An Intelligent Software Agent Machine Condition Monitoring System Using GPRS and Data Mining

R.Anandan
Assistant Professor[1]
[1] Department of Computer Science & Engineering
KarpagaVinayagaCollege of Engineering & Technology,
(Affiliated to Anna University, Chennai)
Madhuranthagam, Chennai – 603 308, India
ar_anandan@hotmail.com

Abstract

There is a tremendous development in machine condition monitoring, since the cost of machine is very high, it is a tedious process to maintain the mechanical machine in good working condition and the delay in production would provide a drastic situation for the manufacturer. In this study a new condition monitoring tool is designed in such a way that it takes full control over the machine using Artificial Intelligence and GPRS.

In present context the study is focused to the bearings in a mechanical machine, since the major faults are mainly due to the bearings in the machine.

An Intelligent fault monitoring software is build using JADE framework and the fault diagnosis report is maintained by GPRS connectivity.

Once these treacherous faults arise the machine will be stopped and the message will be sent to the end user.

Keywords: Java Agent Development Framework (JADE), GPRS Connectivity, Machine Condition Monitoring.

Introduction

Condition monitoring of machinery has increased in importance as more engineering processes are automated and the manpower required to operate and oversee plants is abridged. The monitoring of the condition of machinery can considerably decrease the cost of maintenance. Firstly, it can allow premature detection of potential cataclysmic fault, which could be particularly expensive to repair. Secondly, it allows the execution of conditions based maintenance rather than cyclic or failure based repairs. In these cases, significant savings can be made by delaying program maintenance until convenient or necessary period of time. Although there are many efficient methods for modeling of mechanical systems, they all suffer the hindrance that they are only valid for a specific machine. Changes within the blueprint or the operational mode of the machine normally require a manual acclimatization. Using artificial intelligence to model technical systems eliminates this major disadvantage.

The use of condition monitoring has been shown for a variety of applications [1][2].

The root causes of electrical machines failures commence the failure sequence and are noticeable by condition monitoring if the corrupting process is slow. Such root causes are [4]:

Defective design or manufacture, improper ambient conditions, overload, over-speed, fatigue, excessive vibration.

The catastrophe modes achieve the degrading process started by the root causes. Such failure modes are: core insulation failure, stator winding failure, bearing failure, rotor and stator mechanical integrity failure.

An effective condition monitoring approach must concentrate on root causes and failure modes that show a slow failure cycle. For rotating electrical machines, the primary root causes for failures are bearing related, followed closely by winding and rotor related causes [5].

Materials and Methods

In this present study the condition monitoring is focused towards bearing in the machine. A ferro electric sensor is placed in the rear side of the bearing and their conditions are monitored using multi agent software in a JADE framework and the output is determined. Sixty Eight such instances are observed in this present work and the result is statistically computed using Normal Distribution and the graph is plotted and the occurrence of fault is determined. If the bearing is found defective a Short Messaging Service (SMS) is sent to the in charge concerned through a GPRS procedure.

JADE Implementation:

Java Agent Development Framework (JADE) is a software framework that enables the development of agent applications in compliance with the FIPA (Foundation for Intelligent Physical Agents) specifications for interoperable intelligent multi-agent systems. The JADE agent platform tries to keep the high execution of a distributed agent system implemented with the Java language. It is also a middleware for developing distributed applications through leveraging state-of-the-art distributed object technology embedded within the Java runtime environment. Therefore, the goal of JADE is to simplify the development while ensuring standard compliance through a comprehensive set of system services and agents. JADE uses an agent model that allows high runtime efficiency, software reuse, agent mobility, and the realization of different agent architectures [6][7]

The advantage of JADE includes the

- Support for mobile devices
- Graphical runtime environment
- FIPA compliant
- Strong development team
- Open source
- Ontologies
- Predefined interaction protocols as specified by FIPA
- New interaction protocols can be easily introduced

To enhance the capability and use of mobile device by open source, this work is developed using JADE

GPRS Procedure:

GPRS (General Packet Radio Service) is a new bearer service for GSM that greatly improves and simplifies wireless access to packet data networks. It applies packet radio principle to transfer user data packets in and efficient way. It transfers the data packets at the rate of 14.4 to 115.2kbps.

