MONITORING SYSTEMS DESIGN FOR EARLY DAMAGE DETECTION OF ELECTRIC MOTOR BASED COMPUTER

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Abstract

Damage to the electric motor can be detected at an early stage of temperature and vibration. temperature and electric motor abnormal vibration occurs due to the damage including damage to the bearing, load imbalance, misalignment, insulation failure in the motor windings and others.

This research aims to design of monitoring system for temperature and vibration analysis of electric motors based computer. This research can be used to help detect early occurrence of early damage to the electric motor that can lead to patterns of temperature and vibration and amplitude are likely to rise, so it can endorse the program of maintenance on the electric motor. The design consists of temperature and vibration sensors, sensor amplifier, data acquisition and computer programmed with Labview.

After testing it was found that the tool has been able to work as expected. Testing patterns of temperature and vibration motor disorders tended to be higher than the motor works normally. temperature and vibration motors higher the bias caused by the motor load is not balanced, there is damage to the winding or mechanical damage. In testing shows that the temperature and vibration monitoring will be detected if there are irregularities in the motor which will cause a rise in temperature and vibration. If the rise exceeded the limit that has been setup then the tool will turn on alarm lights

Keywords : early detection, damage, electric motor, monitoring system , computer

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1. INTRODUCTION

The electric motor is indispensable for industry and households, covering a lot of use of such use for propulsion, conveyors, pumps, compressors and others. Most users will hardly notice the motor on the causes of damage to the motor. Sometimes users do not know the causes of damage of the motor. Actual damage to the motor can be detected at an early stage of its temperature and vibration. Electric motor abnormal temperature and vibration that occurs due to the damage of which damage to the bearing, load imbalance, misalignment, insulation failure in the motor windings and others. Examples damage in Industrial Motor shown in Fig 1. Temperature rating of the insulation class Motor shown in Table 1. An electrician can detect the type and extent of damage to the electric motor temperature signal like a doctor detect disease patients by analyzing pulse/heart rate.

Fig 1. Examples damage Motor in the Industry

Table 1. Temperature rating of the insulation class Motor

Temperature rating of class isolation	
Insulation class	The maximum winding temperature (C)
A B* F* H	105° 130° 155° 180°
*The motors are commonly used in industry	

Early detection of damage to the motor by looking at the pattern of the motor temperature that occurs can support predictive maintenance program that is currently promoted by the industry.

Vibration categorized into sections such that a constant vibration when the indicated value of the measuring device is not changed or fluctuated only slightly as shown in Fig 2a.

Fig 2a. Constant vibration

Fig 2b. fluctuations vibration

Fig 2c. Fluctuations irregular vibration

Fig 2. Basic forms of fluctuation in vibration level over time

If the value indicated on the measuring device fluctuates periodically or only intermittently, then the average of the maximum values indicated in each fluctuation was taken called vibration fluctuations (Fig 2b). Fluctuations irregular vibration which is if the indicated value of the measuring device fluctuates irregularly recorded as much as the same amount of time at the same interval as in Fig 2c.

2. RESEARCH PURPOSES

This research aimed to determine and study the effect of temperature and vibration as a result of damage to the motor. The temperature and vibration were in response to an electrical or mechanical system either caused by a given excitation force and change in operating conditions as a function of time. Comparative analysis of the motor temperature in good condition (normal) and the defects in components made in stages such that it can be determined the type and extent of damage the motor. This study is also intended to acquire a new alternative monitoring systems engineering and analysis of temperature and vibration of electric motor that uses a computer base with good performance but at a cheaper cost and materials available in the Indonesian market. In addition, to reduce the dependence factor of temperature and vibration monitoring devices that tend to come from imports are expensive and hard to come by. In addition to mastery of computer application technology on temperature monitoring systems as well as to develop local human resources creative and productive. From the results of future research is the product of technology that can be developed and marketed with the cooperation of electronics and computer companies in the country.

