

## Design of Safety Monitoring and Alarming System for Petrochemical Plant Based on WSN and GPRS

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With the development of science and technology, wireless sensor technology is becoming more and more mature, wireless sensor networks are becoming more and more perfect. Its advanced technology has been applied in more fields. In recent years, the rapid development of China's petrochemical industry has given great impetus to China's economy, but the explosion accident of the petrochemical plant has exposed the drawbacks of the traditional safety monitoring system and the network, based on this situation, this paper focuses on the application of wireless sensor in the petrochemical plant, and designs a set of security monitoring and alarm system using WSN network and GPRS network. The system has the function of preventing theft, fire prevention, gas-leakage, and obtaining the spot monitoring parameters and image information at any time and at any time, it can effectively improve the safety management of the plat in the petrochemical plant. The real use of technology can protect the Safety of factory employees and the safety of public property.

### 1. Introduction

Petroleum and chemical industry as a very important pillar of the national industry, is an important support for the national economic take-off, but also is the country's key projects to achieve industrialization. Because of the demand of petroleum and chemical products in various fields, all kinds of high pressure equipment and dangerous products must be installed and produced, so the safety of petrochemical plants is also very important (Xie, 2010). It cannot guarantee no danger of anything going wrong that only from improving the quality of equipment, the quality of management personnel and the professional quality of the staff of the factory, it must be with the help of modern advanced science and technology of safety supervision of petrochemical plant, safety monitor condition of the factory production environment, timely and accurate access to all kinds of danger information, such as: fire, gas-leakage and theft suppression in the bud. Therefore, this subject adopts the method of combining WSN and GPRS mobile communication, designs the safety monitoring and alarm system of petrochemical plant, in a local area network composed of wireless sensors, the alarm information can be obtained through a specific portable handheld terminal; in the wireless LAN, alarm information can be obtained through the mobile phone receive SMS and MMS way.

### 2. The general design of safety monitoring and alarming system in petrochemical plant

The structure of the safety monitoring and alarm system in the petrochemical plant mainly consists of two parts, one part is the internal network equipment, including security detection node, wireless transceiver, PC upper computer, portable handheld terminal management node; another part is the network equipment including a base station and GPRS remote terminal equipment. The overall structure of the system is shown in figure 1.

The scene of the environmental parameters and danger information can be queried by querying the equipment, when combustible gas exists in the field, it is immediately detected by the combustible gas sensor, then detect concentrations will be compared with the set value, if excessive, immediately report to the police, at the same time will measure the results sent to the PC upper computer and show the concentration size and location information, and the base station signal will be send to mobile phones in the form of text messages.

When other dangerous situations occur, the field node will be tested in the same way. When the factory staff want to understand the situation, the position of the query and the specific parameters to be checked can be input by the key through the portable handheld terminal, then the corresponding node will be real-time parameters sent to the portable terminal. PC upper computer and portable handheld terminal can also check the site parameters or receive alarm information.

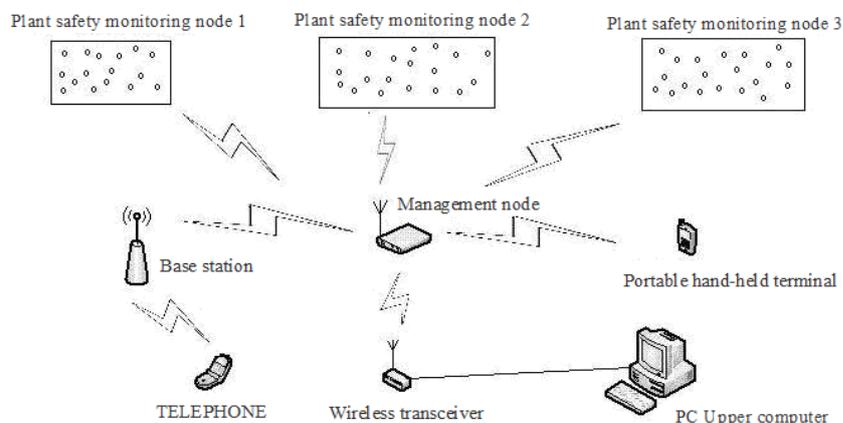


Figure 1: the overall structure of the safety monitoring and alarm system in petrochemical plant

#### (1) Plant safety monitoring node

Plant safety monitoring node is equivalent to people's "skin" from time to time in contact with the external environment, it can perceive the information of the working environment of the plant area (Liu et al., 2008). It is mainly composed of smoke sensor, temperature sensor, humidity sensor, combustible gas sensor and camera.