GPRS is a best-effort service, implying variable throughput and latency that depend on the number of other users sharing the service concurrently, as opposed to circuit switching, where a certain quality of service is guaranteed during the connection.

GPRS usage is typically charged based on volume of data transferred, contrasting with circuit switched data, which is usually billed per minute of connection time.

GPRS, which supports a wide range of bandwidths, is an efficient use of limited bandwidth and is particularly suited for sending and receiving small bursts of data, such as e-mail and Web browsing, as well as large volumes of data.

In our project, we are using GPRS it has been processed into monitoring level of our system values into the outer race velocity, inner race velocity, cage velocity, bearing peach diameter, role element diameter, contact angle, rpm frequency, and total friction values. In finally our total friction values are overhead our monitoring system has proposed into sending the mail to corresponding authority person.

In addition we fix the GPRS device into the system monitoring services. Perhaps any unexpected values are arise to our system it will processing into the e-mail sending and stop the functionality of our running system through our GPRS command. The figure1 below illustrates some of the GPRS services for the effective communication.

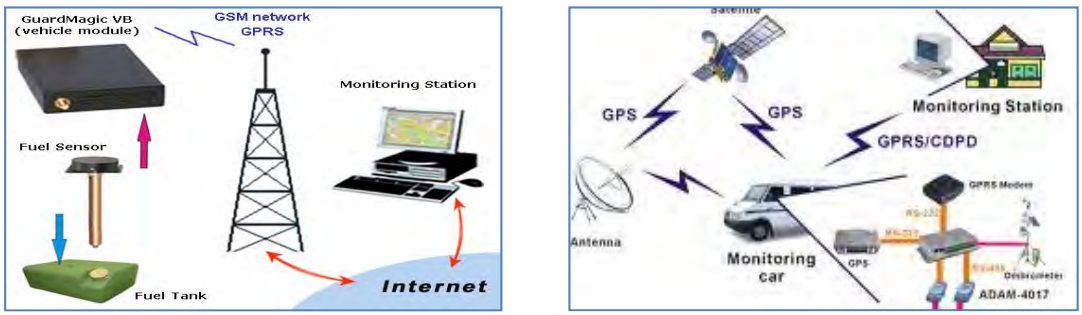

Figure 1: GPRS Services

In this present study a software module is designed using JADE and multi agent software is built, it controls the fault diagnosis of the bearing inside the machine.

The Outer Race Velocity, Inner Race Velocity, Cage Velocity, Bearing Peach Diameter, Role Element Diameter, Contact Angle, Rpm Frequency, Total Friction Values of the bearing is calculated.

The calculated value is compared with the optimal value of the bearing obtained from the manufacturer.

Here the fault tolerance is mainly obtained from the frictional value. If the frictional value exceeds 10000 rpm the machine is stopped with its operation.

The figure 2 below shows the input screen through which the input values of the bearing is fed to the multi agent framework.

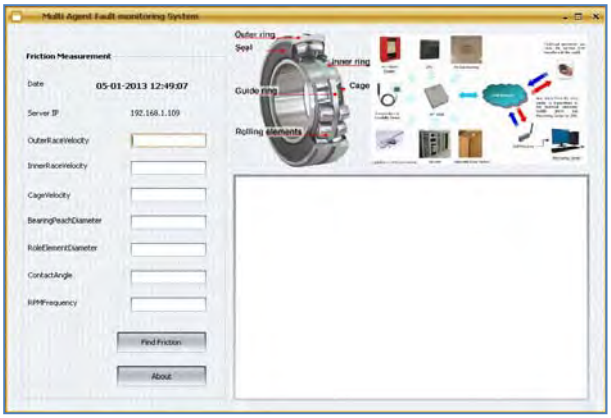

Figure 2: Input Screen showing the bearing values to be entered

The figure 3 shows the value obtained from the defective bearing.

