International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Real Time Condition Monitoring of Power Plant through Intranet

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Abstract: ***Condition monitoring is an important aspect of maintenance program of rotating machines. The data acquisition and analysis were cumbersome in the analog era and dedicated instruments were required and the diagnostics was usually a laboratory-based exercise and time consuming. With the advent of high-speed microprocessors, the practice has completely changed. A modern continuous condition monitoring and diagnostics system is first described. With the recent advances in internet-based technologies, the condition monitoring procedures are poised for a quantum jump in the way the machines can be maintained continuously on-line at remote locations or checked through the web for any faults.***

Keywords: ARM (Advanced RISC Machine), DSP (Digital Signal Processing), LVDT (Linear variable differential transformer), A/D converter (Analog to Digital converter), RISC (Reduced Instruction Set Computing).

1. Introduction

Condition monitoring is an important aspect because it provides information about the health of a machine. We can use this information to detect warning signs early and helps the organization to stop the unscheduled outages, optimize machine performance, and reduce repair time and maintenance cost. The reason of importance aspect of condition monitoring is as follow:

- Power plant equipment is crucial for maintenance, as any of their downtime is very expensive and can run to a few million dollars each day.
- In case of catastrophic failures, the losses can even amount to a few billion dollars.
- Life is so precious. So saving the person life in an industry is an important concept when compared to the machine health.

So therefore a continuous condition monitoring and diagnostics proves economical in running power plants generating electricity. A significant parameter that reflects the condition of a rotating machine is its vibration signature. A deteriorating condition in the machine such as an imbalance in the rotor, loss of alignment, looseness in a bearing assembly etc., is immediately reflected in the vibration emanated from the rotor that travels to the supporting structure. This vibration signal is utilized to monitor the health of a machine and perform diagnostics to predict and correct a machine problem. This paper mainly concentrated to provide the following;

- Automation
- Saving the person's life
- Monitoring of power plant situated at different locations

In the below Fig1.1, vibrations are the first warning sign that a machine prone to failure. This warning sign can provide 3 months of lead time before the actual failure date. Monitoring this data with the vibration analysis in hardware and software helps us to predict the failure early and schedule proper maintenance.

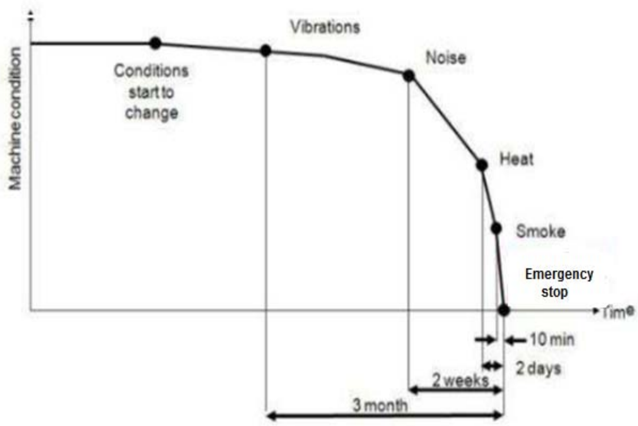

Figure 1.1: Machine Failure examples and warning signs

2. Types of Vibration Sensor

The following are the sensors used to measure the vibration signal from the rotator machine.

- Ceramic peizo electric accelerometer
- Linear variable differential transformer
- Proximity probes
- Variable reluctance

These sensors differs in the following parameters.

- Damping coefficient
- Natural frequency
- Scale factor

Scale factor relates the output to an accelerometer and is linked to sensitivity together. The natural frequency and damping coefficient determines the accuracy level of the vibration sensor. For example if you were to pull the mass back away from equilibrium and release the mass. The mass vibrates forward and backward until it comes to rest. The friction that brings the mass to rest is defined by the Damping coefficient. The rate at which the mass vibrate forward and backward is its Natural frequency.

2.1 Ceramic peizo electric sensor or accelerometer

Vibrations or acceleration is most commonly measures using a ceramic peizo electric sensor or accelerometer. These are most commonly used sensors because they are the most versatile sensors. These sensors are used in shock measurement, high frequency and slower low frequency vibration measurement. These sensors will produce output in milli volts, require a high impedance, and low noise detector to interpret voltages from its piezoelectric crystal

2.2 LVDT & proximity probes

Both are similar but they are limited to steady state acceleration of low frequency vibration measurement. However LVDT vibration sensor has slightly higher natural frequency meaning that it can handle/detect more vibration.

2.3 Variable reluctance vibration sensor:

It uses permanent magnets and movement through coils to measure motion and vibration. This is a special vibration sensor because it registers output only when the mass it is measuring is in motion. This makes it particularly useful in earth quakes shock studies and oil exploration to pick up vibration reflected from underground rock strata.

