown Figure 2. A service implements a different feature or function, and the various resources are exposed in the form of a RESTWeb (representational State Transfer Web) API through microservices. Each independent microservice is a small application

[4]. Each service runs independently of each other in a separate operating system process and is suitable for building distributed applications based on industrial clouds [5].

3. Functional design of combined substation state monitoring system

The functional design of the combined substation monitoring system based on the IoT and industrial cloud is shown in the Figure 3.

(1) Basic information management unit. This element realized the management of basic information of combined substation transformer, we can check the information of equipment manufacturer, production date, equipment price, installation time, maintenance times, maintenance cost, last maintenance time, usage status, equipment type, etc.

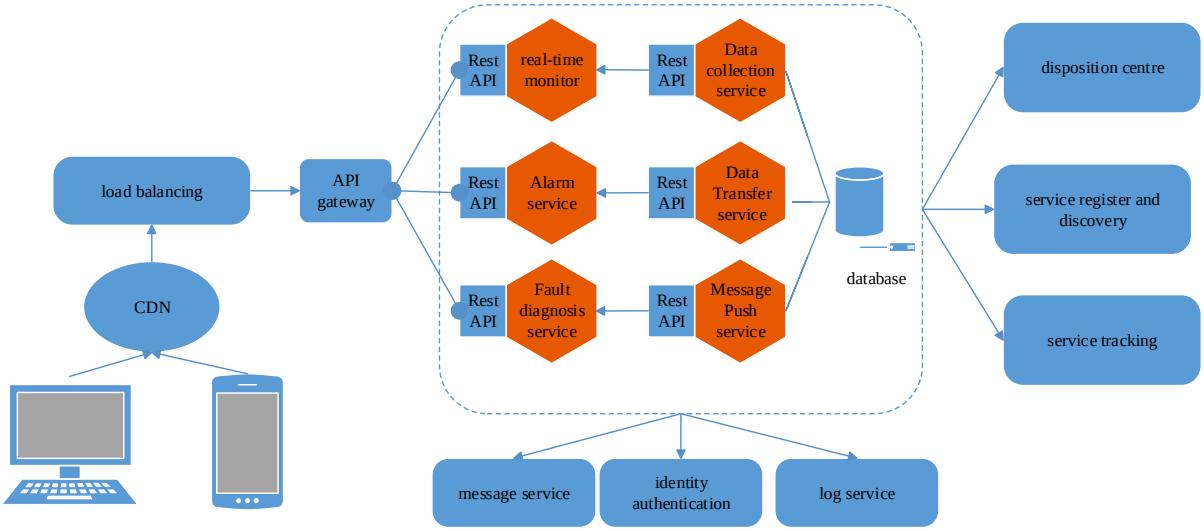

Figure 2. Software architecture of system.

(2) Real-time monitoring unit. Real-time monitoring unit is to monitor the status of, check the key parameters and check the running curve of the key parameters of the current combined substation. In addition, the real-time monitoring unit includes the combined substation video surveillance, the purpose is to enable staff to keep abreast of the operation of the combined substation at any time, so as to realize the picture mobile monitoring of combined substation.

(3) Fault alarm unit. When abnormal operation occurs, alarm can be issued in time, and alarm information can be sent to relevant operators in time to remind operators to deal with, in order to avoid major production accidents occurring. In addition, users can subscribe to the alarm information of relevant equipment, so as to achieve fixed-point push. In order to satisfy the reasonable maintenance of the malfunction equipment, it is necessary to visualize the key information such as the changing location of the combined substation, the fault time and the fault data, so as to provide the decision-making basis for the operation and maintenance personnel.

(4) Operation and maintenance scheduling management unit. Operation and maintenance management module is the key unit for reliable operation of the combined substation. Operation and maintenance scheduling not only ensured the orderliness of daily inspections but also guaranteed the timeliness of sudden fault handling. What's more, daily inspection operations dispatching, fault alarms handling and emergency dispatching, task progress tracking and viewing can be realized.

(5) Operation and maintenance unit. In order to reduce the fault time of the combined substation, the maintenance status of combined substation can be record to form a maintenance knowledge base. Due to fail to effectively accumulate maintenance experience, the traditional combined substation maintenance still relies on personal skills and experience, the problem of high maintenance cost and low

maintenance efficiency caused by this way is particularly prominent. Therefore, it is necessary to record the operation maintenance of combined substation in monitoring platform. According to the fault type and stop time mark, a combined substation maintenance experience base can be established, the professional maintenance experience supporting can be provided.

