PROCEEDINGS OF SCIENCE

Hazardous Chemical Security System Study Based Internet of Things

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The production, storage and transportation of hazardous chemicals are of high risk with extreme temperature, high pressure, inflammable explosive toxic and corrosive characteristics. Combined with the actual demand of hazardous chemicals production, applications of wireless sensor, object recognition, intelligent processing and data transmission etc., the storage and transportation safety system of hazardous chemicals in this paper is analyzed, designed and implemented. The system of safety management can put the post treatment into prevention, improve the efficiency of safety inspection and the logistics efficiency, get obvious economic and safety benefit.

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1. Introduction

The Internet of things is an intelligent network, which is formed by combination of infrared sensors, radio frequency identification devices and laser scanners, etc. [1-3]. The Internet of things connect different people or objects in accordance with the specific protocol, communicate with each other at any time and any place, identify any information with the dynamic information of intelligent products and provide a quick and efficient information sharing network platform.

Currently, China has more than 8000 hazardous chemicals transportation enterprises, 135000 transportation vehicles, 600000 employees and 42000 dangerous chemicals [4]. Hazardous chemicals production, storage and transportation is a high risk industry. In recent years, many hazardous chemicals storage and transportation accidents have taken place in China, which have resulted in serious damage to social public safety, people's life and property safety. The rapid development of hazardous chemicals needs a set of intelligent network system which can carry out effective and safe supervision on its storage and transportation.

In this paper, sensor technology, video surveillance, intelligent identification, network transmission and other internet of things technology are applied to the safe storage and transportation management of the company, and applied to the effective monitoring and management of goods, personnel, storage location, transportation trajectory and various control parameters. The safety and transportation system proposed in this paper based on the technology of the Internet of things has obvious economic and safety benefits which can improve the emergency rescue and disaster management capabilities of hazardous chemicals enterprises while reducing the probability of occurrence of safety accidents effectively. Totally, the number of accidents was reduced by 43.57% in comparison with that of the previous year and the fees spent on the accidents were saved by 29.91%, when compared with the previous year.

2.System Design

Our company is involved in many kinds of hazardous chemicals which have large differences in terms of storage and transportation and will cause great harm to the environment and the people in the event of leakage. My company cooperates with the networking research institutes and technology company in-depth in terms of chemical storage and transportation management field based on Internet of things technology, implements dangerous goods storage and transportation system, improves the dangerous chemical products storage and transportation management greatly, achieves considerable economic safety benefits.

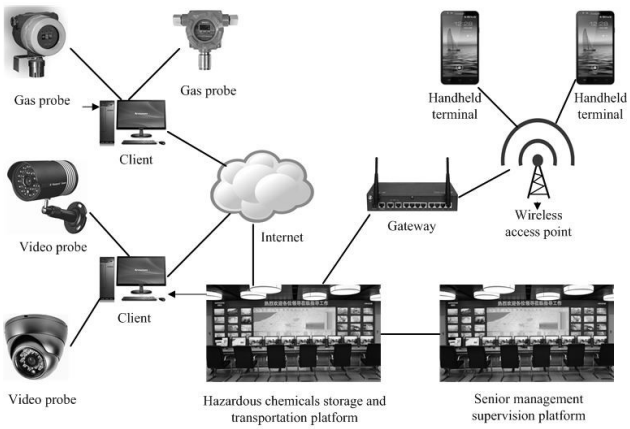

Figure 1: Dangerous Goods Warehouse Monitoring Topology Diagram

2.1 Warehouse Monitoring

Traditional production enterprises of hazardous chemicals measure pressure, temperature, humidity and other environmental factors of the sensor with a large number of manpower to

carry out inspection, record and report in case of dangerous situations which may cause damage to the operator. The storage and transportation system of hazardous chemicals invovled herein make use of networking technology, automatic collection and intelligent processing etc. to process environmental data, save manpower greatly and avoid disaster effectively.

The intelligent sensor is installed in the storage area in this paper to collect, transmit and process the storage environment parameters automaticlly such as pressure, temperature, humidity, etc. Once the abnormality alarms, start the emergency treatment plan and relevant data can be sent to the mobile terminal through wireless management. The video surveillance camera is installed in the storage area and intrusion alarm is realized for the personnel not authorized by using video recognition technology. Set sensor parameters in advance; if beyond the scope, warn timely to remind the staff of carrying out corresponding operation.