Figure 3:Values with Defective bearing

Once the values are found to be defective immediately the mail Id of the dealer is fed in to the machine the prompt window is shown in figure 4, then the prompt for password is asked to enable that it is the responsible user as shown in figure 5.

Figure 4: Prompt for Mail of the dealer

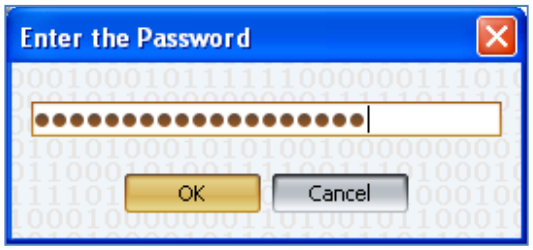

Figure 5: Prompt for password

As soon as the Email Id is fed in to the machine immediately the alert message is send to the end user as shown in figure 6

Figure 6: Alert Message

Once the message is delivered the delivery report is given to the user as shown in figure 7

Figure 7: Mail Delivery Report

The condition of the defective bearing is shown in the output screen as in figure 8

Figure 8: Output Screen showing the result

After getting the result as the bearing is defective immediately the multi agent software gives the request to stop the machine as shown in figure 9 and the machine is stopped and the bearing is replaced form the existing defective bearing.

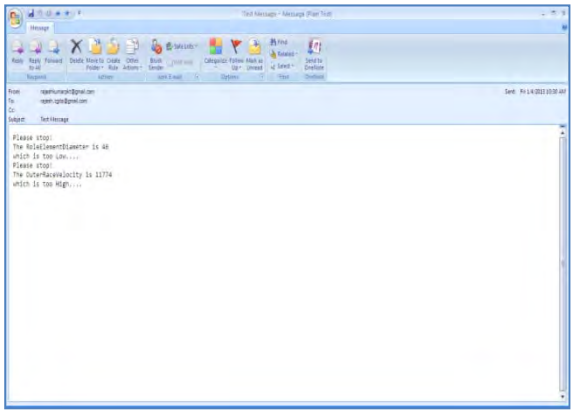

Figure 9: Machine is stopped as per request

Result and Discussion

The Outer Race Velocity, Inner Race Velocity, Cage Velocity, Bearing Peach Diameter, Role Element Diameter, Contact Angle, Rpm Frequency, Total Friction Values of the bearing is calculated. These are considered as input parameters.

During rapid running condition there may be wear and tear in bearing, these instance are repeatedly calculated. In the present research 68 such instances are observed and as such in figure 10 the minimum and maximum values of each input parameters are observed and their successive mean and standard deviation are calculated by the formula stated in table1.

Table 1: Feature determined for Norma Distribution

S.No	Name	Description	Statistic
1	Mean	The "mean" is the "average" you're used to, where you add up all the numbers and then divide by the number of numbers.	$\overline{X} = \frac{\sum_{i=1}^{n} X_i}{n}$
2	Standard Deviation	The Standard Deviation is a measure of how spread out numbers are.	$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2}$
3	Normal Distribution	A standard normal distribution is a normal distribution with mean 0 and standard deviation 1.	$z = \frac{X - \mu}{\sigma}$

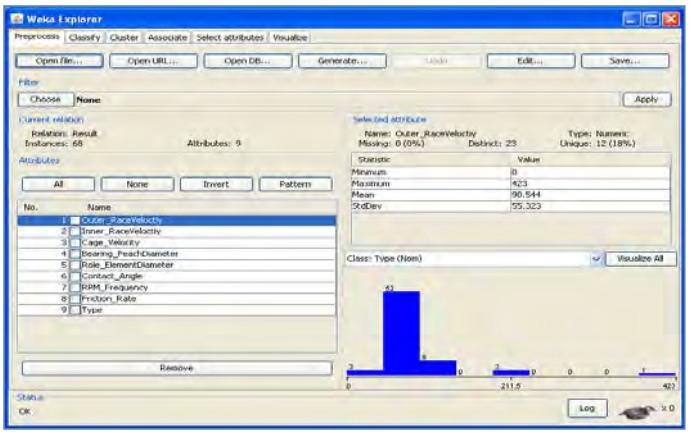

Figure 10: Resultant Screen Showing the Outer Race Velocity with Minimum, Maximum, Mean and Standard Deviation

