Design and realization of CNG intelligent monitoring system

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***Abstract*—One CNG remote intelligent monitoring system is designed and realized in this article. The monitoring system can receive real time monitoring information and monitor environment of CNG filling station by using GSM short message platform , terminal PC and cell phone based on ARM microprocessor, PTM100GSM module, pressure and temperature detection system, when the pressure, temperature or consistence of gas storage well is over the threshold , the monitoring system will send the alarm signal. It's proved that the monitoring system works stably and reliably and can effectively monitor fatal public danger signal.**

Keywords- CNG; intelligent monitoring; pressure detection

I. INTRODUCTION

CNG(Compressed Natural Gas)is a new ideal replaceable energy for vehicles. CNG has the advantage of low cost, high benefit, pollution-free and simple operation; it attracts more and more attentions from each parts of the society because of increasing serious environment questions. Recently, the natural gas automobiles are becoming more and more popular; the CNG automobile gas stations come in increasing numbers and distributed in different place, which increases the difficulty of monitor and control. Besides, many CNG automobile gas stations still perform relative behindhand manage system and control means, which causes so many disadvantages and questions in the management, equipment monitoring, secure production etc. there are multiple secure accidents every year in the CNG automobile gas station. For example, the CNG automobile gas station located in Shandong province Donying Huanghe road exploded in 2007, there are two people died and three injured in this accident. So ,it is necessary to take effective means to remove or decrease accidental risk of gas station. In this paper, the designed CNG intelligent system uses communication module and realizes remote pressure and temperature detection based on GSM network and GPRS text message functions. The monitoring system can monitor the equipment tens even thousands of miles away, relative surveillance and working people do not need to inspect in the gas station, which greatly save manpower and cost, it is very important to protect the safety of people's lives and property and maintain social stability.

II. DESIGN OF SYSTEM MODEL

The monitoring system is composed of pressure, temperature and consistency collecting terminal and monitoring center, and we called pressure, temperature and consistency collecting terminal as environment data collecting terminal, environment data collecting terminal consists of ARM microprocessor, pressure sensor, temperature sensor, consistency sensor , power module and PTM100GSM communication module. Environment data collecting system mainly collects pressure, pressure and data of CNG gas storage pot. Microprocessor sets the alarm initialization value of pressure and temperature, and storage the data in the E2PROM. Usually, system works in the normal and alarm mode. In the normal mode, microprocessor processes pressure and temperature data, it startups the communication module at the initialization time and sends the collecting data, in the meantime, it will compare the collecting data with the threshold value, if the data value is over the threshold value, the microprocessor will immediately start the alarming module and send the alarming message or dial the police to tell the surveillant to be more attention to the environment security.

The monitoring center consists of communication module, interface circuit, cell phone and PCs. It sends or receives text message by wireless communication system made of communication and interface circuit through GSM network. The text message is sent to the data center of Mobile Corporation, the communication module is connected to the data center via computer serial interface. Orderly, the computer receives data sent by environment collecting terminal and saves it, when it receives alarming data, the computer will give sound and light alarm and send the environment status information to the preconcert cell phone and telephone, in this way, the working people can promptly know the running status of monitoring system even far from the monitoring position. The working environment of automobile gas station can be monitored in real time to find danger and promptly call the worker. If the pressure data is normal, the working status of the pipes can be monitored. The schematic structure diagram of intelligent monitoring system is shown as Fig.1, we choose LPC2132 processor as the processor of the system, LPC2132 processor is one 16/32 bits ARM7TDMI-SCPU which supports real-time simulation and embedded track, its maximal operational clock is 60MHz, and with one 64Kb embedded high-rate Flash and one 16Kb SRAM which simplifies the complexity of the system design. On the other hand, tiny LQFP64 and lower power make LPC2132 processor are wildly used in communication gateway, protocol convertor, software MODEM, voice identification

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and terminal imaging etc. there are multiple 32 bits timers, two standard UART interfaces, 10 bits DAC, one PWM channel and one SPI communication interface, 47 GPIO and 9 edge or level-triggered external interruptions of LPC2132 processor, which makes it very suitable for industry control and medical system.

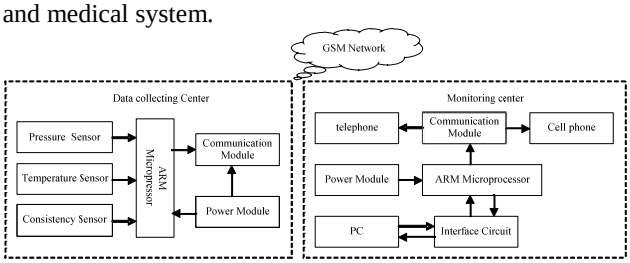

Figure 1. Schematic structure diagram of intelligent monitoring system

III. HARDWARE DESIGN OF SYSTEM

Hardware design is system to achieve basic, in this paper, hardware design of mainly includes selection of sensors, communication circuits design, SIM cards and voice circuit design, power circuit design etc.