2.2 Transportation Monitoring

My company produces several hazardous chemicals, including tar, crude benzene, benzene, toluene, xylene and LNG and needs several raw and auxiliary materials, including benzene, caustic sodacon and centrated sulfuric acid. The system puts on the storage product name, quantity, variety, producer and other information of RFID tags on the vehicle of each hazardous chemical for transportation. The management personnel uses RFID tags to quickly check inventory and grasp the situation of warehouse products. Based on the GPS vehicle tracking technology, this paper records the starting and stopping time of the vehicle and the driving trajectory, and sends to the terminal of the management personnel. If the vehicle has an accident, start the emergency plan and rescue immediately, report to the monitoring command center.

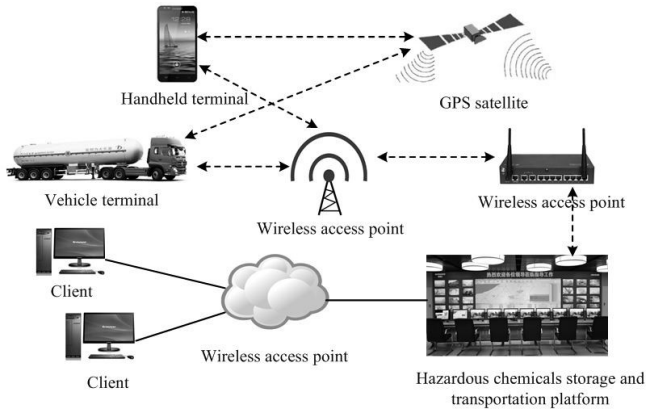

Figure 2: Diagram of Dangerous Chemical Transportation Monitoring

2.3 Technical Route

The hazardous chemicals storage and transportation system, including the client/server(C/S) system, the browser/server(B/S) system and the background server system. C/S system server is developed with JAVA Sun language and the client part is programmed with the C# Microsoft language. The client communicates with the server based on the TCP/IP protocol data. Map displays engine by using ArcEngine software. B/S system is developped by using JAVA Sun language, including of Spring, Hibernate, Struts combination framework based on WebLogic middleware software. The background subsystem is programmed with JAVA language, transmits data based on the message bus, uses the grid technology for GIS data alarm part alignments and calculations.

The B/S architecture performs the display logic, displays on the browers and the transaction processing logic on the server. Based on the open database link drive protocol, the browser is requested to operate the database on the server, and the processing results are returned to the browser level. B/S architecture development features the important advantage of the packaging characteristics and the client contains the logic of little, known as thin client. The C/S architecture client includes a number of programs running on the user's computer. The C/S framework is called the fat client to achieve the majority of business logic and interface display

and reduce the amount of network traffic and server computing.The server has two kinds of database server and the Socket server, in which, the former uses the database connection to access the client's program and the latter communicates with the client's program through the Socket.

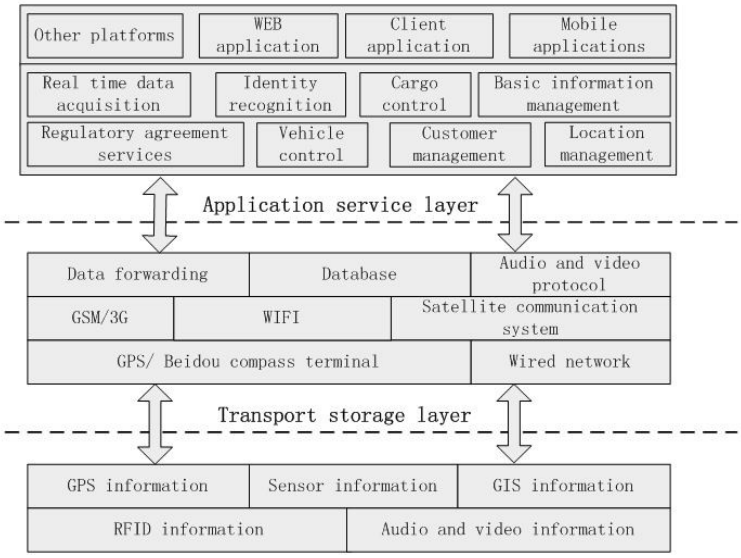

Figure 3: Hazardous Chemical Safety Storage and Transportation System Level Diagram