#### (2) Management node

As a factory safety inspection node and portable handheld terminal, PC upper computer and GPRS remote terminal data transfer station, plays a "bridge" the important role in the system. The management node is mainly composed of MSP430FG4618 microcontroller, power module, GPRS module, wireless transceiver module.

#### (3) Portable hand-held terminal

The portable handheld terminal is used to check the field parameters and receive alarm information in the network. It is mainly composed of the MSP430FG4618 microcontroller, wireless transceiver module, power module, buzzer, LCD screen and keyboard composition.

#### (4) PC upper computer

The security detection and alarm system interface of the PC upper computer is prepared based on the VC 6, insert MSCOMM serial communication control can achieve PC serial communication. The data command and wireless transceiver device can be connected to the data transmission by the RS232 serial port through the management software On the PC upper computer.

#### (5) GPRS remote terminal - mobile phone

GPRS remote monitoring is mainly refers to carry the mobile phone device, the environmental parameters of the scene can be queried and the alarm information can be received in any location through the phone.

### 3. The hardware design of the safety monitoring and alarm system in the factory

#### 3.1 The hardware design of the scene node

The scene node includes plant security detection nodes and management nodes, the two nodes are MSP430 series microcontroller as the core, they are the front part of the whole system. The plant security detection node is mainly responsible for the fire prevention, anti-theft and anti-gas leakage, it is the bridge of the whole system and responsible for the transfer of information.

##### (1) The hardware design of the plant security monitoring node

The plant security monitoring node consists of MSP430 series FG4618 microcontroller (Xie and Zhao, 2009), ME300B 4×4 keyboard (Deng, 2007), nRF401 wireless transceiver module, SHT11 digital temperature and humidity sensor (Zhang and Yang, 2007), TGS813 combustible gas sensor (Sun, 2007), ion smoke sensor, TX-05C infrared switch, ZSV-01P camera, ZX12864M1A LCD screen, power supply module for an audible alarm buzzer and LM2596T regulator chip.

##### (2) The hardware design of the management node

The management node consists of MSP430FG4618 microcontroller, power supply module, nRF401 wireless transceiver module and GPRS M20 module (Bai, 2003). The management node is the data transfer station, is the intranet and extranet connection "channel".

### 3.2 Hardware design of portable handheld terminal

Portable handheld terminals need to use two kinds of power supply voltage that are 3.3V and 5V. The power module design of portable handheld terminal is the same as plant security detection node, but there is no connection to a variety of sensors.

### 3.3 Hardware design of wireless transceiver for PC upper compute

PC upper compute is connected with wireless transceiver device through the RS232 serial port, the main task of the wireless transceiver module is to send the data that is sent from management node to PC upper compute, also can send the command from PC upper compute to the management node to perform their tasks.

## 4. Software design of the safety monitoring and alarming system of the plant

### 4.1 The software design of the plant security monitoring node

As the site safety detecting device for factory, its program flow chart is shown in Figure 2. Each module will be initialized after the system is energized, then enter the system interface, if the scene node receives the command from the PC upper compute, portable handheld terminal or GPRS remote terminal, it can execute the corresponding operation according to the command, and send the detected data back to the corresponding terminal equipment.