Table 2.1: Comparison of common vibration sensor

Vibration Sensor	*Natural Frequency*	*Number of Axes*	*Damping Coefficient*	*Scale Factor*
Ceramic Piezoelectric	>5kHz	Up to 3	Small	Requires high output
LVDT	<80 Hz	Up to 3	Medium	Varies
Proximity Probes	<30 Hz	Up to 3	Medium	Varies
Variable Reluctance	<100 Hz	Up to 3	Medium	Varies

3. Existing System

Modern power plants are continuously monitored for their health through several vibration signals. At each bearing location vibration signals in three directions, vertical, horizontal and axial, through accelerometers and the shaft vibration through two non-contact probes can be measured and the analog signals are converted to digital form. Typically 5000 samples a second can be obtained and 4096 of these can be used to determine the frequency components using a Fast Fourier Transform for each vibration signal. The time domain signal as well as frequency components can be compared with acceptable values to assess whether the machine is running in a healthy condition. A Cepstrum analysis for plants that contain gear transmission systems and rolling element bearings is also included to identify the side bands for diagnostics of the system. The shaft vibration signals in two perpendicular directions are used to obtain the shaft orbits, which can give useful information on any malfunctioning of the system.

A continuous monitoring of the system identifies any malfunction under development so that corrective action is taken in time to keep the machine running in a healthy environment. A system based on this procedure is now operating in a nuclear power plant located in the western state of Gujarat at Kakrapar

4. Proposed System

In recent times, with the advent of affordable A/D converters and fast personal computers, digital measurements and signature analysis gradually replace the analog era. Digital Signal Processing is now ushering a quantum leap jump in the field of diagnostics of rotating machinery. Though a system like the one described above is a significant advancement in power plant maintenance over the years, several improvements can be further made to improve the efficiency of the system using the Internet technology. The exponential growth of the World Wide Web is making it an attractive framework for a wide variety of applications. Today the World Wide Web is the most cost-effective way to share information among geographically dispersed users. The Web seamlessly connects disparate hardware platforms running different operating system in diverse locations. Java is enabling Web applications to be richer and more interactive. It is now becoming feasible to build collaborative applications over the Web. Java applets, because of their ability to run on a client machine and establish communication to a process on the Web server, are ideal for developing monitoring applications such as condition monitoring of power plants.

If the machine is running outside healthy limits, an expert system based on a suitable Knowledge base of the machine can be applied to find the possible cause of a malfunction. The data files are managed in the form of current data file, yesterday's file, last week's file, last month's file and last year's file for trend monitoring. The present day programs can also assess whether the signals obtained are real or spurious through signal properties, like coherence, convolution etc. The proposed architecture for “Real Time Condition Monitoring of Power Plants through Intranet” for a high speed rotating machine is shown in fig 4.1

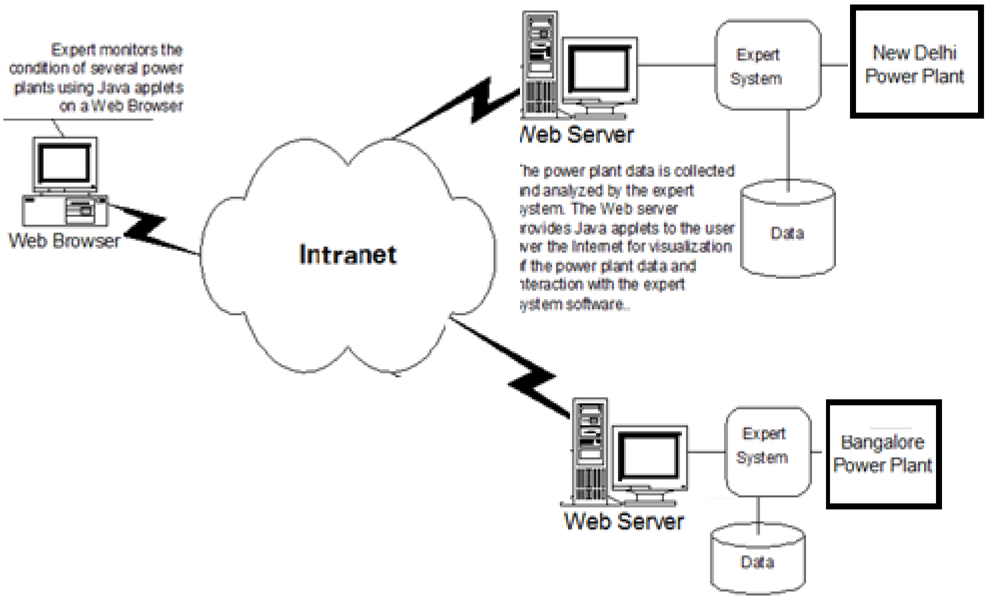

Figure 4.1: Architecture For Real Time Condition Monitoring of Power plants through Intranet (RTCMPI)

The Proposed Embedded system for real time monitoring and control will be designed using ARM946ES. The ARM946ES is DSP-enhanced ARM core and best suited for applications that require a blend of high-quality DSP performance and efficient control implementation. This includes high volume applications such as in mass storage devices, speech coders, speech recognition and synthesis, networking applications, automotive control solutions, smart phones and communicators, and modems.

