FAULT DETECTION BY VIBRATION ANALYSIS OF MACHINE

Rahul Acharya[1], Aniket Jaiswal[2], Rituanjay Singh Rathore[3], Ranu Katakwar[4]

[1,2,3,4] Student, Dept. of Electrical Engineering, Shri Shankaracharya Technical Campus,

Bhilai, Chhattisgarh, India.

Abstract - Machine uptime may be increased in industrial applications by using equipment monitoring. This reduces the likelihood of unexpected failures and subsequent plant outages. Because all failure scenarios may increase machine vibrations, monitoring this region is the most common and commonly utilized way for determining equipment status and predicting failures.

The goal of this research is to use vibration analysis to detect flaws in rotating machinery. An AC motor drive controls the operational speed of the motor in a motor condition monitoring experiment. The motor's vibration is detected and monitored. Spectrum analysis tools and a MATLAB programmed are used to evaluate the recorded vibration data. The entire vibration level is determined, and the vibration intensity is compared to the standard seriousness table to establish the motor's condition. The natural frequency correlates to the type of defect or failure scenario indicated. This data provides insight into the machine's condition.

Index Terms- Vibration analysis, Forecasting defects, Location of faults, electronic control system, Motor function and condition.

I. Introduction

Vibrations from motors contain crucial details about machine function and condition, allowing for the identification of potential system damage. An electronic control system that measures vibrations and current can predict defects, helping to conserve resources. Industrial instruments powered by electrical motors, such as compressors and CNC machines, have coupling components like shafts and bearings that deteriorate over time, causing increased vibration and decreased efficiency. Traditional maintenance procedures replace components on a set timetable, while reactive maintenance replaces components as needed. Predictive maintenance, using vibration analysis, can estimate the operational status of a machine and provide information on the state of components. Continual vibration analysis can be used to perform remedial action if a component fails, leading to more efficient fault prediction and 100% availability in critical applications.

1) Objectives

The use of electrical machines, particularly induction machines, has replaced human intervention in many industrial processes. However, these machines are susceptible to faults that can disrupt sustainability and result in human and financial costs. This paper presents an online system for the detection and diagnosis of electrical faults in induction machines using computer-aided monitoring of supply currents. Principal Component Analysis is used to extract and modify data obtained from supply currents to detect the presence of broken rotor bars and stator short-circuits in the induction motor. Vibration analysis, using an adequate vibration transducer such as MEMS accelerometers, can also be used to identify mechanical problems like mechanical looseness and misalignment in the motor shaft.

2) Problem Statement

The critical issue of reliable and efficient monitoring and detection of faults in electrical machines, particularly in induction motors. Ineffective maintenance practices that rely on reactive or preventive measures can result in significant downtime or unnecessary component replacements, leading to high financial and human costs. To tackle this issue, there is a growing need to adopt advanced techniques such as vibration analysis and computer-aided monitoring of supply currents for predictive maintenance. Furthermore, techniques like Principal Component Analysis and MEMS accelerometers can provide cost-effective and reliable solutions for the detection and diagnosis of faults in induction motors.

3) Proposed Solution

The proposed solution to the issue of reliable and efficient fault monitoring and detection in electrical machines, particularly in induction motors, is to adopt advanced techniques like vibration analysis and computer-aided monitoring of supply currents for predictive maintenance.

II. Literature survey

In heavy industries, maintenance strategies such as preventive and reactive maintenance are commonly used, where components are replaced on a fixed schedule or only after they have failed. However, these methods are not ideal as they often result in higher costs and lower system reliability. (1)

The focus of the present study is on the utilization of predictive maintenance as a means of monitoring the condition of machinery components in operation. Through the use of vibration analysis, predictive maintenance can provide real-time information on the status of these components, allowing for the early detection of faults and the implementation of timely repairs to prevent system failure. The ability to quickly identify and address component failures can improve system reliability, reduce downtime, and ultimately lead to significant cost savings for industrial operations. (2).

Vibration analysis is a powerful tool that enables fast and efficient identification of defects in machinery. It can lead to significant cost savings in industries by identifying potential problems before they cause disruptions in system performance. With the ability to detect faults at an early stage, corrective action can be taken to prevent further damage to the machinery, resulting in increased reliability and reduced maintenance costs. (3).

