Research on Online Monitoring Method for Longitudinal Rip of Steel-Core Belt

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Abstract. Steel-core belt is the large transport device in coal mine and other departments, the longitudinal rip of steel-core belt will bring great losses to production and safety, this article proposed one kind of online monitoring method based on distance measuring sensor and 8051 MCU. This method is to use distance measuring sensor to real-time monitor the width of the steel-core belt, and through compiling 8051 MCU process, realize online monitoring for the longitudinal rip of steel-core belt.

Keywords: Longitudinal rip, distance measuring sensor, MCU, data acquisition.

1 Introduction

Steel-core belt conveyor is a large transportation equipment, which is widely used in mine, metallurgy, port, electric power and other department, it has some features such as high efficiency, great carrying ability and easy to realize automatic control, made it be widely used in coal production automation. However, steel-core belt in its width direction tensile strength is very low, makes the conveyor belt frequent happen longitudinal rip accidents. Steel-core belt occurs longitudinal rip for many reasons, and its main aspects including: Some rod-like material insert conveyer belt; large elongated rock fall to steel-core beit; some fixed parts of the rack to caught conveyor belt; various iron wire hitched conveyor belt and so on. Steel-core belt is expensive, it will cause significant directly or indirectly economic losses once produce longitudinal rip[1-3].

Opaque material on the steel-core belt leaking through the gap when the steel-cord belt occurs longitudinal rip. By infrared photoelectric sensor placed below the conveyor belt detects whether there are any opaque material leave out, which can detect if the tear fault occurred[4]. This detection method is structure simple and easy to install, but in some cases, after the belt is torn, the two side of the conveyor belt overlap, the cracks are sealed, result in the opaque material can not leave out, so this method will not detect the tear fault. To this detection method's deficiencies and limitations, this paper have been modified and improved its, presents a detection method based on distance measurement sensor and 8051 MCU, and design a new conveyor belt longitudinal tear online monitoring system use this method.

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2 The Working Process of the Monitoring System

The width of the steel-cord belt is a constant during the conveyor belt operation , when the longitudinal tear occurs, the bandwidth will change. Through online real-time monitor the width of the conveyor belt to diagnose whether there have been occurred tear fault.

The working process of the monitoring system is: Ranging sensors, arranged on both sides of the conveyor belt, online real-time measure the width of the belt and send out the voltage signal, during the conveyor belt running. The voltage signal is filtered and amplified treatment, and through the multi-channel analog switch sent to the A/D converter, after A/D converter finishes the signal conversion, puts the digital signal sent to the 8051 MCU, after single chip calculating and processing, the data through communication interface is sent to the computer for further data analysis, image reconstruction, storage and print, and real-time shows the width of the belt in the LED screen. When the changes of the width of the conveyor beyond the set alarm threshold , which can be obtained through several tests, 8051 MCU will send the alarm to stop the conveyor running, thus prevent the expansion of the degree belt torn, and warn the technical workers overhaul. This can be achieved online real-time monitoring for the tear fault of steel-core belt.

3 Monitoring System Design

3.1 Page Numbering and Running Heads

The hardware of this system is mainly composed by the range-finding sensors parts, data acquistion circuit components, 8051 microcontroller and peripheral cricuit section, communications interface and the PC. Structure of the system is shown in fig 1.

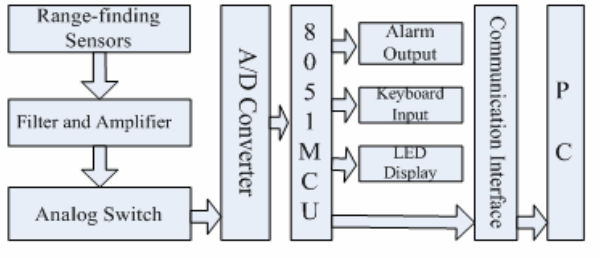

Fig. 1. Schematic diagram of the system

3.2 Page Numbering and Running Heads

Two range-finding sensors installed on both sides of the conveyor belt, two distance sensors respective detect the distance between the sensors to the conveyor belt for L_1

and L_2, the distance between two sensors is fixed at L, then the width of the conveyor belt D can be calculated:

$$D=L-(L_1+L_2)$$

Sensors' arrangement is shown in fig 2.