3. RESEARCH METHODS

The study begins with collecting data monitoring and analysis system temperature electric motor. The data collected is used to design the system (hardware) and software of the temperature monitoring tool. Execution design and manufacture is done step by step in order to obtain maximum results. Methods of system design tool begins by creating a separate temperature monitoring devices of the computer system, having obtained maximum results are then combined into a system that will be used. The use of computers as a tool used to facilitate display the results of the motor temperature, the analysis of the results and working system.

Equipment monitoring and analysis system temperature and vibration electric motors planned to consist of several series including the temperature sensor, vibration sensor, sensor amplifier, data acquisition, computer with Labview program, ADC (Analog to Digital Converter), Alarm and indicator lights. Fig 3 shows a block diagram of monitoring tools and analysis Computer-based electric motor temperature and vibration. Monitoring system include program plan that will be used in the monitoring system and electric motor temperature analysis is based computer. The programs include system selection on the menu display, reading of 3 units of motor temperature sensor consists of a temperature sensor A, B and C and 3 units vibration sensor. The temperature and Vibration readings from the sensors can be displayed in real time and used for data analysis.

If the temperature showed abnormal in one or both sensors, the computer will activate an alarm and indicator lights. Besides being able to display the data temperature can also be filmed in

a data base that will be used for purposes of data analysis for daily, weekly or monthly.

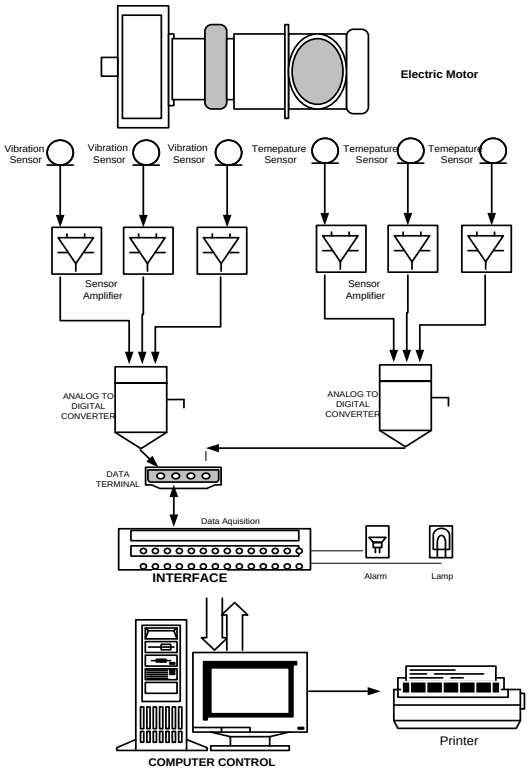

Fig.3. Block diagram of temperature and vibration monitoring and analysis of electric motor based Computer

4. RESEARCH RESULT

After performing the manufacture of tool monitoring system, then the next to test each piece and having achieved a good result overall testing continued. Testing includes testing of temperature sensors, vibration sensors, sensor amplifier circuit, and temperature monitoring systems interfacing with the computer.

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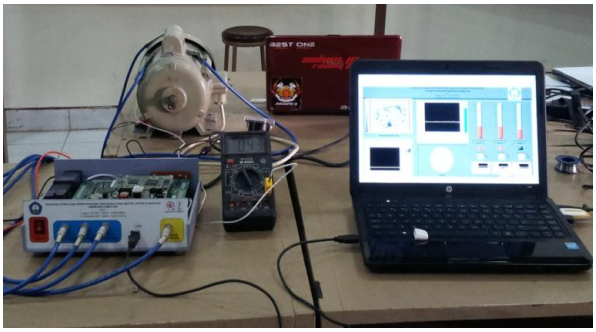

Fig 4. Hardware on early detection of damage the electric motor based computer

Testing the temperature sensor and the amplifier is intended to determine the characteristics of the sensor. Testing is done by connecting the sensor to the sensor input to the output amplifier incorporated into data acquisition and then read on a computer. Hardware, Display and Labview Program on early detection of damage the electric motor based computer shown on Fig 4. Fig 5. and Fig 6.

