Research on Automatic Monitoring System of Missile Equipment Storage Environment

Hongyun Wang, Shen Zhao, Weiwei Gao and Yi Wang

Four Department, Army Engineering University, Shijiazhuang 050003
Email: 258033232@qq.com

Abstract. Temperature and humidity are the important factors that affect the life span and service quality of missile. At present, most of the temperature and humidity monitoring methods that are generally used in the army are in low measurement accuracy, fussy operation, and difficulty to maintenance. So, in this paper, a low power, short distance wireless temperature and humidity monitoring system is designed. In this system, the SCM AT89S52 is used as the core, the AM2301 is used as the sensor which is a digital temperature and humidity integrated sensor, the NRF24L01 is used to realize wireless transmission, the LCD12864 is used to display and the keyboard is used to set temperature and humidity alarm threshold. The structure of the system is simple and the measurement accuracy is high, solved the problems of the existing system.

1. Introduction
The missile is stored in bad temperature and humidity environment for a long time, can easy to cause the reliability decrease and cause the fatal fault. So, monitoring the temperature and humidity of missile environment is an important long-term task in the army. At present, most of the temperature and humidity monitoring methods that general used in army are in low measurement accuracy, fussy operation, and difficulty to maintenance. It is difficult to adapt to the requirements of missile temperature and humidity monitoring at present, and does not meet the development requirements of army information construction. In all kinds of methods, wireless data transmission has the advantages of practical, efficient, fast, low cost, and easy to carry, quick and easy to set, and become the mainstream of measurement and control system.

2. Scheme Selection

2.1. The Temperament and Humidity Monitoring Scheme
There are three methods for temperature and humidity monitoring: one is use the traditional analog device, and then is the integrated device IC, and the last is the digital sensor. The traditional analog sensor has the advantages of fast measuring speed and wide measuring range. However, the signal comes from the sensor is not electric physical quantity, this physical signal is need to convert to digital signals, and many link line need the designer to consider, so the number of components in the system is increased, affecting the reliability and the miniaturization of the system. Moreover, analog signals are likely to affected electromagnetic interference during long distance transmission, and produce error. In addition, the accuracy of analog system is impossible very high, and the system has a certain nonlinear. The sensor with direct digital output can avoid the above problems. The digital sensor can convert the analog into digital output directly. Its signal is not affected by the temperature drift of the amplifier and signal processing system in principle, and has high anti-interference ability. Although
the digital sensor has the disadvantages of slow reaction speed and non-wide measuring range. But it has high measurement accuracy and resolution, easy signal processing, transmission and automatic control, easy to dynamic and multi-channel measurement, intuitive reading, simple structure and high reliability.

2.2. Wireless Transmission Scheme

There are three main schemes in short distance wireless communication: firstly, the Bluetooth technology, second, the infrared technology and the third wireless transmission. Bluetooth technology support voice and date transmission at the same time, use the frequency hopping spread spectrum technology, itself has error correction mechanism, high reliability, the core part of the Bluetooth specification protocol allows multiple devices for mutual positioning, connect and exchange date, and to achieve interoperability and interactive applications. However, Bluetooth equipment is expensive and the communication distance is short. Infrared transmission is used for electromagnetic wave infrared distance measurement, the model has the advantages of mature technology, small volume, low power, high transmission rate, convenient connection, easy to use, date transmission, less interference, high security, low cost. However, it also has disadvantage that can only be transmitted by sight and can’t be transmitted when moving. Most of the functions of short distance wireless transmission system are integrated into a chip inside. Generally use RF transceiver digital signal, micro controller and peripheral devices constitute a special or general wireless transmission module. All high frequency components, including inductors and oscillators, have been integrated in the chip, with good consistency, strong stability, and free from external interference. The new generation of short distance wireless transmission system has the advantages of small size, low power, simple and rapid development, and can be easily embedded into various devices, realize the wireless connection between devices.

In this system, considering the economy and transmission distance, this part of the circuit design uses wireless transceiver chip.

3. Device Selection

3.1. Selection of Digital Temperature and Humidity Sensor

In the selection of digital temperature and humidity sensor, the main considerations are as follows: The peripheral circuit should be as simple as possible. The accuracy and distinguishability should be appropriate, reduce the unnecessary circuit and software development cost. The bus load capacity of sensor can meet the needs of multi-point temperature measurement. The I/O pin of MCU should be saved as much as possible. The communication protocol should be as simple as possible, the software development difficulty and the cost should be as small as possible. In considering the above factor, there are two main options.

