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DESIGN OF WIRELESS NETWORK DETECTION SYSTEM FOR HIGH-RISE BUILDINGS

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Abstract: The research status of wireless monitoring system for structural durability of industrial high-rise buildings is analysed. The factors affecting structural durability of industrial high-rise buildings, such as natural environment and industrial production environment, are deeply researched. The monitoring parameters of wireless monitoring system for structural durability of industrial high-rise buildings are determined. The design of the topology structure of the wireless monitoring network for structural durability of industrial buildings has been completed, and the design objectives of the topology control and power control of the wireless monitoring network for structural durability have been elaborated in depth. The system can realize visual analysis of durability data of industrial high-rise buildings and storage management of cloud servers.

Keywords: wireless monitoring system, high-rise buildings, hardware, circuit design

I. INTRODUCTION

For a long time, the structure of industrial buildings has been damaged to varying degrees by natural disasters, environmental erosion, material degradation and deterioration, especially high-rise buildings. These damages accumulate over a long period of time, and then cause various durability problems of industrial building structures. The structure of industrial high-rise building is composed of steel structure, reinforced concrete structure and other structures. However, reinforced concrete structure still occupies the vast majority of industrial building structures.

Because of its harsh service environment, industrial buildings are easy to cause serious structural durability damage, thus shortening the life of buildings and even causing serious industrial accidents. Therefore, the durability of industrial building structure is a matter of great concern to experts and scholars in the civil engineering field. Many domestic and foreign research institutions and University researchers have also done a lot of research and Research on the durability monitoring of industrial building structure. Therefore, aiming at the durability problem of industrial building structures, the corresponding wireless monitoring system for structural durability is designed and developed, and a large data platform is constructed. The durability parameters of industrial building structures are monitored in real time, so as to ensure the personal safety of field workers, and to provide intelligent diagnosis and reliability research and evaluation for industrial building structures. Estimation provides a theoretical basis for the effective use of social resources and sustainable development, and has great practical significance for reducing the loss caused by durability damage of industrial buildings.

II. DESIGN SCHEME OF WIRELESS MONITORING SYSTEM

A. *Durability Testing Technology*

Reinforced concrete structure is one of the common structural forms in industrial buildings. Generally, the deterioration of reinforced concrete structure is relatively slow, but the industrial building structure is usually under extreme environment or special external force for a long time, which will accelerate the deterioration of industrial building structure and then cause structural damage, leading to the deterioration of industrial building structure performance. Similar to the concrete structure of industrial buildings, the steel structure of industrial buildings also needs routine inspection and detailed inspection under special circumstances. According to the inspection plan of relevant management norms, the steel structure of industrial buildings can be effectively managed and maintained.

B. *System Overall Architecture*

The wireless monitoring system for structural durability of industrial buildings monitors the environmental and structural parameters of industrial buildings by using sensing technology and communication technology. Structural monitoring reflects the service status, stress status, damage and other information of industrial buildings under the influence of various factors. It provides reliable data reference for the preliminary design of new industrial buildings and the diagnosis, evaluation and later maintenance and reinforcement of the durability of existing industrial buildings. It is of great significance to the safe operation of industrial buildings, to avoid accidents such as personal safety caused by structural damage of industrial buildings, and to reduce the cost of maintenance and reinforcement in the later period.

The basic process of wireless monitoring for the durability of industrial buildings is to monitor the service status of industrial buildings in various external environments through relevant sensors, transmit the collected durability data of industrial buildings to management servers and large data platforms through wireless sensor networks, and then combine with corresponding workers. The structural model of industrial buildings analyses the collected data of parameters, makes intelligent diagnosis of the damage situation (the location and degree of specific damage) of the durability of industrial buildings, and finally achieves the durability of industrial buildings by analyzing the service reliability, structural durability and bearing capacity of the diagnostic knots.

The reliability and stability of monitoring nodes in wireless monitoring system for durability of industrial buildings play a decisive role in the application and promotion of the whole system. The bad service environment of industrial buildings can easily lead to the performance degradation of microprocessors and the failure of monitoring sensors, which will cause the failure of monitoring nodes, and then affect the long-term, reliability and stability of the wireless monitoring system for the durability of industrial buildings. Therefore, it is very important for the hardware selection and design of wireless monitoring nodes, and it is also a subject that has been constantly discussed in the engineering field.

C. Main Hardware and Circuit Design

Nowadays, with the rapid development of microprocessors, various functional types of microprocessors emerge in an endless stream. The processors of wireless monitoring nodes for structural durability of industrial buildings need the advantages of anti-interference, stable performance and high cost performance. In this study, PIC16F72 module based on 32-bit microcontroller of ARM core will be used to monitor the durability of industrial buildings, as shown in Fig.1.