4.1 Block Diagram for Proposed System

The block diagram of Real Time Condition Monitoring of Power plant through Intranet (RTCMPI) is as shown below.

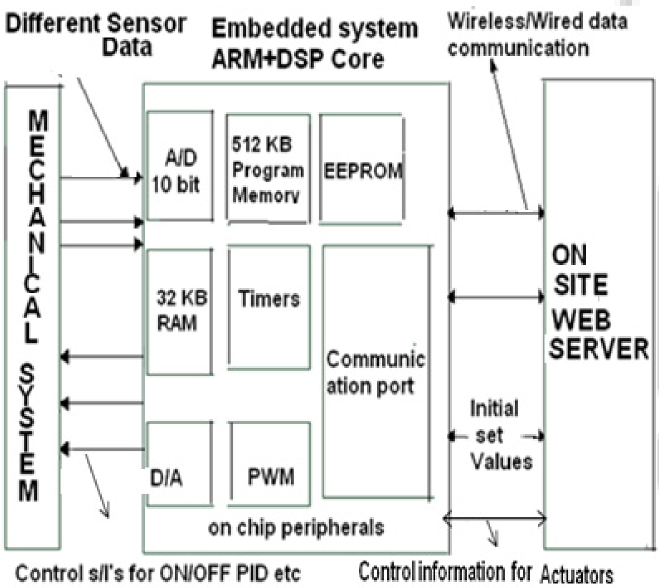

Figure 4.2: Block Diagram for the proposed embedded systems

The technical scope of the Real Time Condition Monitoring of Power plant through Intranet (RTCMPI) is as follows;

- Acquiring Sensor Data.
- Processing Data (Involves signal processing using on chip DSP extension)
- Comparison it with set values shown in Table 4.1 and Identify the System status

Table 4.1: Standards Based on Machinery Type

RMS Velocity Ranges of Vibration Severity		Vibration Severity for separate classes of Machines			
mm/sec	in/sec	Class 1	Class 2	Class 3	Class 4
0.28	0.01	A	A	A	A
0.45	0.02	A	A	A	A
0.71	0.03	A	A	A	A
1.12	0.04	B	A	A	A
1.8	0.07	B	B	A	A
2.8	0.11	C	B	B	A
4.5	0.18	C	C	B	B
7.1	0.28	D	C	C	B
11.2	0.44	D	D	C	C
18	0.71	D	D	D	C
28	1.10	D	D	D	D
45	1.77	D	D	D	D

Class A: Small Machines
Class B: Medium Machines
Class C: Large Rigid Foundations
Class D: Large Soft Foundation

5. Conclusion

Condition monitoring and maintenance of power plants through vibration signatures and digital processing in real time is becoming increasingly the norm of the day to keep the machines healthy with a long life, minimize the downtime and eliminate the possibility of any catastrophic failures. A system based on this concept is described.

The advantages of adopting modern Intranet based technologies in this process are given and two new strategies are presented which will enhance the efficiency of the maintenance system and cut down the costs considerably. The conversion of existing software for condition monitoring and expert system diagnostics from VC++ to Java for intranet applications is in progress so that the Netscape Navigator or Microsoft Internet Explorer browsers can download the program from a Web page and run it locally on the Web user's system. An applet with features to select a signal to monitor and option to look at it in time domain and Zoom In/Zoom Out and Panning support is described. The availability of such systems on Web can make the maintenance program of rotating machinery very simple and economical.

6. Future Scope

Future Development of this paper includes improving the efficiency of the system through the latest technology. The use of this approach is found to be accurate, eliminating human errors, operation time and work handling time

References

[1] Rao, J. S., Darpe, Ashish, K, John Jose and Bhatnagar Amit, Development of an On-Line Diagnostic System Software for a Turbogenerator Set, 8th ISROMAC, vol. II, p. 1156, March 27-30, 2000, Hawai
[2] Rao, J. S., Chawla, A., Darpe, A. K., Bharati, Kapil, Roy, D. A., Pithawa, C. K., Chandra , U and Rama Rao, A., Development of an Online Diagnostic System Software for Turbogenerator Set of Kakrapar Atomic Power Station, CP 021, VETOMAC-I, 25-27 October 2000, Bangalore, India
[3] Rao, J. S., Vibratory Condition Monitoring of Machines, Narosa Publication, 1999
[4] http://www.ni.com/white-paper/13654/en#h33.

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