III. CIRCUIT DIAGRAM

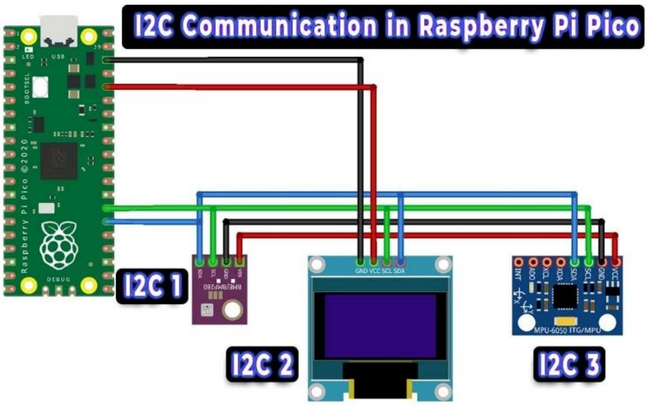

Figure 1: Circuit diagram

The induction motor or the industrial motors which needs frequent maintenance and due to some damages or faults can lead to generation of vibration which then are sensed by the vibrational sensors which are attached in the motors. This enables us to not only detect and inform but also fault. Beforehand knowledge of fault and analyze it which helps in dealing with same fault again and it gives the maintenance authorities enough time to take necessary steps.

IV. WORKING PRINCIPLE

The project consists of vibrational analysis involves analyzing the dynamic behavior of mechanical systems by studying how they respond to both internal and external forces. The process of vibrational analysis starts with creating a mathematical model of the system, which includes its mass, stiffness, and damping parameters. This model is then used to compute the system's natural frequencies and modes of vibration. These parameters can be derived through analytical methods such as finite element analysis or experimental testing.

During the operation of the mechanical system, vibration sensors are attached to various points on the system to measure the vibrations. The data collected by these sensors is then analyzed using signal processing techniques to extract information about the system's behavior, including its natural frequencies, damping ratios, and mode shapes. The data is then compared to the model to identify any discrepancies or abnormalities that may indicate a fault or defect.

V. MODE OF OPERATIONS

We now understand how the model works.

Firstly, when the power is turned ON, the LCD will display “X and Y “in screen which tells the number of vibrations along the axis as shown in Fig 4.1.

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 04 | April - 2023 Impact Factor: 8.176 ISSN: 2582-3930

Figure 4.1: Operation Begin

After this, also includes to calibrate the model. Fig 4.2. Along with this the LCD will also display the data and the LED will blink.

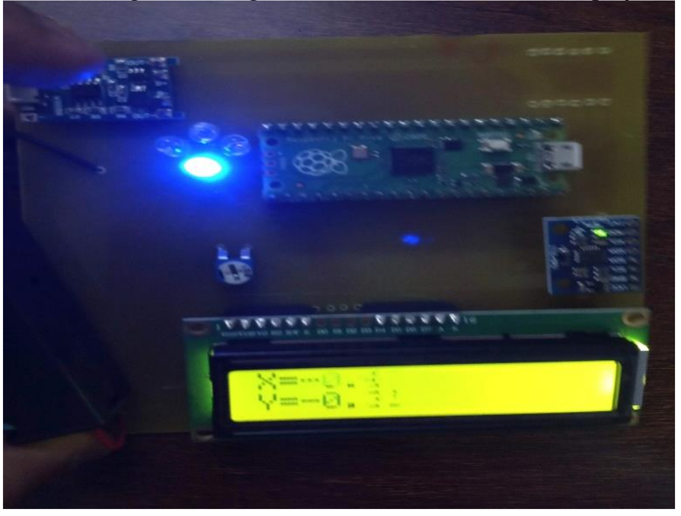

Figure 4.2: Calibrating

When there is no fault in the motor, the LCD will display as shown in Fig 4.3.

Figure 4.3: No fault in motor

Whenever there's a fault in the motor then the motor will vibrate which will result in blinking of LED and values of X and Y along the graph, as shown in Fig 4.4.

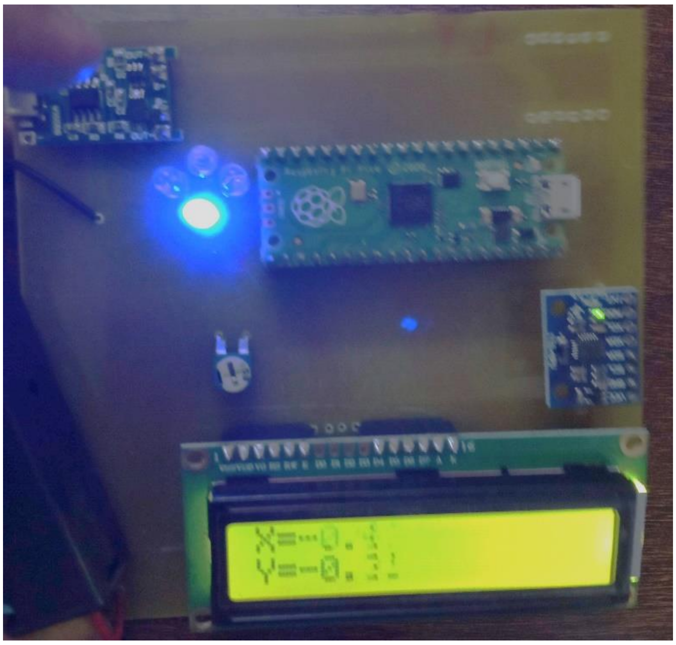

Figure 4.4: Current Leakage at line

At last, Fig4.5 presents the final results which will be obtained in the python Thonny software.