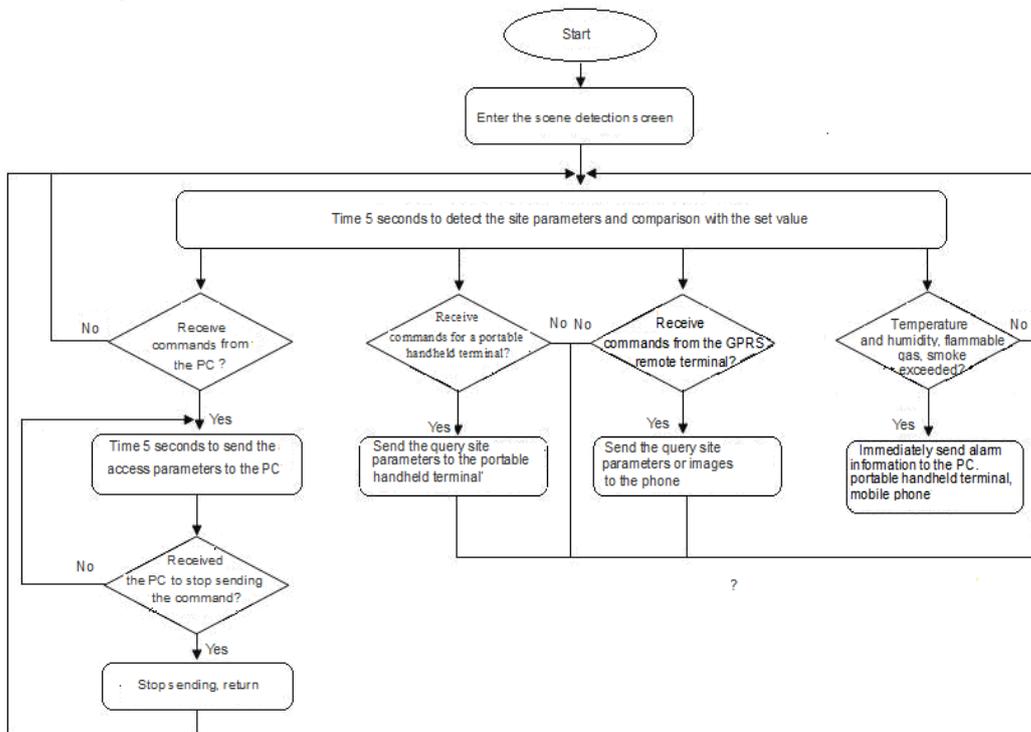


Figure 2: Program flow of the plant safety inspection node device

### 4.2 Software design of portable handheld terminal

The portable handheld terminal program is shown in Figure 3, The system will be serial, LCD screen and other modules to initialize After boot, then enter the main menu interface. The field environmental parameters: temperature, humidity, concentration of combustible gas, smoke, and real-time picture of the site can be displayed by the corresponding input commands of the keyboard.

### 4.3 Software design of host computer

(1) VC 6 MSCOMM serial communication controls

MSCOMM control (Microsoft Communications Control) is the ActiveX control of simplified Windows serial communication programming which is the Microsoft company to provide. As long as the program is inserted

into the control can be achieved in the PC serial data transceiver. (Zhang and Liu, 2006) According to the parameters of the security monitoring of the need to write a program to achieve the desired operation of the 4 interface, because the program is longer, the preparation process is no longer listed.

