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Research on fire source location and early warning algorithm based on sensor network

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Abstract. In the construction and development of modern society, the form of urban buildings presents the characteristics of diversification, although different types of building structure for social residents' life and production has brought convenient conditions, but also caused more safety risks, the building internal fire safety technology requirements are increasingly high. In this context, the traditional fire detection technology has been unable to meet the needs of building fire prevention, so scholars from various countries in the practice of exploration, integrated the use of network technology and intelligent algorithm to build an automatic fire alarm system, which can accurately detect and effectively control the fire in the early stage, can truly realize the prevention oriented development requirements. In this paper, based on the research status of building fire source location early warning technology in the new era, according to the basic principle of wireless sensor network system and fire location DV-hop algorithm, based on the multi-sensor data fusion technology to create a fire source early warning system. The final experimental results show that this algorithm can ensure the accuracy of fire warning positioning and improve the scientific and accurate decision making of the system.

Keywords: Wireless sensor; Fire source location; Early warning algorithm; DV-hop algorithm

1. Introduction

Nowadays, when scholars from various countries use automatic fire alarm technology to build building fire protection system, it is mainly used to prevent and contain the spread of building fire and provide powerful means to protect the life and property safety of social residents. With the continuous improvement of our social economy and science and technology, the application technology of existing fire automatic alarm engineering has been developed rapidly. However, because the communication protocol of fire automatic alarm system is different in practice, the overall technical level is relatively backward. There are more problems in the analysis of building fire early warning. For example, the application scope is small, the level of intelligent technology is low, the degree of networking is not high, the subjective connection mode needs to be improved, and the automatic fire alarm system has some problems such as missing alarms and false alarms. In view of the above problems, automatic fire alarm application technology should further focus on the current international development of the new situation, speed up the updating process, strengthen the application of digital technology and new technology, new materials, improve the system capacity, make automatic fire alarm application technology towards high reliability, low false alarm and network, intelligent direction. From the perspective of networking, computer technology is used to connect controllers, detectors, internal systems, various systems and the city "ll9" alarm center through certain network protocols to realize remote data call, implement network monitoring and management of automatic fire alarm system, and make each independent system form a large network. From the perspective of intelligence, the detection system can imitate people's thinking, actively collect the simulation of environmental temperature, humidity, dust, light wave and other data, and fully use fuzzy logic and artificial neural network technology for calculation and processing, to compare and judge various environmental data, so as to accurately forecast and detect fire, avoid false alarms and missing alarms. From the point of view of miniaturization, it refers to

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the miniaturization of the probe part or "subsystem" in the network. If the automatic fire alarm system is networked, then the central controller and other equipment in the system will become small, and even the small alarm equipment installation unit can no longer be set independently, and rely on the network of equipment, service resources to judge, control, alarm, so that the automatic fire alarm system installation, use, management will become simple, save money, convenient.[1-3]

As early as in the late 1990s, some scholars put forward the theory of wireless sensor technology in practice. The United States was the first to put forward in an international conference that the 21st century would be the golden development period of wireless sensor network. In 2003, the American Science and technology magazine rated the emerging wireless sensor network as one of the ten hottest industries of emerging technology; In 2004, the famous science and technology magazine IEEE Spectrum devoted a lot of space to discussing the future development prospects of wireless sensor networks. Nowadays, many universities around the world have carried out the research topic of wireless sensor. For example, the University of California, Berkeley developed the sensor system, which was effectively upgraded in the subsequent empirical analysis. Harvard University is determined to study the theoretical basis of the communication protocol of the entire network; The Massachusetts Institute of Technology studies how to process signals. When studying wireless sensor networks extensively in China, although the start time is late, there is a greater gap with the international advanced level, but with the steady improvement of social economy and science and technology, the research distance can be shortened, so as to provide favorable conditions for the development of our social economic reform. Therefore, on the basis of understanding the research status of fire source location and early warning technology, this paper systematically discusses the application effect of fire source location early warning algorithm based on sensor network according to the basic principle of wireless sensor and DV-hop algorithm of fire location, in order to provide technical support for the construction of high-quality fire source early warning system in the new era.[4-6]

2. Method

2.1 Wireless sensor network system

In the traditional sense, wireless network is composed of wireless routers, which can optimize the utilization efficiency of resources and bandwidth in practical applications, so that users can obtain stable service experience. However, only a small number of nodes need to be moved and cannot operate in harsh or remote dangerous environments. The wireless sensor network studied in this paper takes data as the core, can quickly adapt to a wider range of applications, and will transmit data to the node of remote monitoring and control. The specific structure is shown in Figure 1 below:[7-9]

