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Design of Wireless Automatic Fire Alarm System

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Abstract

To meet the application requirements of wireless automatic fire alarm system, based on the analysis of the applicable sites of wireless fire alarm system and the characteristics of communication service, this paper designs a dedicated wireless communication protocol for fire detection and alarm, and develops a complete set of wireless automatic fire alarm system, to achieve rapid fire detection and alarm and state supervision of fire-fighting facilities with low power consumption.

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Keywords: wireless communication; inspection protocol; fire alarm system

1. Introduction

In recent years, with the rise of the Internet of Things technology and wide spread of big data, cloud computing and other concepts, wireless communication-based automatic fire alarm system has attracted extensive attention at home and abroad. Although the construction and wiring of dual bus system has been relatively simple, but there are still problems of high installation and maintenance costs, as well as upgrading difficulty, especially for families and some special applications where actual needs have been unable to meet. For example, in ancient relics, in the installation process of wired fire alarm system, slotting and through-wall duct installation are required and can cause damage to buildings. So wired fire alarm system is not applicable. In addition, for buildings with multiple property rights, small street shops and temporary buildings, etc., wireless system is very suitable.

The convenient installation of wireless fire alarm system requires no through-wall ducting and wiring, with no damage to buildings, and is adaptable to changes of use and function of buildings, therefore attracting wide attention of researchers at home and abroad. 2.4G wireless networking technology, represented by zigbee, is a common technology used in automatic fire alarm system. But 2.4G transmission's advantage lies only in the range of visibility, and obstacles still present significant influence to its transmission. For some large scale and complicatedly separated buildings, to ensure better transmission quality of 2.4G network, large number of relays or radiation power increase will be needed, which will result in increased costs, conflicting with the low-cost, low-power target of wireless fire alarm system.

In view of the above problems, this paper analyzes the business characteristics of wireless fire alarm, proposes 433M wireless fire alarm system architecture and dedicated communication protocol scheme, and completes the design of a wireless fire alarm system, in order to solve the actual firefighting requirements of 3-in-1 places, multi-property street shops, brick or wooden historical buildings, temporary buildings and other places.

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2. System Architecture Design

Wired automatic fire alarm system takes high cost, and is difficult in construction, but wired signal transmission, and sheath and brass pipe protection ensure high signal quality, therefore realizing a high-capacity, high-stability system. Wireless fire alarm system uses open signal transmission, which is greatly influenced by distance and obstructions, so that the system transmission rate and capacity are slightly lower compared to wired system; and in order to ensure error-free real-time transmission of fire alarm signal and fire-fighting facility's monitoring signal, the system scale should not be set too large. Thus, for the application mode of wireless fire alarm system, different design of architectural pattern should be adopted depending on available fire-fighting facilities on site:

1) For large-scale buildings where wired system has been set, when the layout of internal unit changes, or local transformation or expansion of existing systems is needed as building units partially increase, the wireless system can be used as a supplementary sub-system connected to the existing wired system of cable systems. Under this combination mode, the wired system still serves as backbone network with high overall system stability, while wireless system is used depending on local environmental characteristics, to realize configuration flexibility, and low cost of transformation;

2) For small-scale buildings where wired system has not been set, or temporary buildings with period of service, wireless form shall be used for the entire automatic fire alarm system as the system capacity is not large and can ensure error-free real-time signal transmission.

According to the two different situations, this system adopts two separate architecture modes to be used in full wireless communication environment and combined wired-wireless environment, which can be connected to fire alarm controller respectively through wireless signals or CAN bus, as shown in Figure 1. The whole system consists of a fire alarm controller, relay modules, and field modules:

1) Router. Router provide externally data exchange interface of wireless fire alarm system, and are responsible for establishing a local wireless network to connect with the field modules by way of 433M RF as well as polling on field modules. Fire power is used as power supply. Compared with 2.4G band, 433M RF wavelength is longer, and can pass easily around obstacles with interference resistance, so it is suitable for use as foundation communication technology of wireless automatic fire alarm system.

Both wired and wireless connection between the fire alarm controller and Router can be chosen according to the field environment: CAN bus communication for wired system, and 433M RF or GPRS communication for wireless system. Router only report to the controller when fire signal or fault signal is polled.

2) Field modules. Field modules include 3 types: fire trigger module, facility monitoring module, and output module. The fire trigger module comprises fire detector and manual alarm button. The facility monitoring module includes fire door monitoring device, and fire hydrant pressure monitoring device. The output module includes sound and light alarm and linkage output module, etc.

Multiple Router can be set up to connect with the fire alarm controller. Each relay module manages part of the fire trigger modules, facility monitoring modules and output modules, establishing its own network of same frequency. Between networks built by different Router, frequency hopping is used to avoid same frequency interference. By extending the number of Router, complete coverage of business needs for field automatic fire alarm can be achieved.

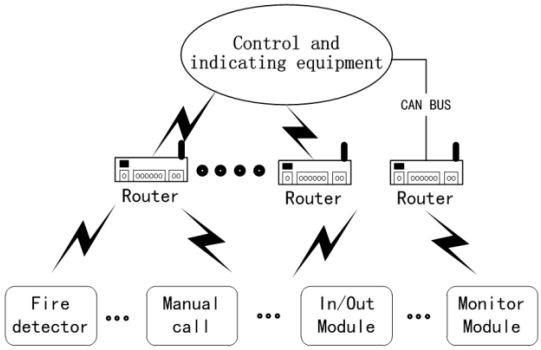

Fig. 1 Architecture of Wireless Fire Alarm System

3. Module Hardware Design

The Router and field modules in this system are designed and constructed as shown in Figure 2. The core control chip adopts TI MSP430 low-power chip, and wireless transmission function is based on MRF49XA RF chip. According to