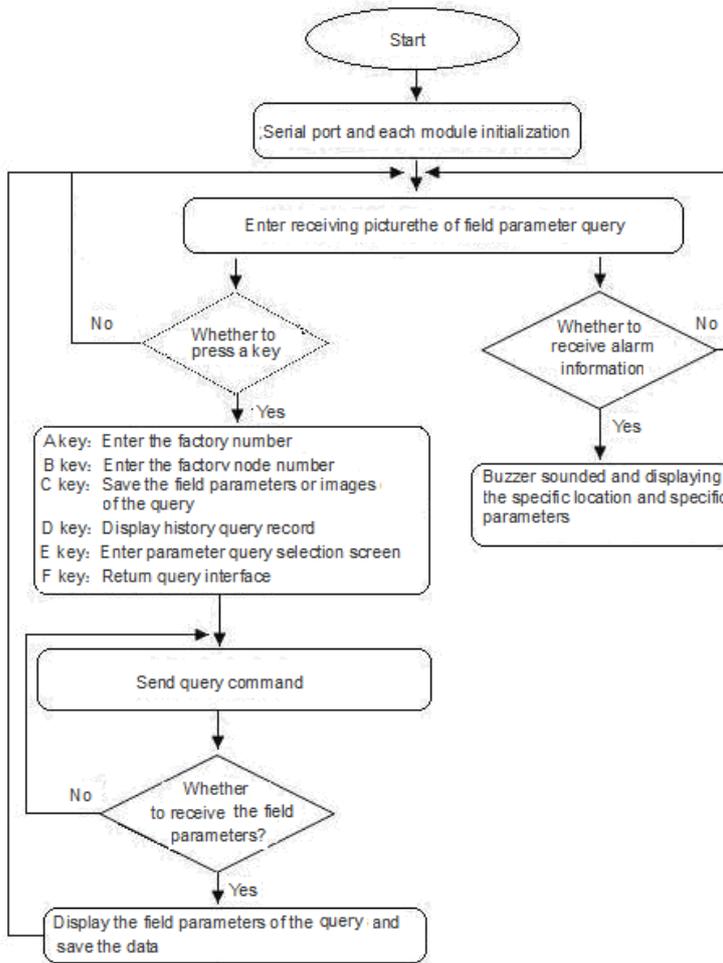


Figure 3: Program flow chart of portable handheld terminal

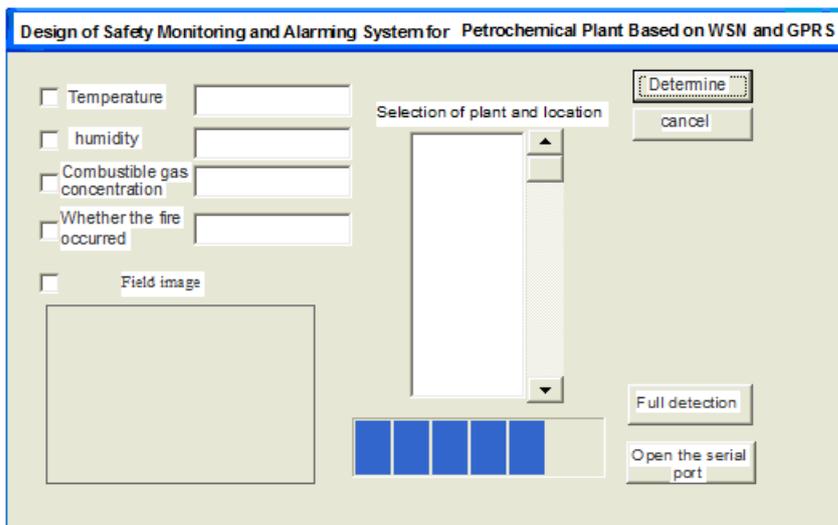


Figure 4: PC upper computer monitoring interface

## (2) PC upper computer program flow chart

PC upper compute interface can be used to receive display temperature, humidity and combustible gas real-time data and smoke status, can carry on data collection, and can realize the image data receiving and display. Its program flow chart is shown in Figure 5.

