Advanced Materials Research *Online: 2013-08-30*
ISSN: 1662-8985, Vols. 753-755, pp 2179-2182
doi:10.4028/www.scientific.net/AMR.753-755.2179

Analysis and Design of On-line Monitoring and Fault Prewarning System for Mine Ventilator

Shiman Xie[1,a], Zhaoyan Xuan[1,b], Zongyan Li[1,c] , Hongmei Feng[1,d] ,Fei Yang[2,e]

[1]Shool of Mechanical Engineering, Hebei United University, Tangshan, Hebei, 063009, China

[2]The Outer-Ring Management Office, Urban Construction Bureau, Tangshan, Hebei, 063000, China

[a]xie_s@126.com, [b]xzyanan@126.com, [c]lizongyan007@163.com,[d]hxt_668@126.com, [e]Y_fei86@163.com

Keywords: Mine Ventilator, Vibration Signal, Fault Prewarning, LabVIEW.

Abstract. According to the present state that traditional regular repair methods are always adopted for mining equipment maintenance, this paper puts forward a method of installing various sensors on the equipment which are combined with computer and signal analysis technology so as to realize on-line monitoring, fault prewarning, and remote release. This paper analyses the common faults of mine ventilator and their characteristics, selects the vibration sensor and its mounting points based on the characteristics of the fault signal, selects the signal acquisition cards based on equipment operating conditions and analysis parameters accuracy, builds up the hardware and software platform, completes the design of system function module and data flow, and achieves modularization programming for the whole software system by combining labVIEW and database. This system realizes the condition-based equipment maintenance so that informatization and automation can be achieved in equipment management.

Introduction

The mine fans play a vital role, as the “lungs” of the mining operation, which make sure underground working could carry on smoothly and the safety of the people. According to statistics, more than 70% coal mine accidents are due to the ventilation equipment failure resulting in poorly ventilated, ventilation mismanagement and so on. At present, the traditional maintenance method is often used when the devices is in need of repair in china. This way is not beneficial to understand the operation of the equipment in time, and easy to cause the excess or deficiency maintenance. The equipments’ running status can be reflected in a timely manner, because all kinds of sensors- which installed on the device-were connected with computer. Through analysis the vibration signals-time domain and frequency domain analysis-combined with the frequency characteristics of a variety of mechanical failure, we could achieve to identify and locate the fault. Therefore, it’s necessary that establish a real time on-line monitoring and fault prewarning system for mine ventilator, which includes two parts: hardware platform can collect information from the vibration signal of the running fan, and software platform is responsible for on-line monitoring and off-line analysis. By doing this, we can improve the maintenance way, and realize the state maintenance.

Common Mechanical Failure and Characteristics of Mine Ventilator

Rotor imbalance Fault. This fault is the most common fault of rotating machinery, which caused by two aspects: eccentric quality and the defects of rotor parts. The axis orbit is an elliptical. The frequency is same as speed, and the direction of vibration is radial.

Rotor Misalignment Fault. This fault generally dues to installation error, the deformation after the mechanical support, the change centering and the uneven settlement foundation. The vibration frequency based mainly on double frequency, often accompanied by a, three times frequency, and the orbit is double ring elliptic.

Rotor Bow Fault. In this case, the axial could produce larger frequency vibration. The vibration frequency based mainly on frequency, often accompanied by double frequency, and the direction of vibration is radial, the orbit is elliptic.

The Loosening Problem of Jointed Support System. The system will occur as discontinuous displacement due to the gap-the bolt is not strong. The vibration frequency based mainly on frequency and fraction frequency, often accompanied by two or three times frequency.

Rotating Shaft with Transverse Crack. The stiffness asymmetry caused by transverse fatigue crack is the crack depth function, the location function and the running time relatively rotary shaft vibration mode. The vibration frequency based mainly on higher harmonics, such as two or three times frequency, often accompanied by frequency, and the vibration is not stable. The directions of vibration are radial and axial. The phase characteristics are presented as irregular change.

Surge. The countercurrent is caused by the fan in the unstable region, which can counterattack the rotor. This phenomenon is called surge. The vibration frequency based mainly on ultra-low frequency, often accompanied by frequency. The data have a greatly periodically change because the change of flow at air inlet and outlet. The airflow noise occurs periodically strongly change.

Hardware Platform for Signal Acquisition

The General Structure of Hardware Platform.

The structure of information collects platform for the running fan is shown in Fig.1.