(6) Video monitoring unit. Real-time monitoring of the image information of the combined substation enables the staff to learn the working status of the power distribution equipment, so as to realize the image movement monitoring of the equipment. At the same time, combining with the monitoring of the parameter status of the substation, the real-time analyzing and key information extracting can be realized. Then, intelligent diagnosis and monitoring services based on images and operating parameters are realized by automatically determining the abnormal conditions in the monitoring area.

(7) Energy efficiency analysis unit. Informationization and visualization of the dynamic process of power consumption are the target of energy efficiency analysis unit. By managing, controlling and optimizing the structure, process and elements of power consumption in the production process of the enterprise, the efficiency of power consumption can be improved.

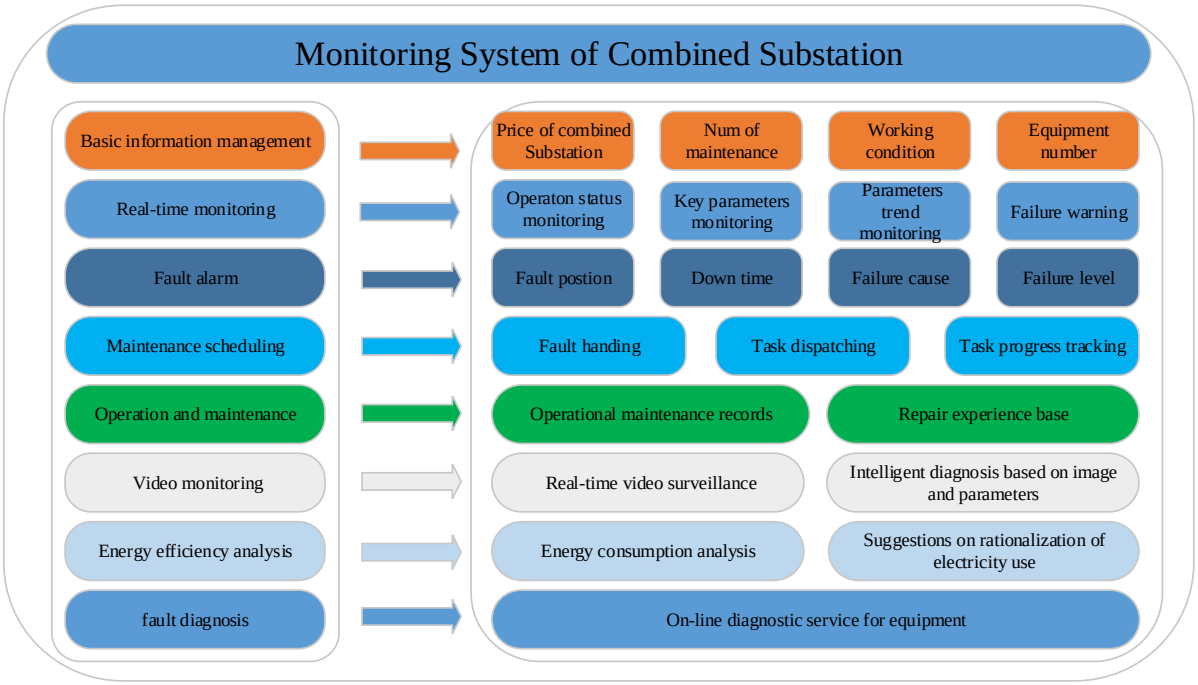

Figure 3. Functional structure of the monitoring system.

(8) Equipment fault diagnosis unit. Based on data analyzing of long-term actual operating conditions of the equipment and the corresponding model established, online fault diagnosis of the combined substation operation can be realized.

4. Conclusion

In view of the shortcomings of the traditional combined substation operation state monitoring, based on the IoT, cloud computing and big data, a combined substation monitoring system is constructed. By using a distributed architecture, the friendly service of the function of the system can be realized. Application services, such as real-time condition monitoring service, operation statistical analysis service, fault alarm service, real-time video monitoring service can be realized, which provide a customized monitor cloud services of the combined substation. By replacing the traditional manual monitoring combined substation scheme, the reliability of the combined substation transmission and

distribution can be improved, the labor cost can be reduced, and the orderly production of the user can be guaranteed.

Acknowledgments
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