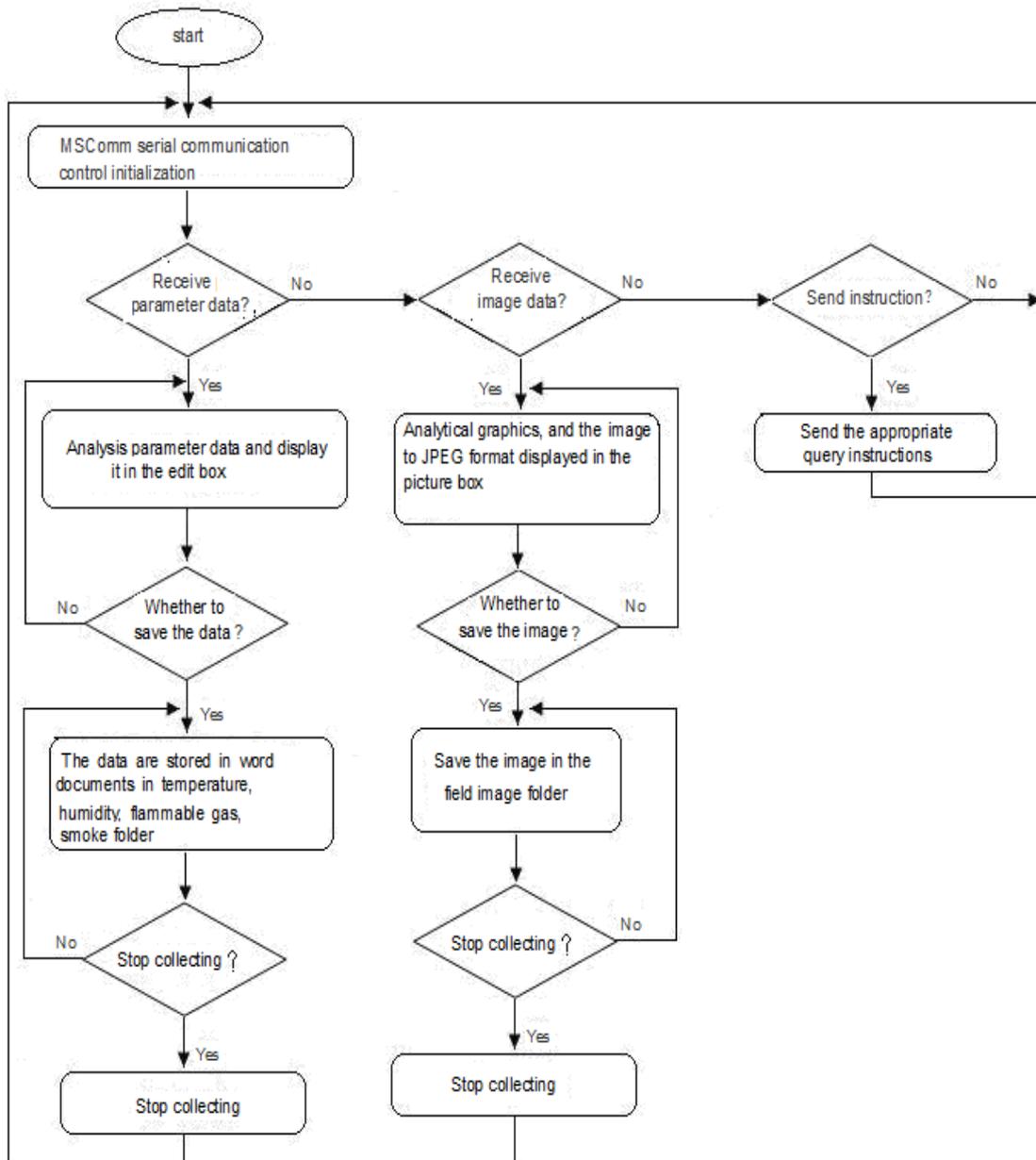


Figure 5: PC upper computer program flow chart

## 5. Conclusions and prospect

Based on the security detection and alarm system application, it combined with the current management situation of petrochemical factory, designs a set of security monitoring and alarm system of petrochemical plants, including plant security detection node, portable handheld terminal, PC upper computer and GPRS remote terminal four parts. The system has the function of preventing theft, fire prevention, gas-leakage, and obtaining the spot monitoring parameters and image information at any time and at any time, it can effectively improve the safety management of the plat in the petrochemical plant. The real use of technology can protect the Safety of factory employees and the safety of public property.

Although this system is designed for petrochemical plant, but its application is not limited to petrochemical plant, it can also be applied to underground coal mine safety monitoring, laboratory, library and other places. In addition, this design uses the TX-05C infrared emitter and ion sensing smoke detector with large power consumption, while some of the energy limited wireless sensor, so the small power consumption of the ion sensing smoke detector and infrared radiation can be used in future research.

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