The Figure10 shows the calculation of Outer race velocity and it is checked with the Normal Probability Distribution condition. If the value matches with the current value and a normal wave is plotted in graph, then the bearing is said to be in normal condition. The resultant figure 11 shows the bearing with normal and working condition.

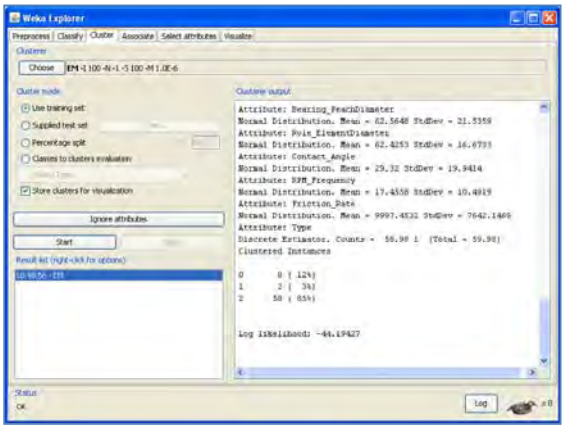

Figure 11: Resultant screen showing Normal Distribution for the bearing with various analysis parameters

Suppose if there is a deviation from the normal curve then the values are predicted to be fault and the intimation given to the service provider for immediate replacement

ACKNOWLEDGEMENTS

The author is grateful to the Management, Advisor, Principal and Dean of Karpaga Vinayaga College of Engineering and Technology, Chennai – 603 308, Tamilnadu, India for their encouragements.

CONCLUSION

In this present study, it found that technique adopted is much more effective than the other condition monitoring tools. The main advantage is once the fault is diagnosed the machine is said to shut down state and the message is successively send to the supervisor of the company.

The machine is monitored for 24 hours and the maintenance cost is considerably reduced. The further course of study can be focused to all the defective parts of the machine.

REFERENCES

[1] Dimeas and N. Hatziargyriou. A multi-agent system for microgrids. Methods and Applications of Artificial Intelligence, pages 447{455, 2004.

[2] Wilson Wang, “An Intelligent System for Machinery Condition Monitoring”, IEEE TRANSACTIONS ON FUZZY SYSTEMS, VOL. 16, NO. 1, FEBRUARY 2008

[3] Ian H. Witten; Eibe Frank, Mark A. Hall (2011). "Data Mining: Practical machine learning tools and techniques, 3rd Edition". Morgan Kaufmann, San Francisco. Retrieved 2011-01-19.

[4] Tavner, P., Lan, R., Penman, J., et al.: Condition Monitoring of Rotating Electrical Machines. London. Institution of Engineering Technology, 2008.

[5] *** IEEE Gold Book: Recommended Practice for Design of Reliable Industrial and Commercial Power Systems. NewYork. IEEE Press, 2007, p. 264-277

[6] Fabio Bellifemine, Agostino Poggi, Giovanni Rimassa , Developing multi-agent systems with a FIPA-compliant agent framework Software Practice and Experience (2001), Volume: 31, Issue: 2, Publisher: Springer, Pages: 103-128

[7] Koen V. Hindriks, Frank S. de Boer, Wiebe van der Hoek, John-Jules Ch. Meyer, Agent Programming with Declarative Goals, ATAL '00 Proceedings of the 7th International Workshop on Intelligent Agents VII. Agent Theories Architectures and Languages, Pages 228 – 243,Springer-Verlag London, UK ©2001 ISBN:3-540-42422-9