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Coal Chemical Production Detection System Based on Fact Database

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In order to ensure the safety of coal chemical production, a dynamic model that conforms to actual production based on the fact database is established according to the analysis of common modelling methods by taking the characteristics of production process of a chemical enterprise as the research object in this paper. The connotation and realization of sub-modules are discussed. Through the simulation experiment and trial operation, satisfactory results are obtained. In production workshop, harmful gas may leak due to a variety of complex industrial processes. In this paper, different sensor probes are used to detect the concentrations of a variety of harmful and combustible gas in the environment. And the collected data is processed based on the multi-sensor information fusion technology.

Experiments show that the detection system based on fact database improves the reliability of production data, and has the function of over-limit sending short messages in real time. This function is realized by hardware and the timeliness of fault processing is improved. It concludes that the detection of coal chemical production can not only improve the efficiency of industrial production, but also strengthen the operation and management of chemical enterprise on industrial production.

1. Introduction

With the continuous development of social economy in China, more chemical products have been applied to daily life. The production capacity of chemical enterprises is also expanding, and most of the chemical reactions are carried out under certain conditions. Therefore, there is a huge security risk during the production process (Zhu et al., 2016).

Nowadays, production accidents in chemical enterprises has led to serious problems in life and property security and social hazards, and production managers urgently need to improve the safety of chemical production (Belmokhtar and Agbossou, 2013). Today's chemical enterprises can analyze the inherent characteristics and operating rules of their own systems through some fault models and prediction mechanisms and predict the track of future events by analyzing the influence relationships among the various modules, while they can understand the reason of failure in the chemical production process and take early measures to prevent production accidents (Li et al., 2016, Ahmed et al., 2015). Therefore, it is of great practical significance to establish the security model of the chemical enterprises and the implementation of the control system, which has important social and economic significance (Tokach et al., 2016, Yoshimura et al., 2016).

With the development of science and technology, the society's requirements for the production of chemical enterprises are also constantly increasing (Dohyung et al., 2015, Sakimoto et al., 2016, Sun and Alper, 2015). In addition, when a dangerous accident occurs in chemical production, it will cause great harm and loss to life and property (Burk et al., 2016). Therefore, it is necessary to take precautionary measures in chemical production, which are closely related to social stability and people's life and property security (Nie, et al., 2015). Nowadays the requirements for corporate assessment are improving in China. Enterprises are also in urgent need of more capital and technology to study the implementation of security system models and control systems in chemical production (Perathoner and Centi, 2015).

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2. Detection and monitoring of harmful gas

In production workshop, harmful gas may leak due to complex industrial processes. Therefore, it is necessary to use multi-sensor detection device with wireless transmission to timely feedback the gas concentration in the workshop and thus monitor the scene. Based on these requirements, a hazardous gas detection system based on multi-sensor information fusion is designed in this chapter.

2.1 Multi-sensor information fusion

The information fusion technology based on multi-sensor, generated in the military applications, is to comprehensively process partially incomplete information from the same or different types of sensors distributed in different locations, and exclude the redundancy and contradictions in the multi-sensor information to reduce the uncertain factors after the comprehensive processing and complete the relative three-dimensional and comprehensive description of the environment perception by the system, and finally improve the rapidity and accuracy of intelligent decision-making, co-ordination and response of the system; meanwhile carry out automatic comprehensive analysis according to certain rules to complete the identification objectives and information processing required by task evaluation.
As the sensors work at the same time in the multi-sensor information fusion, the system can obtain the complete target information even if some sensors fail, thus enhancing the reliability of the system and increasing the confidence of the information. In addition, there are the following benefits: extending space-time coverage, reducing ambiguities in measured data, improving detection performance of the system, spatial resolution and increasing measurement dimensions, etc.

2.2 System design

There are a variety of dangerous goods in the coal chemical production workshop, and the toxic gas may leak at any time in the workshop. Continuous monitoring and proper ventilation are the means to protect people from toxic gas. The fan will operate if the ventilation system senses toxic gas in the workshop. However, different gas requires different actions by the monitoring personnel. For example, one may have to evacuate or block gas immediately or open a window. Therefore, it is very important to detect the harmful gas in the workshop.
The system designed in this paper detects the concentration of harmful and flammable gas and sends the data to the host computer in a wired and wireless manner for storage, image analysis and prediction for easy review. At the same time, the information fusion and mobile communication technology is used to achieve long-distance transmission of information, so that the information of concentration exceeding permissible standard can be sent by SMS to the default number at any time, which improves the speed for processing the information of concentration exceeding permissible standard. The whole hardware system is divided into sensor node system, communication system, data fusion information processing system and host computer database management system, as shown in Figure 1:

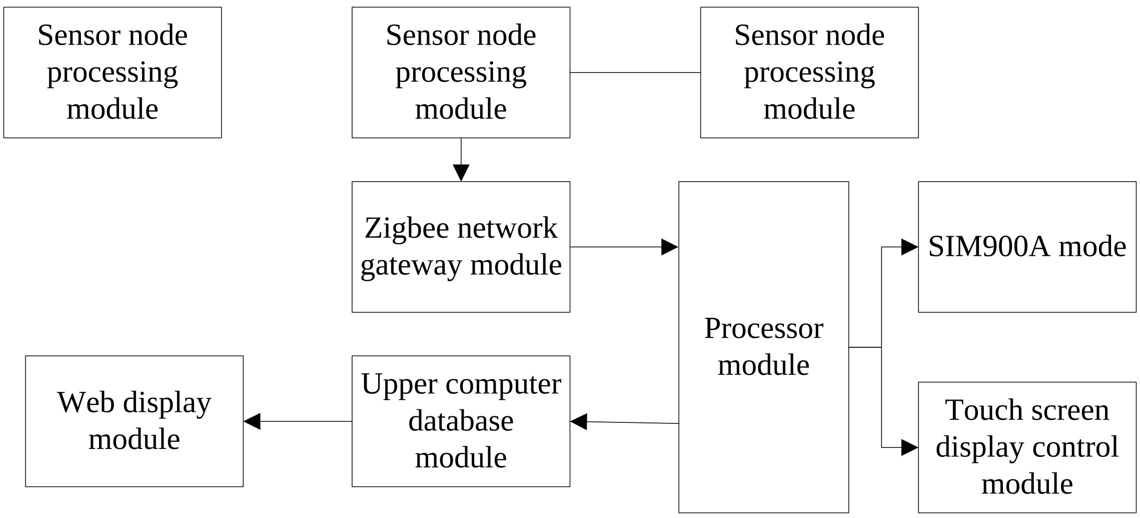

Figure 1: System framework diagram

Sensor node as the signal acquisition and pre-processing end can be used to pre-process the analog signal of the sensor, and then the signal is sent to the Zigbee gateway module through the built-in Zigbee module signal. The modules are composed of power module, sensor probe module, voltage conversion module, voltage comparator module and Zigbee module. Figure 2 shows the frame diagram of sensor node module:

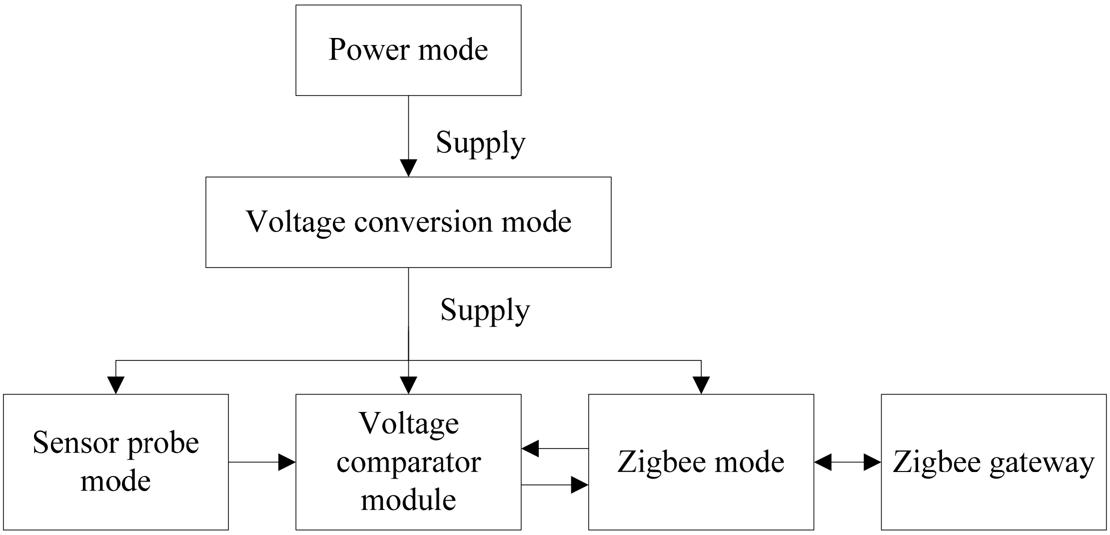

Figure 2: Frame diagram of sensor node module

3. Positioning of personnel in the warehouse of dangerous goods

Accurate positioning of personnel in the warehouse of dangerous goods is conducive to safety protection of personnel. The monitoring platform can inform the corresponding process according to the location of personnel, thus removing the potential dangers. In this paper, an improved algorithm based on LANDMARC algorithm (Dynamic Positioning Identification of Active RFID validation) is proposed. The traditional LANDMARC algorithm has poor positioning accuracy in some areas due to the impact of multi-path effect. In this paper, the RFID positioning technology is applied to the production workshop of a chemical enterprise with higher requirements in short-distance positioning to solve the problem of LANDMARC algorithm in the application.