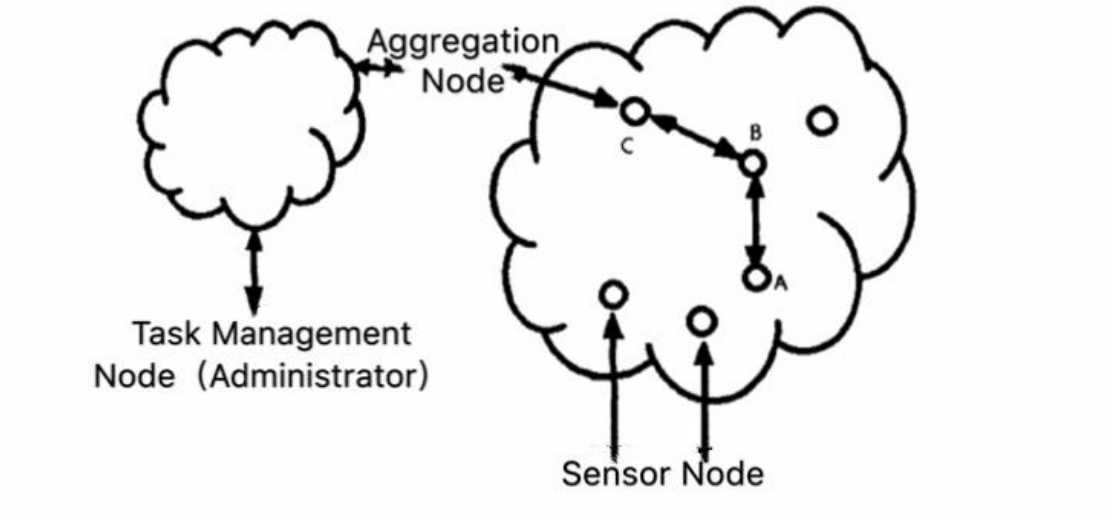

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Figure 1 Structure diagram of wireless sensor network system

Based on the analysis in the figure above, it can be seen that the network node of the sensor mainly includes four parts: firstly, it refers to the unit of the sensor, secondly, it refers to the signal processing, thirdly, it refers to the communication module for transmitting information, and finally, it refers to the power supply part. The actual structure is shown in Figure 2 below:[10-12]

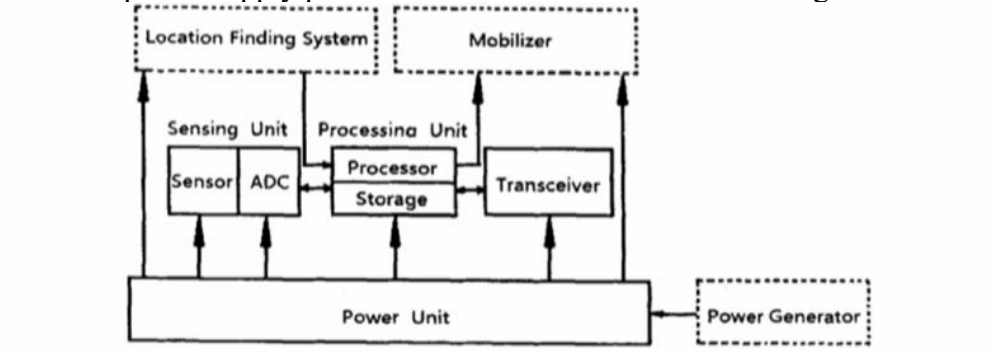

Figure 2 Node structure diagram of the sensor network

2.2 Fire fighting system with wireless sensor network as the core

The wireless sensor network system is installed in the building fire protection system. After collecting the field data information, it is transmitted to the gateway through calculation and analysis. Finally, the gateway will transfer the fire information to the database server, so that the system monitoring personnel can quickly obtain the monitoring data of the sensor. The specific structure is shown in Figure 3 below:[13-15]