A. Selection of sensors

We usually install pressure sensor, temperature sensor, and combustible gas density detection sensor in the CNC gas storage well system according to the detected data, the principle of selection sensor is based on the sensitivity, responsibility, linearity amplitude, reliability, accuracy, and measure mode, in addition, the installation of sensor also should consider the special environment of automobile gas, and improve the security measure of defending static electricity and explosion.

A.1 Selection of pressure sensors

The monitoring system chooses capacitive sensors according to the characteristic of present measurement with lager space and larger precision, and chooses pressure sensors of 0-2.5MPa or 0-25MPa considering the pressure of gas storage well or gas storage pot to tolerate.

A.2 Selection of temperature sensors

Temperature sensor is mainly used to detect environment temperature of CNG gas storage well or gas storage pot. Because the higher environment temperature of gas storage well or gas storage pot is, the more likely the automobile gas to explode, it is necessary for us to detect this parameter of temperature. In this design, we choose resistor temperature sensor to detect the environment of automobile gas. But it must be installed closely adhere to the outside surface of gas storage well or gas storage pot to more sensitively detect the environment temperature.

A.3 Selection of combustible gas density detection sensors

The monitoring system is mainly designed to detect whether the gas is being leaked, so we choose firedamp sensor specially used for gas detection, when the firedamp sensor works, and the resistivity of its semiconductor material increases with the firedamp gas density increases.

B. Communication circuit design

In the monitoring system, the communication circuit is designed to upload environment detection data of CNG automobile gas station and give an alarm, which is the basic circuit of information interaction between master computer and slave computer. The communication module of system is GSM/GPRS module developed by Guangzhou Putal communication technology Ltd. The communication module is integrated TCP/IP and Multimedia Messaging Service (MMS) and support data transmission transparence, which makes data transfer very easy between wireless terminal and server computers. We can transmit pictures through MMS channel. Three shielding cans of the communication circuit can effectively shield baseband, radiofrequency power amplifier and radiofrequency transceiver, which insure the module with good radiofrequency indicators and steady performance. The communication works on frequencies EGSM900MHz, DCS 1800 MHz and PCS 1900 MHz with RS232 data interface, its work voltage: 3.4 ～ 4.3v. The module is integrated TCP/IP protocol; Extended TCP/IP AT commands are developed for customers to use the TCP/IP protocol easily, which is very useful for those data transfer applications it also provides quick, reliable and secure transmission for data, voice, short message and faxes. The communication circuit can send and receive point to point (MT/MO) and cellular broadcast information, EMS, MMS etc. for the voice function; it can handle voice communication and emergent call. And its echo-suppress and noise-remove circuit can effectively improve voice quality. The circuit of communication module is shown in Fig.2.

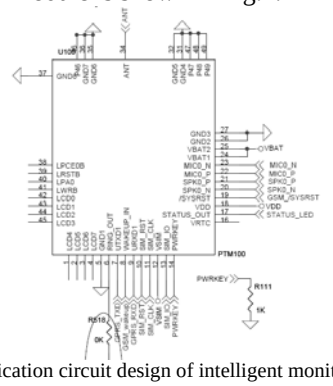

Fig.2 communication circuit design of intelligent monitoring system

C. Design of SIM card and audio circuit

The SIM card holder is designed as drawer type for users to easily use, which avoids static electricity damage and protects the SIM card well.T1, T2, T3 in the signal line of the SIM card are reserved for ESD protective pipes, if static electricity damage is very serious, TVS protective pipes and varistors can be stick in the positions of T1,T2,T3 and T4 to protect SIM card from electricity damages. The

audio in-out interface of the system uses standard telephone handle socket, the telephone handle can be directly plug into the socket and give someone a call. The positions of B101，B102，B103，B104 which seriously connected to the MIC and SPLK lines are reserved as anti-interference high-frequency magnetic beads, if there exits electromagnetic interference when the users communication, the B101，B102，B103，B104 can be replaced with high-frequency magnetic beads to restrain high-frequency interference. But usually they can be replaced with 0 ohm resistors if there is no interference. SIM card and audio circuit is shown as Fig.3

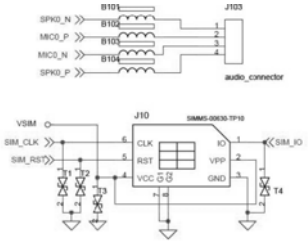

Fig.3 design of SIM card and audio circuit

D. Design of power supply circuit

Total power input of the system is 5V, but power voltage of PTM100 communication module is advised 4.2V, the maximal peak value of current can be 2A, but the kernel and I/O interface of ARM LPC2132 microcontroller are powered by 3.3V single power supply, the demand for current is very small, so we can use TD2020 DC-DC circuit to switch 5V supply into 4.2V and send to the PTM100 communication module, then another power is disported from 4.2V and send to the SPX1117-3.3 to become 3.3V power supply and provide to the LPC2132.