Scheme one: Selected the independent temperature sensor DS18B20 and humidity sensor DHT11, to collect the temperature and humidity of the environment respectively. The circuit structure is complex and the precision is poor relatively.

Scheme two: Using the sensor AM2301, which integrate temperature measure and humidity measure. It use a specified digital module collect technology and temperature and humidity sensing technology, with high reliability and long-term stability. Moreover, because of the unique one bus interface, the sensor has obvious advantages in measuring temperature and humidity at multipoint.

3.2. Selection of Wireless Transceiver Chip

The wireless transceiver chip is variety. Choosing the right chip during design can improve the development cycle and save cost. When choosing, should pay attention to the following points: select the chip with few peripheral components, select products with low comprehensive power consumption, choose products with high emission power, select the small chip with less packing will help reduce the PCB area, the cost and fit the design of portable products.

The NRF24L01 is a high speed wireless transceiver chip which is developed by Nordic VLSI ASA company of Norway. This chip takes the structure of NRF24L01 as the foundation. The RF, 8051MCU
ADC, Frequency channel, UART, SPI, PWM, RTC and WDT all integrated into one chip. Inner the chip, it has voltage regulator and VDD’s voltage to keep watch on, the data speed is 1Mbps and the output power is 0dB. No external filter is required, extremely few periphery. All work parameters such as transmission power, operating requency etc can be set through software. All high frequency components such as inductance and oscillator ect is integrated into the chip, the consistency is good, the function is stable and is not disturbed by the outside world. The work frequency is 2.4GHz, which is open in the whole world, and do not need to apply for the communication license. These kinds of chip is used in wireless keyboard, the mouse, wireless earphone, industry sensor, PC, telephone, warning device, remote control and other short distance wireless applications at high speed.

4. System Function Design
In this system, MCU is as the nucleus, AM2301 is as the sensor that to measure the temperature and humidity, NRF24L01 is as the wireless transmit-receive chip, and other modules make up the whole system, which is an intelctive short distance wireless temperature and humidity detection system. The whole system as Figure 1.

![Figure 1. The whole system structure](image)

4.1. Power Module
According to the design requirement of the system, it needs voltage 5V and 3.3V. Considering the portability and reliability, the Li-ion/Li-ion polymer battery is used to supply power to the whole system. The output of the battery is 3.7V, then step up the voltage to 5V, supply the power source to MCU, Display module, and Wireless transfer module. The 5V voltage step down to 3.3V use the chip AM1117-3.3, supply the power source to the temperature and humidity measure module.

4.2. Temperature and Humidity Module
The structure of this module is briefness, only need one link to connect with MCU.
The special explain about one bus communication as follows: first, when the link is shorter than 30 meter, use the 5.1k resistance (R5), when longer than 30 meter reduce the resistance according the actual situation. Second, the length must not be more than 100cm when using 3.3V voltage to supply power. Otherwise, the line drop volgate can lead sensor lacks electricity, cause the measurement deviation. Third, the interval to read sensor date is 2s, when the time smaller than 2s, probably leads the measurement is inaccurate or the communication failed. Fouth, the outcome of the mearment that every time read is the result last time, if want real-time data, should continuously read the outcome of senor many times, the interval to be more than 2s gaining the accurate date every time.

4.3. Wireless Transceiver Module
Due to the high frequency circuit design, the component placement and wiring methods have high requirements. Therefore, in this system, the finished product module is used, so we needn’t to consider the design problem of high frequency circuit. The Circuit and PCB of NRF24L01 as figure.3.
In this system, you can use LCD12864 or PC to display. Adopt the cheap buzzer as the alarm appliance.

5. Software Design
The function of the system is achieved under the control of the software program. The software design method is relatively with hardware; also adopt the modularization design concept. The whole function is separated into different procedure module, then design, program, debug separately, and connect the subprogram through main program and interrupt. It is in favour of amending and debugging, enhance the transplant possibility. In this system, the software is split into two parts: one is the collect and wireless transfer peogram, the other is the recive the date, display and alarm program. The flow chat is as Figure 4.

![Flow Chart](attachment:flow_chart.png)

**Figure 4.** The flow chats of the system

6. Conclusion
This system is a concrete application of short distance wireless communication technology in the measurement of temperature and humidity. The measuring system has the advantages of simple, stable, strong anti-interference, portability and easy expansion. After testing, the actual launching distance is about 50 meters in the open area, and the transmission distance is reduced after the wall passes through the wall, but the data can still be received. This system is suitable for the temperature and humidity monitoring during the storage and transportation of the missile. After the nonlinear compensation of software, the accuracy can be further improved; it can meet the needs of the army for real-time monitoring of weapons and equipment.

7. Reference
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