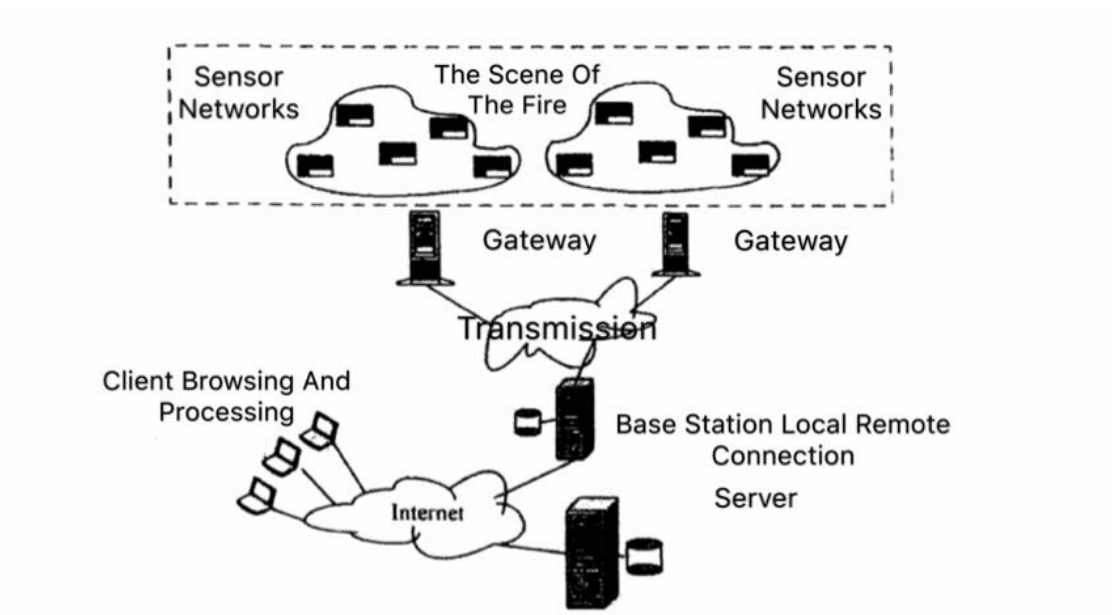

FIG. 3 Application of wireless sensor network system in fire fighting system

When there is a fire source inside the building, because the heat released by the fire will radiate into the surrounding air, the fire will go through three stages of development: first, before combustion, then during combustion, and finally after combustion. The change trend of the temperature value induced by the sensor in different stages is shown in Figure 4 below:

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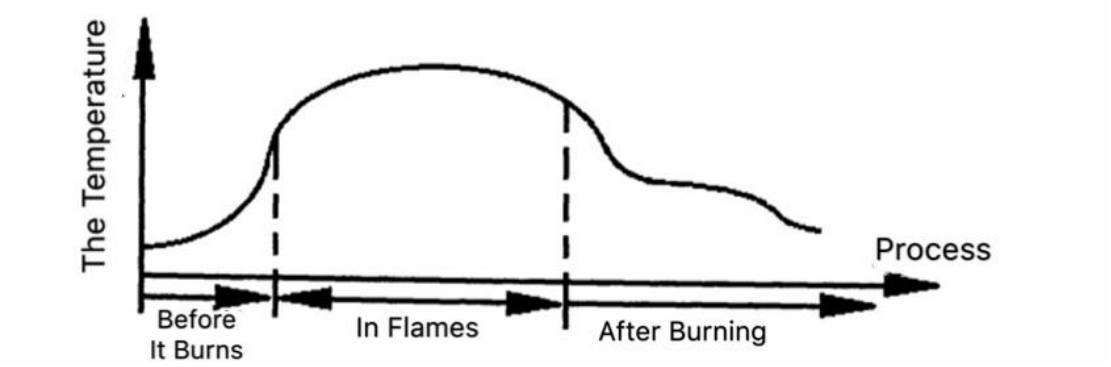

FIG. 4 Variation curves of sensor induced temperature values at different stages

2.2 DV-hop algorithm

This location algorithm is a non-ranging location algorithm and is compatible with AD hoc networks. Under the condition of sufficient network nodes, about 30% accuracy can be achieved. The specific process is divided into the following three points: First, the distance vector is exchanged. Secondly, the calibration of numerical calculation and broadcast stage. After the above operations are completed, all reference nodes will obtain the coordinate parameters and hop numbers of other reference nodes, according to which the average hop distance of the whole network can be accurately calculated, and other reference nodes can carry out data propagation again. The correction value of a node will be subject to the first data received. In this way, the correction value accepted by most nodes will be issued by the nearest node. At this time, the correction value can show the average per-hop distance around the node to the maximum extent, and finally ensure that all unknown nodes obtain their own correction value. Finally, the coordinates of the unknown node are determined. After the above two operations, the jump distance matrix of all unknown nodes to the reference node is made clear. At this time, trilateral measurement or maximum likelihood estimation can be used to accurately grasp the coordinates of unknown nodes.