D.1 Power supply design of communication module

The core chip of 4.2V power supply circuit uses OCP2020/TD2020 power supply chip of ORIENT-CHIP Corporation, it is a DC-DC power supply IC with characteristics of great output current and high efficiency. One high-current P-MOSFET pipe and one high-precision feedback comparative amplifier are integrated inside the circuit. The voltage range of power chip is 3.0～20V, and the maximal load current is up to 2A, but static current is only 5.5mA, which can totally satisfy the requirement of the monitoring system. The power circuit of 4.4V is shown as Fig.4.

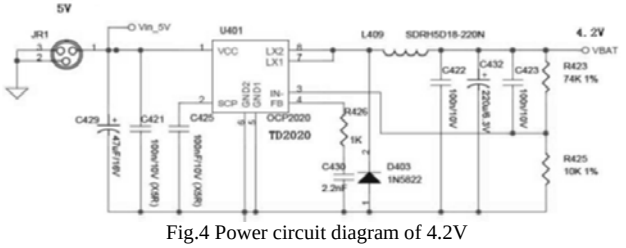

Fig.4 Power circuit diagram of 4.2V

D.2 Power supply design of ARM microcontroller

Safe working voltage of ARM microcontroller is 3.3V, the power supply circuit of the monitoring system uses SPX1117M-3.3 LDO chip of Sipex Corporation, it has characteristics of heavy output current and precise and steady voltage. Its output current can be up to 800mA, the precision of output voltage can be limited in ±1%. Besides, it has functions of current limit and thermal protection and can be wildly used in the handle instrument instruments, digital home appliance and industrial control etc. there is at least one 10μF tantalum capacitance to in the output end to improve instantaneous response and stability. The power circuit of 3.3V is shown as Fig.5.

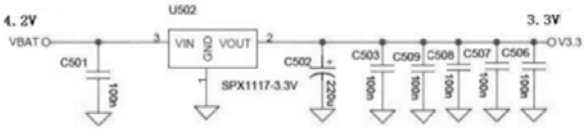

Fig.5 Power circuit diagram of 3.3V

IV. SOFTWARE DESIGN

Software design includes two parts: environment data colleting terminal software and monitoring center software. Software programming of environment data collecting terminal can be divided into five phases: initialization of microcontroller, setting of pressure threshold, setting of temperature threshold, setting of timer interruption and communication rate. The flow chart of the environment collecting terminal is shown as fig.6. When the system starts to work, it usually sets an internal (can be set at will, the system choose 10 minutes) to collect environment data, ARM works at low-power mode, when the timer starts up, the ARM microcontroller collects pressure and read environment temperature data and gas consistence data, then the collected data are compared with set threshold, if the data exceed the threshold, the monitoring system immediately send alarming signal, if the data are normal, the environment data will be sent into the monitoring center in the set time, and the communication module is charge of receiving normal data. Monitoring center can do so many functions by writing different AT commands in the communication module, when the serial interface interrupts, the communication module will read the text message in the SIM card, if the value exceeds threshold, and the data will be sent to the cell phone of the working people, then the communication module will dial the surfacemen and surveillant according to the prearranged phone number, normal data and alarm data will be saved in the computer to maintain and look up data. The flow chart of monitoring center is shown as Fig.7

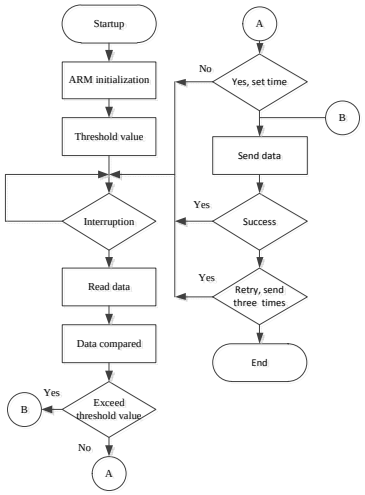

Fig.6 flow chart of the environment collecting terminal

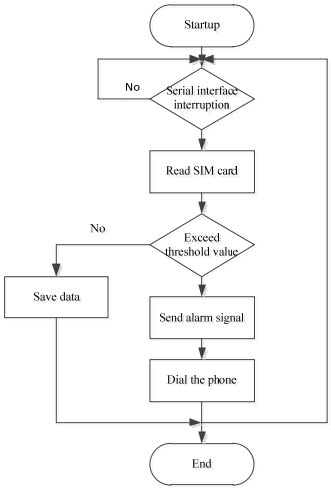

Fig.7 flow chart of monitoring center

V. CONCLUSIONS

As we all know that the wire distribution of remote data monitoring network is very difficult and costly, it is very effective for us to design intelligent monitoring system using GSM/GPRS wireless communication network. In our design, the CNG intelligent monitoring system can monitor the environment of CNG automobile gas station in real time, and can detect more data by using different environment sensors, for example, the system can be remote Auto security alarm system by equipped with infrared detecting sensors. If the monitoring system have multiple environment data collecting spots, which can build up background network, every spot can be numbered, the sending data displays the number of environment collecting spot, in this way, the CNG automobile gas station can be monitored in networking and managed unmanly. The monitoring system can be popularize and play a great role in the daily life.

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