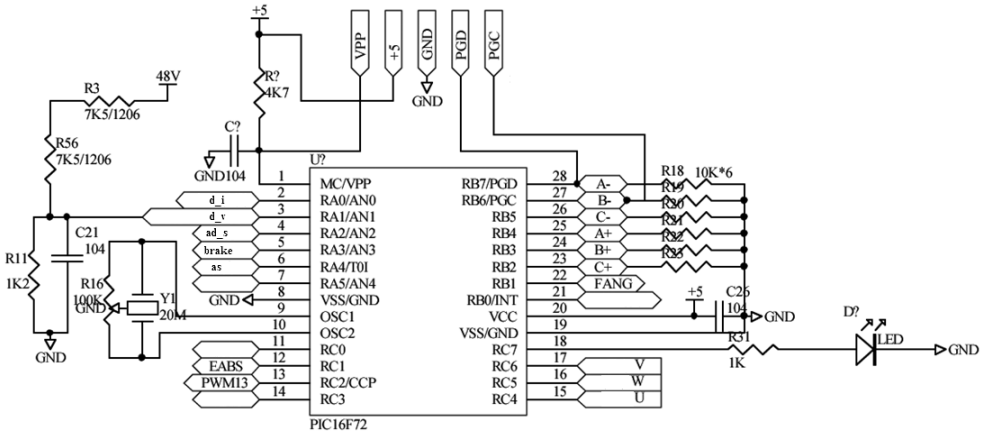

Fig.1 Circuit schematic diagram of processor module

Considering the complex and changeable production environment of industrial buildings, this paper chooses the waterproof DS18b20 temperature probe as the temperature sensor for environmental monitoring of industrial buildings, as shown in Fig.2. The water-proof DS18b20 temperature probe is made of stainless steel shell (6*50mm), with 100 cm lead length and 3.0V-5.5V power supply. The three lead terminals are power supply terminal, grounding terminal and data terminal respectively. Although the function of waterproof DS18b20 temperature sensor is similar to that of traditional DS18b20 temperature sensor, it is more suitable for environmental monitoring of industrial buildings with waterproof and lead design.

Fig.2 Waterproof DS18b20 temperature probe

In this paper, HM1500 humidity sensor is selected for the design of durability monitoring system for industrial buildings, as shown in Fig.3. HM1500 humidity sensor is encapsulated in solid-state polymer structure, powered by 3V~10V, and sensitive to reaction. The lead end is similar to the temperature sensor. HM1500 humidity sensor has low dependence on industrial environment temperature and high resistance to corrosive media in industrial production environment. It can quickly dehumidify after a long period of saturation, thus ensuring the reliability and stability of environmental humidity monitoring in industrial buildings.

Fig.3 HM1500 humidity sensor

The monitoring of CO_2 concentration in industrial building environment is different from temperature and humidity. Because some industrial production will bring many other gases unrelated to CO_2, this will have a certain impact on the identification and concentration monitoring of CO_2 gas. MG811 sensor probe is selected for monitoring CO_2 concentration in industrial buildings. The measurement range is 0-10000 ppm, as shown in Fig.4. MG811 sensor probe has high sensitivity to CO_2 gas and little change under the influence of temperature and humidity in industrial environment. It has good stability and reproducibility of CO_2 gas concentration.

Fig.4 Power Drive connection diagram

III. OPTIMIZATION OF WIRELESS MONITORING NETWORK

A. *Topology of Wireless Monitoring Network*

The durability wireless monitoring network of industrial buildings adopts Mesh network topology structure. Mesh network structure is a new type of wireless sensor network structure, which is different in structure and technology from traditional wireless network structure (plane network structure, hierarchical network structure, hybrid network structure). By using wireless Mesh network structure and wireless sensor network topology control technology, the durability wireless monitoring nodes of industrial buildings can be forwarded by multi-hop. The durability wireless monitoring network can be accessed by monitoring base stations (or sink nodes, gateways). The durability of the structure collected by task management nodes of the monitoring network can be trusted by monitoring base stations (or sink nodes, gateways). The information is screened and processed. Finally, the information of durability parameters of industrial buildings is transmitted to the data management system.

In order to ensure the normal operation of the wireless monitoring system for structural durability of industrial buildings, it is necessary to optimize the topology control of the wireless monitoring network for structural durability. Topology control is to ensure a certain quality of network connectivity and coverage. Generally, the main objective is to prolong the lifetime of the network. Through power control and backbone network node selection, unnecessary communication links between nodes are eliminated, and communication interference, network delay, load balancing, simplicity, reliability are taken into account. Extensibility and other performance form an optimized network topology for data forwarding. Therefore, it is necessary to design appropriate topology control for wireless monitoring network of industrial building structure durability. Different applications of wireless sensor networks correspond to different design objectives of topology control.