3.1 RFID system composition and working principle

Chapter 2 The composition of RFID system is different according to the different types of actual use, but generally speaking it is composed of readers and electronic tags. In general, electronic tags are passive responders and composed of built-in chip and external signal receiving device. The chip is usually equipped with radio-frequency transmitting and receiving devices, core computing memory unit. The reader is generally used as a computer terminal for information interconnection with the computer and for read-write and storage of electronic tag data. It is generally composed of control module, high-frequency communication module and antenna. Generally speaking, RFID is classified based on the operating frequency. Table 1 shows the classification of electronic tags and related characteristics.

Table 1: Classification and characteristics of electronic tags

Parameter	Low frequency	High frequency	Ultra-high frequency	Microwave
Reading distance	<60cm	10cm-1m	1-5m	1-15m
Transmission speed	Low (8 kbps)	High (64 kbps)	High (64 kbps)	High (64 kbps)
Recognition speed	Low (<1m/s)	Middle (<5m/s)	High (<50m/s)	Middle (<10m/s)
Crashworthiness	Limited	Highly valued	Highly valued	Highly valued
Application area	Identification of animals, containers, tools	Electronic system	Physical distribution management	Automatic production control

3.2 Experiment and analysis

A 10*10-meter workshop is simulated based on an improved algorithm from LANDMARC in the paper. In the simulation, the parameters from previous work are used. The operating frequency is set as 915MHz, and reader signal strength is 30dBm. Antenna gain reader and tag is the omni-directional antenna with 0dB, while the backscatter loss is -10dBm. For the long-range path loss model, zero means that Gaussian random noise with a standard deviation of σ = 5.2 dB is also added to the path loss, where the path loss index, n, is set to 1.8. The algorithm is the improved LANDMARC one based on distance, which is more obvious in the short-range positioning accuracy. The algorithm is improved based on LANDMARC to optimize the overall positioning accuracy. From the Matlab simulation results, the proposed algorithm improves the overall accuracy compared with the LANDMARC algorithm, and it is more obvious in the short-range accuracy compared with the KNN algorithm.