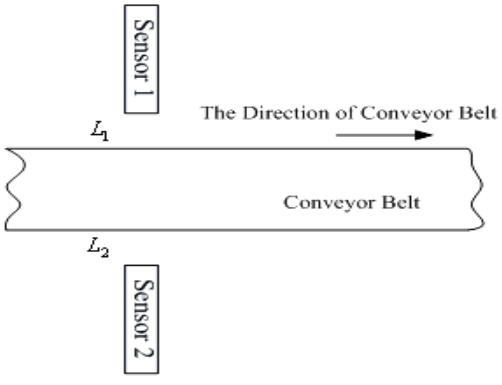

Fig. 2. Range-finding sensors installation position

3.3 The Data Acquisition Circuit

Data acquisition circuit includes the following four parts:

(1) Filter circuit: Using a hardware filter to remove the interference part of the signal.

(2) Amplifier: Using the operational amplifier enlarge the usefulness weak input signal to a considerable degree to match the back of the A/D converter' scale, in order to obtain the highest possible resolution.

(3) Multi-channel analog switch: Select the several input signal to achieve time-share A/D converter.

(4) A/D converter: Put the analog signals that come from the analog input channels in the front convert to data signals, and sent to the microcontroller. In this system, analog-digital conversion completed by the AD574A. AD574A is the 12-bit successive approximation A/D converter chip that was produced by Analog Devices, it is equipped with three-state output buffer circuit, can directly with various 8-bit or 16-bit CPU connections, do not additional logic interface circuit, and contains high-precision reference voltage and clock circuitry, it does not require any external circuit and the clock signal of to complete analog-digital conversion, the conversion time is only 35μs[5].

3.4 Microcontroller and Its Peripheral Circuits

This system uses Intel's high performance 8-bit microcontroller which fabricated in CMOS process, 8051 can compatible with TTL and COMS logic levels, with five interrupt sources, programmable full duplex serial port, with two layers of priority

level interrupt structure, can realize rapid pulse programming, with 4KB internal ROM and 128 bytes of internal RAM, and 8051 MCU have the advantages include: powerful control ability, simple programming, stable performance, small size, fast speed, real-time performance, low cost, take up less space, flexible installation, easy integration ect. It can make up the shortcomings that large measurement errors and poor reproducibility of previous testing equipment.

Signal through the A/D converter sent to 51 singlechip, after the microcontroller operation, sent the results into the liquid crystal to real-time show the current width of the conveyor belt, in the meantime sent the large amounts of processed data into the host computer for further processing. Because of the serial port of 8051 is a standard TTL level interface, while the serial of host computer is the RS-232C standards, in order to complete the data transmission from MCU to the host computer, need to use the MAX232 chip to achieve the communication between 8051 and PC[6]. Interface circuit is shown in fig 3. After the data through the I/O interface into the computer, then use the computer for the data to do the further processing, image reconstruction, disply, storage and print.

In addition, in the design process of the monitoring system in order to improve anti-jamming capability, circuit adopted the photoelectric isolation technology, space shielding technology, ect. The alarm threshold for the change of the bandwith can obtain by test the same type conveyor belt mang times, and stored the alarm threshold in 8051, and through prepare microcontroller program, compare the current change of bandwidth with the size of alarm threshold, when the variation of the conveyor reaches the alarm threshold level, microcontroller will send alarm. In the operation process of the conveyor belt, in order to prevent the error alarm by wear and tear, should in time to change the size of the alarm threshold in the event of wear and tear.