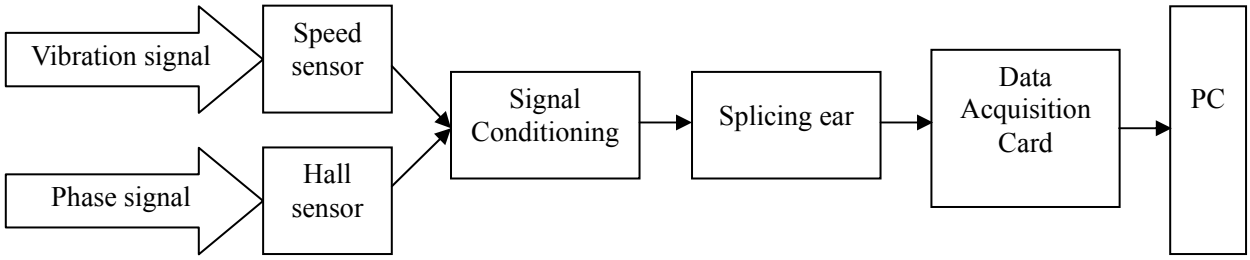

Fig.1 Hardware Platform for Signal Acquisition of the Fan

Selection Calculation and Installation Design for Sensor.

The spindle speed of the fan is 1000 r/m, so the vibration frequency is showed as

$$fr = 1000/60 = 16.7 \text{ Hz}. \quad (1)$$

According to the principle of vibration signal acquisition, we choose speed sensor to measure (*A,C,E* vertically installed and *B,D,F* horizontally installed). The phase signal measurement point adopted Hall sensor (G). The installation points are shown in Fig 2.

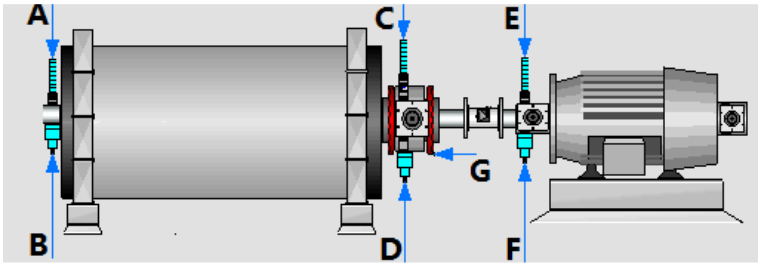

Fig.2 Installation Points of Sensors

Performance indices Calculation of Acquisition Card.

This system used a multi-channel asynchronous acquisition card instead of multi-channel synchronous acquisition card. The purpose is to ensure each phase in accordance with others and the phase error less than 1%, so the lowest sampling frequency is:

$$1\text{k} \times 8/1\% = 80\text{kHz} \quad (2)$$

The revolution of sampling requirement is 2mv, according to maximum measurement range ($\pm$10v), so the lowest sampling digit capacity is *14*:

$$\log_2 \frac{20\times1000}{2} \approx 13.3 \quad (3)$$

The Software Platform Based on LabVIEW

The General Structure of Software Platform.

This platform mainly included *three* modules, and they are shown in Fig.3.

<table>
<tr><td colspan="2">Off-line analysis module</td><td rowspan="4">WEB remote release module</td></tr>
<tr><td>Trend analysis</td><td>Expert system</td></tr>
<tr><td colspan="2">On-line monitoring module</td></tr>
<tr><td>Time & frequency domain analysis</td><td>Alarm management</td></tr>
<tr><td colspan="3">The basic function module</td></tr>
<tr><td colspan="2">Signal acquisition pre-processing</td><td>Data storage management</td></tr>
</table>

Fig.3 Software Platform of the Fan

The function of the basic module is collection the external signals by the specified sampling frequency and interval, and pretreatment of channel separation, data transformation, phase alignment and so on, then store real-time data by specified data structure. Besides, the inquiry and the delete function for historical data can be found in this module. The sampling data comes true analysis in online monitoring module, and the real-time states of the fan are represented at the intensity value. According to the intensity threshold value, this part implements primary or secondary alarm, meanwhile the data are managed in this module. In the off-line analysis module, according to the historical data, the trend of the running fan could be forecasted, and the expert system based on expert knowledge base could give an evaluation and repair suggestions. In remote distribution module, through the intranet of the enterprise, the data could be released, including real-time data and off-line analysis results, so that users can remotely view.

The Program Realization for LabVIEW.

Based on LabVIEW software development environment, this system mainly contents “the front panel” the user interface design and “the flow chart” in kneading board’s program structure design.