3.Detailed design

3.1 Layered Design

The system is divided into three levels: data acquisition layer, transport storage layer and application service layer. The data acquisition layer makes use of camera, sensor, RFID tags and other data acquisition equipment, collects driving information, environmental information and product information, etc. The transmission and storage layer accesses to various processing equipment to achieve reliable information storage for the purpose of sharing and interaction in accordance with the relevant protocol, based on the transmission network such as the communication network and Internet of things. The transmission and storage layer including communication technology, data mining technology and intelligent recognition technology and other core technology. The application service layer analyzes a large amount of data to build a good interface intelligently to achieve intelligent industry applications.

3.2Warehouse Monitoring

Warehouse monitoring uses the C/S structure, the client collects environmental data (including audio and video data, liquid level and other data) for processing, transmission and display. The server receives data and then realizes the interconnection with other platforms. The system installs variety of sensors and video cameras, acquires of a variety of environmental data, including temperature, liquid level, pressure, video data. By installing a liquid level detection sensor to monitor the oil tank liquid level and alarm, the temperature detecting sensor monitors and alarms the oil tank temperature; at meanwhile, the flow sensor is adopted to detect and monitor the inlet and outlet pipes of the oil flow rate and alarm; the combustible gas sensor is utilized to alarm and monitor the oil and gas leakage; one PTZ camera is used to monitor the state of the oil tank safety; the color gun type is fixed to focus cameras, monitor staff and access vehicle. As shown in Fig. 4, the warehouse monitoring includes the field monitoring system and the remote monitoring system.

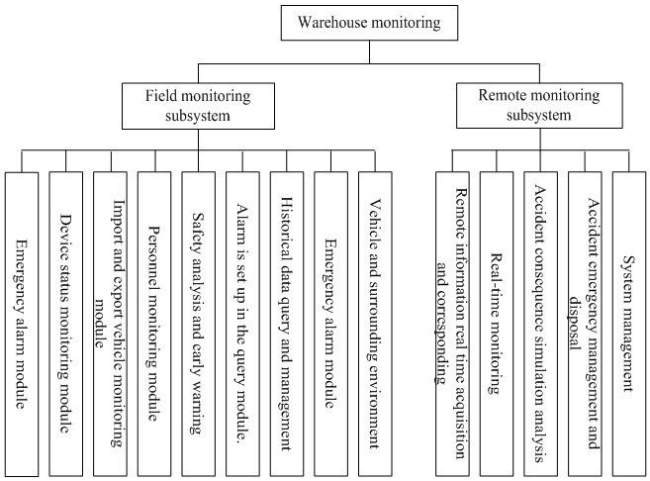

Figure 4: Dangerous Goods Warehouse Monitoring Module Diagram

The module function of the warehouse monitoring system is: the equipment status monitoring module monitors the status of oil tanks, valves and pipelines in the tank area, the monitoring and controlling module of the vehicle and the vehicle in real time. The personnel monitoring module monitors the working status of the employees in the tank area and the status of the migrant workers. The security analysis and early warning module analyzes the site information and carries out the security situation evaluation. The security analysis and early warning module analyzes the field information, the security situation assessment and the real-time warning. The alarm settings, display and query module sets up different alarm and alarm threshold, the alarm event in accordance with the latest time sequence displayed and queried. The emergency alarm module presses the emergency alarm equipment in the event of an accident and other emergency alarm signal and then uploads the same to the remote monitoring center. The environment monitoring module is to monitor of the environment of the storage tank area in a real-time manner.

The modules and functions of the remote monitoring system are: the remote monitoring and alarming information module is recorded in real time and responds to the field monitoring and alarming information of each storage tank area. The real-time scene monitoring module monitors the vehicle status, equipment status and personnel situation. The accident consequence simulation analysis module simulates and analyzes possible accident consequences. The emergency management and disposal module provides physical and chemical characteristics of the emergency plan and hazardous chemicals. The system management includes the user rights management, the data management and other functions.