Due to the high stability and predictability of this algorithm, the strength of the radio signal has no influence on the positioning results. However, the distance of the signal to the last hop of the location node is often lower than the actual average distance, which will slightly overestimate the distance between the node and the reference node. Therefore, in the application process, aiming at the slight overestimate of the distance generated by this hop, A last hop distance variable can be added to the message so that all nodes can obtain the last hop distance according to their own characteristic capability. This method is called Fire-DV-HOP method, which is very suitable for range positioning and high precision fire warning requirements, and can effectively control data errors.

3. Result analysis

According to the intelligent fire positioning system and intelligent algorithm constructed in this paper, the application performance of the data fusion system is evaluated and analyzed. The specific structure is shown in Figure 5 below:

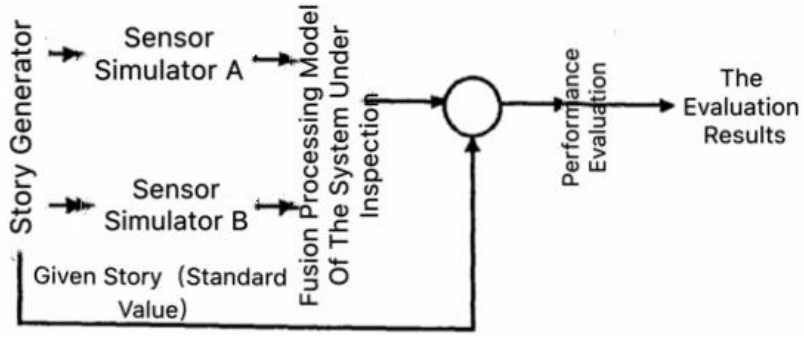

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Figure 5 Structure diagram of system assessment

Based on the above analysis, it can be seen that in order to quickly and easily obtain the information data of fire source, a laboratory of 40m × 22m × 10m can be used for simulation analysis, in which 8 temperature rod sensors, 10 photosensitive sensors and 10 smoke sensors are installed. In the process of experimental simulation, doors and Windows should be closed to prevent the exposure of fire source gas of the monitored fire. Before the next experiment, doors and Windows should be opened to release smoke and dust, so as to ensure the consistency between indoor gas state and natural environment state. The results of the fire experiment are shown in Table 1 below:

Table 1 Analysis of fire experiment results

Indicators	Ion smoke sensor	Optical smoke sensor	Electronic temperature sensor	Intelligent fire warning system
The number of false positives	14	18	17	3
Number of missed reports (times)	23	26	15	4
The average alarm time (s)	20	18	16	9

Combined with the above analysis, it can be seen that the constructed system can effectively integrate information, improve the technical level of its own missing and false positives, and improve the accuracy compared with the traditional sense of a single sensor. Meanwhile, the sensor information fusion results are shown in Table 2 below:

Table 2 Analysis of sensor information fusion results

The evidence	There's a fire	No fire	The uncertainty	Conclusion
Ion smoke sensor	0.400	0.500	0.100	No fire
Optical smoke sensor	0.600	0.200	0.200	There's a fire
Electronic temperature sensor	0.500	0.400	0.100	There's a fire
The fusion result	0.610	0.35	0.032	There's a fire

Combined with the above table, it is found that after the data fusion, the uncertainty of the system is getting lower and lower, and the credibility functions of various sensors are more distinguishable than before the fusion, which can further optimize the ability of data identification and analysis of the system. This proves that the scientific application of wireless sensor network system is the main problem discussed by researchers in the research work of building fire source location and early warning, which can further optimize the accuracy of fire forecast, ensure the stability and safety of the system operation, and provide effective technical basis for on-site fire control and monitoring personnel.

Conclusion

To sum up, since building fires can happen at any time and anywhere, how to effectively prevent them is the main problem discussed by domestic and foreign researchers. This paper proposes to use wireless sensor network to build a new fire source location and early warning system. The micro sensor with heat resistance and sensitivity is applied in the building fire site. DV-hop localization algorithm can further optimize the accuracy of sensor node positioning and ensure that the relevant departments can monitor the fire situation remotely. Reduce the detection difficulty of fire fighters in dangerous environments, quickly obtain more valuable data information, and timely develop

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effective prevention and management measures. It should be noted that although the research system in this paper meets the application requirements under practical simulation conditions, the stability and versatility of the sensor network should be considered if it is applied in a large scale in the real environment. Therefore, Chinese scientific researchers should continue to analyze the system in combination with the practical work environment, and then propose a more perfect positioning and early warning system. To provide technical support for protecting the personal and property safety of social residents.

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