This system requires continuous acquisition six channels, each channel has 512 double precision floating point data. In the normal operating state, a set of data storied by 5 minutes, so the amount of data needed to be stored for a day is:

$$6 \times 512 \times (60/5) \times 24 = 884736 \quad (4)$$

As indicated above, the data is largely, so this system adopts the way by file storage and database combination. The sampling data are stored as files and compression and other data stored in Access database.

Fig.4 shows that this system eventually achieves *two* main functions: user interface for online monitoring and offline analysis. The core of the online monitoring is the real data buffer; the data coming from preprocessing module could enter into buffer zone, and then the other zone could remove the data according to fixed time interval. The early fault alarm could be forecasted by user interaction in the offline analysis module which based on the expert knowledge base.

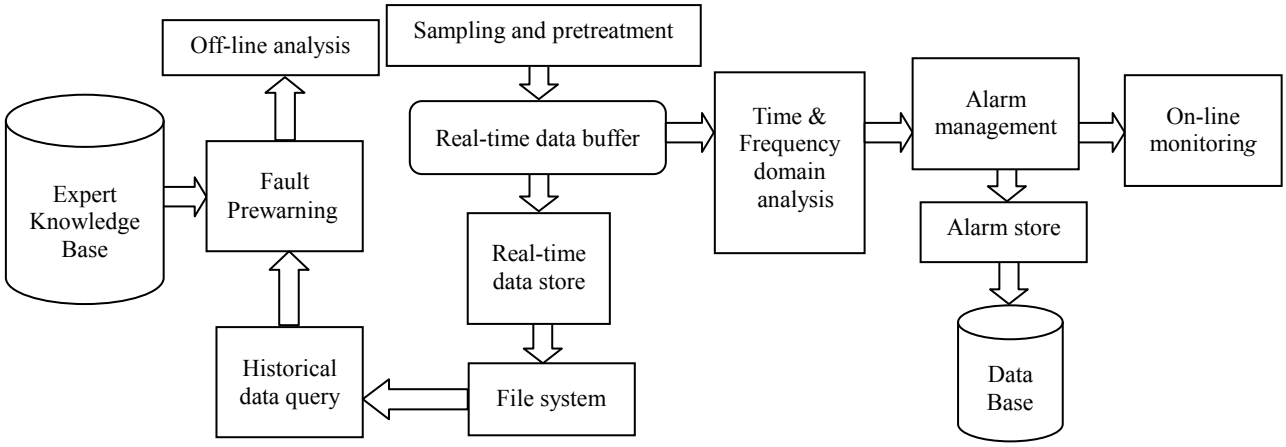

Fig.4 System Function Module and Data Flow

Conclusions

The thesis is researched under the background of "The development of online monitoring and diagnosis system for LInnancang mine ventilator". According to requirement analysis and functional requirement, using virtual instrument technology, the system comprehensive uses the way of time domain and frequency domain analysis, the vibration monitoring and so on for state monitoring and fault prewarning of the fan and its motor. At the same time, the system using database technology and network technology, realized the real-time running state monitoring function, fault prewarning, remote distribution, so the maintenance management of the whole equipment could realize informatozation and automation.

References

[1] Industrial fans - Method of measurement of fan vibration Industrial Fan. The measurement methods of fan vibration ISO 14695-2003.

[2] Jimeng Zhang, Bende Gan, Displacement spectrum method application in the large fan vibration detection and treatment, Procedia Engineering, Volume 15, 2011, Pages 2393-2397, ISSN 1877-7058, 10.1016/j.proeng.2011.08.449.

[3] Zhongning Zhou, Yimin Li, Yongxia Gu, Shaohui Li, Yuansen Xie, Feasibility of monitoring a mine fan by using interaction of vibrator system, Mining Science and Technology (China), Volume 19, Issue 3, May 2009, Pages 337-341, ISSN 1674-5264, 10.1016/S1674-5264(09)60063-6.

[4] M. Ristivojevic, R. Mitrovic, T.Lazovic, Investigation of causes of fan shaft failure, Engineering Failure Analysis, Volume 17, Issue 5, July 2010, Pages 1188-1194, ISSN 1350-6307, 10.1016/j.engfailanal.2010.02.004.

Materials Processing and Manufacturing III
10.4028/www.scientific.net/AMR.753-755

Analysis and Design of On-Line Monitoring and Fault Prewarning System for Mine Ventilator
10.4028/www.scientific.net/AMR.753-755.2179