B. *Design objective requirements*

For the rational use of energy of sensor nodes in durability monitoring of industrial buildings, it can not only prolong the life of structural durability monitoring nodes, but also has important significance for the stable operation of the wireless monitoring system of structural durability of industrial buildings. Coverage is a measure of the quality of service of wireless sensor networks for the durability of industrial buildings. When configuring the wireless monitoring network for the durability of industrial buildings, it is necessary to ensure the quality of service of the wireless monitoring network for the durability of industrial buildings so that the wireless monitoring network can monitor the structure of industrial buildings in a maximum range, reliably and steadily.

In order to communicate with each other among sensor nodes of structural durability monitoring in industrial buildings, the generated wireless monitoring network topology of structural durability must ensure connectivity, that is, from any node of structural durability monitoring, messages can be sent to another node. If the durability monitoring node of industrial building can master the whole wireless monitoring network topology and the energy of all monitoring nodes, it can make the optimal decision. However, the synchronous communication protocol between structural durability monitoring nodes will cause the overhead of the whole wireless monitoring network system and make the durability monitoring network of industrial building structure. The lifetime of collaterals is shortened. The network delay of the wireless monitoring system for the durability of industrial buildings is related to the power control of the network. When the load of the structure durability wireless monitoring network is high, the low transmission power will reduce the end-to-end network latency by alleviating the competition in the monitoring network.

The production environment of industrial buildings and other industrial related monitoring systems will interfere with the communication of the structure durability monitoring network. Noise filtering is needed for the wireless monitoring network on site. Because the current MAC protocol is not suitable for asymmetric links, and the application of asymmetric links to industrial building durability wireless monitoring network will increase network overhead, so the topological link of industrial building durability wireless monitoring network is required to be symmetrical. The wireless monitoring network for the durability of industrial buildings is different from other networks. In view of the complex service environment and production environment of industrial buildings, there are also high requirements for the topology control of the wireless monitoring network.

C. *Power Control of Wireless Monitoring Network*

The topology control of wireless monitoring network for structural durability of industrial buildings is divided into power control and sleep scheduling. Power control is to select appropriate and effective transmitting power for structural durability monitoring nodes. Sleep scheduling controls the scheduling transition between working and sleeping states of structural durability sensor nodes. In the topology control of wireless monitoring network for structural durability of industrial buildings, power control has a greater impact on the overall performance of wireless monitoring network for structural durability than sleep scheduling.

Power control can reduce the transmission power consumption of structural durability monitoring nodes and the energy consumption of the whole wireless monitoring network. By predicting the data transmission channel of the wireless monitoring network for the durability of industrial buildings, the control information of reducing transmission power is sent to Zig Bee wireless monitoring node to reduce the energy consumption of the monitoring node at the transmitter under the condition that the communication connection of wireless monitoring network is good. The decrease of transmitting power of the transmitter monitoring node will reduce the number of neighbor nodes that can accept the signal of the node and save the energy consumption of the node.

The connectivity and topology of wireless monitoring network for structural durability are related to the transmitting power of monitoring nodes. Power control can reduce the number of monitoring nodes to establish communication for structural durability. On the premise of ensuring the connectivity of the whole wireless monitoring network, the topology of the wireless monitoring network for structural durability is optimized, the unnecessary node connections are eliminated, and the overall connectivity of the wireless monitoring network for structural durability is reduced. The optimal topology of the whole network is obtained. The change of transmission power of wireless monitoring node for structural durability will also cause the change of network competition intensity. Power control can effectively control the size of the conflict area of the wireless monitoring network for structural durability, and then regulate the competition intensity of the whole wireless monitoring network.

The influence of power control on the wireless monitoring network of structural durability of industrial buildings is mainly to control and adjust the number of neighbor nodes and the maximum transmission range of nodes, and then to influence

the number of parallel communication and data packets between wireless monitoring nodes of structural durability, so as to achieve the goal of controlling the entire industrial building structure. Wireless ad hoc networks use multi-hop routing to transmit messages. Each hop of a packet will go through three stages: processing delay, propagation delay and queue delay. By controlling the transmitting power of the monitoring nodes in the wireless monitoring network for the durability of industrial buildings, the processing delay, propagation delay and queue delay of the data transmission of the monitoring nodes in the wireless monitoring network can be optimally regulated, so as to improve the real-time performance of the whole wireless monitoring network. At present, there are many power control methods for wireless monitoring network of industrial buildings. It is necessary to select the optimal control strategy according to the actual environment of industrial buildings, monitoring parameters, performance and other indicators.

IV. CONCLUSION

The wireless monitoring system for the durability of industrial buildings is studied. The production environment of industrial buildings and the factors affecting the durability of industrial buildings are analyzed. Based on the analysis of the key technologies of durability testing of industrial buildings, the overall scheme of wireless monitoring system for durability of industrial buildings is determined. The hardware selection and software design of the industrial building structure durability wireless monitoring system are carried out, and the construction of the industrial building structure durability wireless monitoring system is completed.

V. ACKNOWLEDGEMENT

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