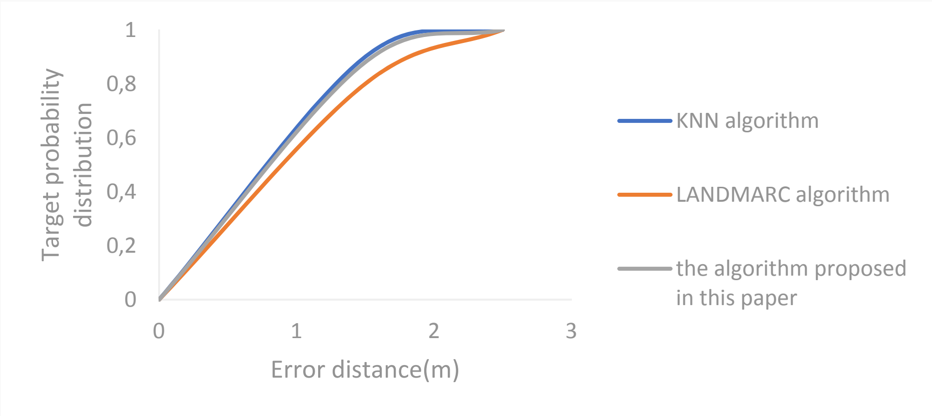

Figure 3: Cumulative error distribution of three algorithms

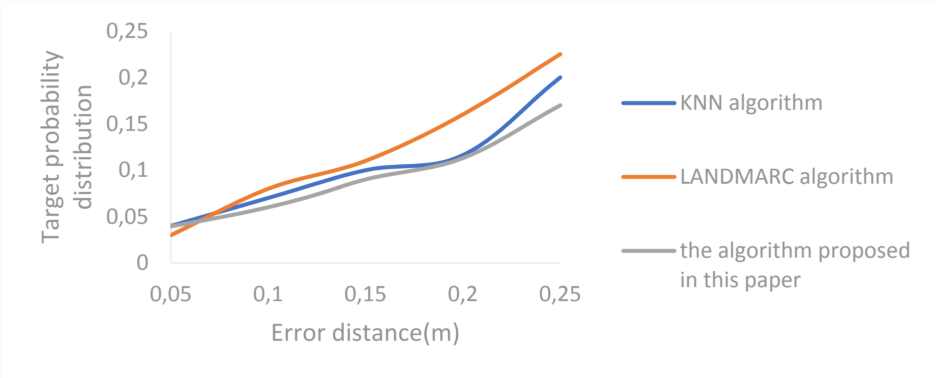

Figure 4: The influence of noise on error

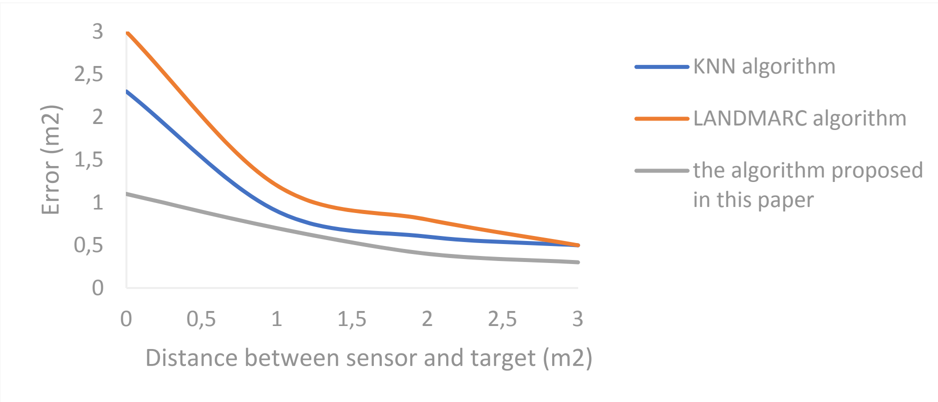

Figure 5: The influence of distance on error

In order to evaluate the effectiveness of the proposed algorithm, the distance error is used to measure the positioning accuracy of the system. The positioning estimation error is defined as e, and its relationship with the real position *(x, y)* and the estimated position *(x_0, y_0)* is shown in the equation below.

$$e=\sqrt{(x-x_0)^2+(y-y_0)^2} \tag{1}$$

The error distribution of positioning is obtained, as shown in Figure 3-5.

3.3 Analysis of simulation results

Figure 3 shows the results of multiple experiments of three positioning algorithms. In this paper, the simulation results of the error distribution and the probability distribution of the target in the error distance (m) of the statistical unit are used to achieve analog simulation. It can be seen that the performance of the improved algorithm is slightly better than the other two algorithms. Figure 4 shows the anti-interference experimental results of the three algorithms. Experiments show that with the increasing of noise, the errors of the three algorithms are significantly improved. However, the anti-interference performance of the improved algorithm is slightly better than the other two algorithms. Figure 5 shows the impact of target distance from the sensor on the error. It can be seen that the accuracy of the three algorithms is reduced when both the target and the sensor are close to each other. However, the accuracy of the improved algorithm is obviously better than the other two algorithms when the target is close to the sensor.

This chapter is to improve the LANDMARC positioning algorithm on the equation of its distance positioning, so as to improve the overall positioning accuracy, especially for the target location in a less distance. RFID technology is used in positioning module of personnel in dangerous goods warehouse, which meets the low-cost requirements of enterprises. In this technology, this paper analyzes the traditional LANDMARC algorithm and proposes an improved algorithm to increase the overall positioning accuracy and fit into the actual warehouse conditions. The accuracy within short distance has been improved significantly.

4. Conclusion

The security system model of the production area is an indispensable part of industrial production, which can improve the efficiency of industrial production and strengthen the operation and management of chemical enterprises for industrial production. The establishment of the model has great practical significance on the cost efficiency of enterprises. Based on the establishment of domestic industrial model, starting form the practical application of industrial production, the harmful gas detection system is designed and optimized for the research on the detection system of harmful gas and personnel for dangerous goods warehouse. For the multi-sensor of the system, the multi-sensor-based information fusion technology is used to greatly enhance data processing efficiency, so that the monitoring platform can get more and more comprehensive information to achieve management. A specific hardware is designed to detect the concentration of harmful and combustible gas in the environment. The collected data are processed based on the multi-sensor information fusion technology to improve the reliability of the data and have the function of over-limit sending short message in real time so as to improve the timeliness of fault processing.

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