3.3 Transportation Monitoring

The transportation monitoring system uses the B/S structure, as shown in Fig. 5. The transport monitoring application server includes the monitoring module, the alarm module, the map service module, the basic information module, the system management module, the statistical report module and the background processing module. The vehicle monitoring module uses WebGis technology to display the position information of the vehicle in the electronic map, manage and monitor the vehicle list, replay the vehicle travel path and display the vehicle running status, etc.. The warning module includes the functions of early warning, instruction, neglect and historical inquiry, etc.. The map service module has the function of map based service, map service and map query service, etc.. The basic information module includes the functions of basic information of vehicles, parking management, personnel management, route management, terminal management, service management and operation management, etc.. The system management includes user management, data dictionary management, operation log management, online user query and other management functions. The statistical report module automatically generates an abnormal parking warning, running status, illegal alarm, positioning, monitoring and management, etc.. The background processing module includes receiving GPS

data, receiving the alarm data receiving, responding to the request response, completing the data communication and managing the message queue.

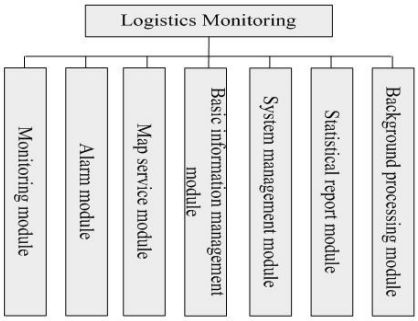

Figure 5: Dangerous Chemicals Logistics Monitoring Module Diagram

4. Key Technology

The key techniques used in the system are the following:

(1) The sensor sensing technology likes the sense organs of human beings, which can sense the signal of light, electricity, heat, force, sound, displacement, etc., and provide the most original information for the Internet of things, and then further process the information. The sensor is the most basic unit of the Internet of things. It is the key device to obtain physical information.

(2) The wireless radio frequency identification technology is combined with network transmission technology, automatic identification of the vehicle's identity information, goods tracking and information sharing[5,6,7]. The electronic tag is the information carrier of the RFID system and has a certain number of memory cells. The reader is able of reading and writing data in the electronic tag, which is a wireless radio frequency identification system.

(3) The GPS location identification technology is more mature because it highlights high accuracy, automation, all-weather and other notable features; moreover, it has been widely used. With the wide application of 4G and 3G technology, the wireless transmission bandwidth is no longer a bottleneck, and it has exerted great effect on the GPS vehicle tracking system.

(4) The information system of the GIS is a part of the decision support system. The information of the storage and processing is an important part of the information retrieval. This paper takes GIS as the basic information platform and visualizes the vehicle position information.

(5) The intelligent technology can make the object to have certain intelligence, be active or passive to achieve the communication with the user, the need for intelligent control technology and system to achieve the research results [8,9,10], mainly including the advanced human computer interactive technology, the virtual reality technology and system as well as the multimedia technology.

5. Application results

Through testing, the proposed system collects and processes the safety information accurately in real time, records and manages of the production process totaly and the responsibilities are divided clearly. The system has improved the overall level of safety supervision and management effectively. We collected, analyzed the historical data and formed Table 1. From Table 1, we can see that the total number of accidents reduced by 43.57% when compared with the previous year and the fees spending on the accidents saved by 29.91% when compared with the previous year.

Item		Before	After	Save/Reduce Rate
Totals of Accidents	Q1	25	15	40.00
	Q2	31	18	41.94
	Q3	29	16	44.83
	Q4	40	21	47.50
Fees of Accidents	Q1	173450¥	120006¥	30.81
	Q2	185000¥	130600¥	29.41
	Q3	179000¥	125000¥	30.17
	Q4	210600¥	149000¥	29.25

Table 1: Proposed Performance of the System

6. Conclusion

This system is based on electronic tags and other things technology, collection, transmission and processing of goods information, the location information, video information, product information to achieve full monitoring without blind spots, establish a complete logistics traceability system, reduce the loading and unloading workload, reduce the inventory costs, reduce the risk of dangerous goods and improve the customer's satisfaction.

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