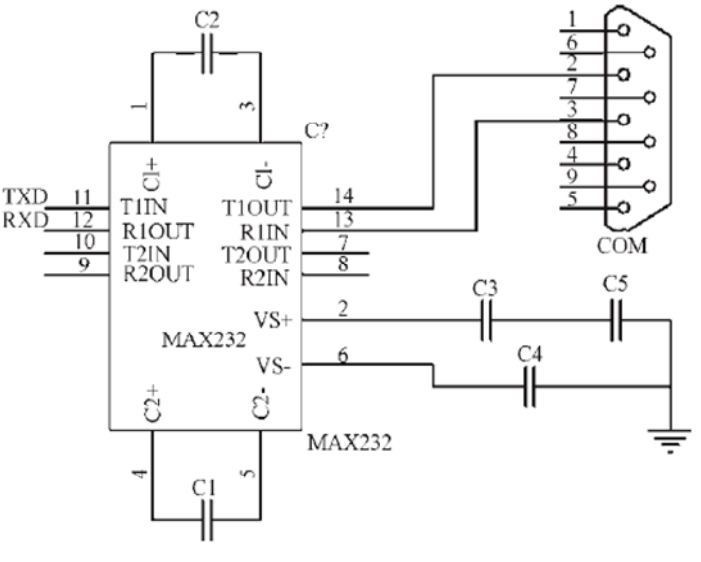

Fig. 3. The interface circuit of 8051 and host computer

3.5 The Data Acquisition Circuit

System software mainly consists initialization procedures, data collection procedures, the logical judgment main program, data shows subroutines, alarm output procedures, serial communication subroutines, ect. Fig 4 shows the block diagram of system software.

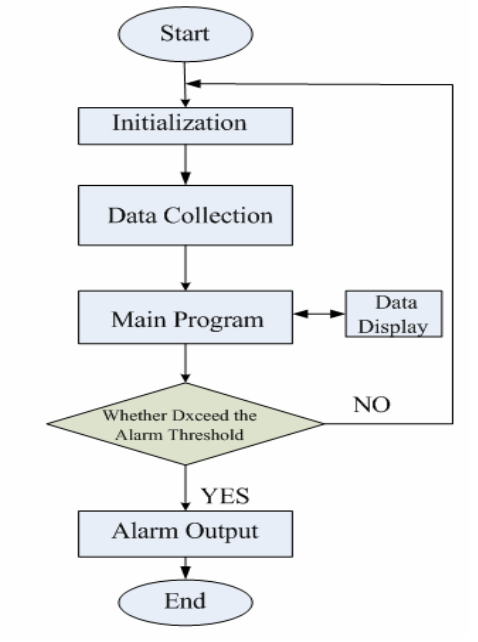

Fig. 4. Program structure diagram

4 Conclusion

This paper describes a kind of steel-core belt longitudinal tear fault diagnosis method based on range-finding sensors and the 8051 microcontroller combine, it can realize digital online monitoring, real-time display the measurment data, more limit alarm, the host computer complete data storage and print.

This detection method and the leak material detection method combined will have significant effect, it has a certain degree of research and reference for conveyor belt longitudinal rip detection technology.

References

1. Liu, Y.: Testing and monitoring longitudinal tear in conveying belt. Shan Xi Mining Institute Learned Journal 13(2), 150–153 (1995)
2. Huang, M., Wei, R.-z.: Real time monitoring techniques and fault diagnosis of mining steel cord belt conveyors. Journal of China Coal Society 30(2), 245–250 (2005)

3. Zhang, A.-n., Sun, Y.-k., Yin, Z.-h.: Research status and tendency of longitude tearing protection for belt conveyor. Coal Science and Technology 35(12), 77–79 (2007)
4. Qiao, T.-z., Zhao, Y.-h., Ma, J.-c.: Design on New Online Monitoring and Measuring System of Longitudinal Tearing for Conveyor Belt. Coal Science and Technology 38(2), 55–57 (2010)
5. Chen, Y.-k.: General data acquisition and processing system based on 80C51 microcontroller. Machinery 35(4), 49–51 (2008)
6. Liu, H.: Design of Data Acquisition and Communication Interface Based on 8051 Single-chip Microprocessor. Software Guide 7(12), 72–74 (2008)