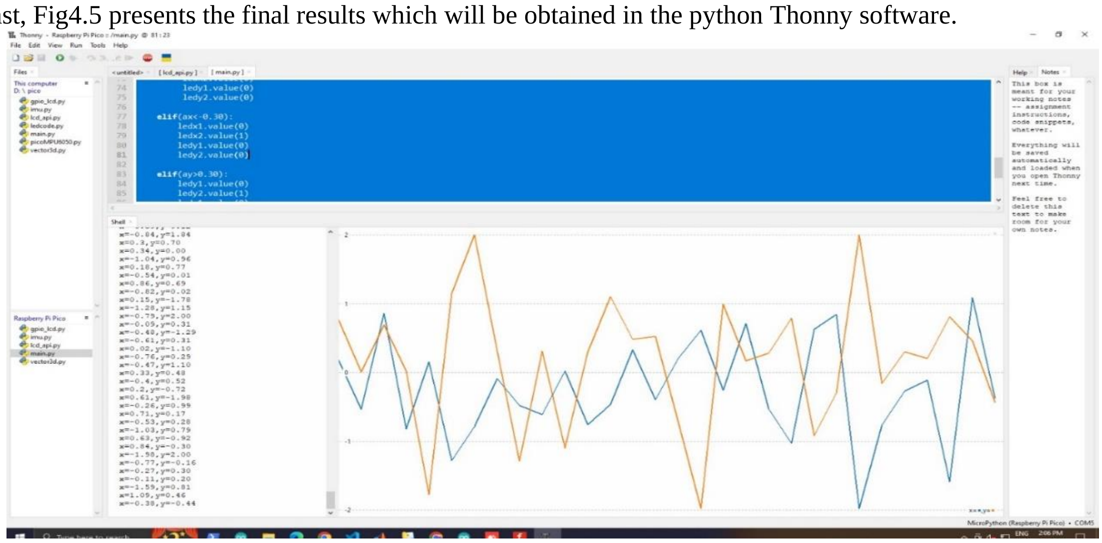

Figure 4.5: Final Result

VI. CONCLUSIONS

India is a developing country and the number of heavy industries is increasing day by day so vibrational analysis is a powerful tool for predicting and diagnosing faults in mechanical systems. By analyzing a system's vibration signature, engineers can detect abnormalities and perform timely maintenance, thereby increasing system reliability and minimizing downtime. Vibrational analysis finds common application in mechanical system design and optimization, especially in systems that are exposed to dynamic loads such as engines, turbines, and structures. It is also useful in predicting the remaining lifespan of machinery and diagnosing faults through the monitoring of their vibrational signatures. Overall, vibrational analysis is a valuable technique for improving system performance, reducing maintenance costs, and increasing safety in various industries.

VII. REFERENCES

1. M.M. Saied, "Optimal long line series compensation (HVAC transmission lines)" IEEE Trans. Power Delivery, Vol.PWRD-1, Issue 2, April 1986, pp. 248-253.

2. M.M. Begovic, and A.G. Phadke, "Control of voltage stability using sensitivity analysis", IEEE Trans. Power System, Vol. 7, Issue 1 , February 1992, pp. 114-123".

3. F. Jurado, and J.A. Rodriguez, "Optimal location of SVC based on system loadability and contingency analysis", Proc. 7th IEEE International Conference on Emerging Technologies and Factory Automation, Vol. 2, 1999, pp. 1193 -1199

4. Al-Badour, M. Sunar, L. Cheded, ―Vibration analysis of rotating machinery using time– frequency analysis and wavelet techniques‖, Mechanical Systems and Signal Processing 25(2011) 2083 –2101.

5. Chen Anyu, Jia Jide, Dai Xiliang, Zhu Zhongkui, ―Engine Fault Diagnosis Based on Wavelets packet and Neural Networks‖, 2010 International Conference on Optoelectronics and Image Processing

6. Xuxiao Fan, Changyou Xu, Zhijing Zhang, Xin Jin, ―Vibration Testing and Analysis Of a Reconfigurable Turn-milling Machine Tool‖, 2010 International Conference on Digital Manufacturing & Automation.

7. S. Gopinath, ―Study on Electric Motor Mass Unbalance Based On Vibration Monitoring Analysis Technique‖, 201O International Conference on Mechanical and Electrical Technology (ICMET 2010).

8.. Li, Baohe Yang, Zhian Wang, Xuhui Wang, ―Fault Pattern Classification of Turbinegenerator Set Based on Artificial Neural Network