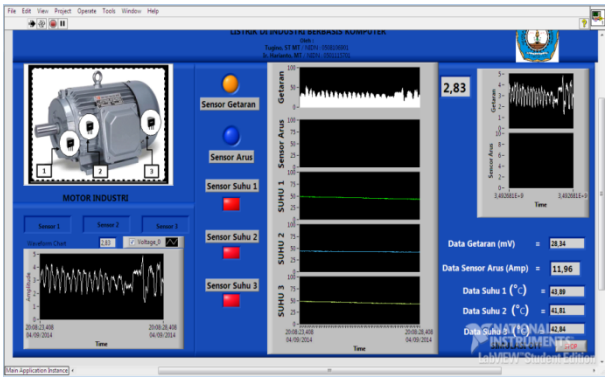

Fig 5. Display program on early detection of damage the electric motor based computer

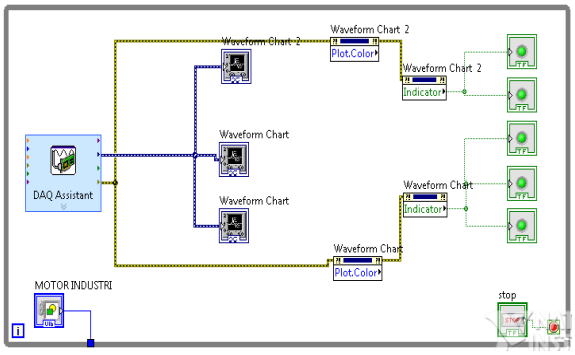

Fig 6. Labview program on early detection of damage the electric motor based computer

Implementation of this temperature sensor testing performed by placing temperature sensors on the body and stick to put in the gap/empty space on the electric motor. There are three temperature sensors are laying the temperature sensor placed on the parts most likely to effect the heat when the motor impaired. The laying of the sensor as shown in the Fig 7. Before the first tested on a motor sensor is tested on the heat source with solder. The heat source is raised then read sensor by measuring the output voltage. Results indicate that if the heat source is increased and sensor approach, the output voltage will rise as well. Fig 8. shows the results of an experiment that used LM35 temperature sensor comparison between the temperature of the input to the output voltage.

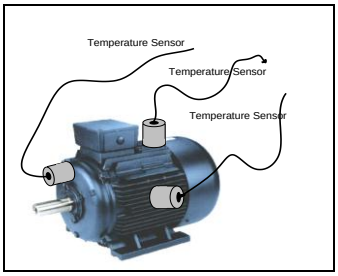

Fig 7. Laying the temperature sensor on the electric motor

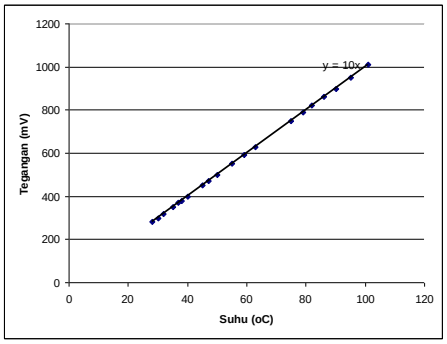

Fig 8. Results of an experiment of LM35 temperature sensor

The test result of LM35 temperature sensor shows that the ratio of the sensor input and output of the sensor showed a linear tendency. It is very important to know the performance of the LM35 temperature sensor.

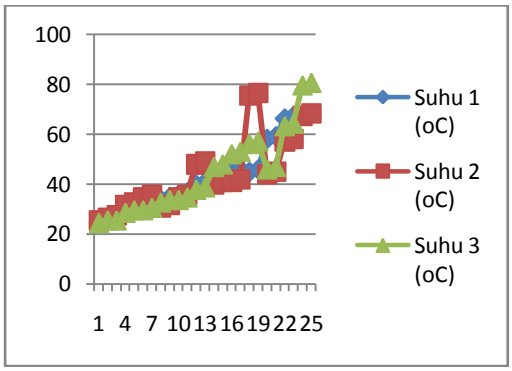

Fig 9. Measurement of the motor temperature sensor Composite 1, 2 and 3

From the experimental results can be seen that each sensor temperature sensor either 1, 2 and 3 have been able to work well. At any increase in the motor temperature sensor, the sensor can respond to this demand with a computer program showed on the display. The red color on the display indicates that the program has reached a temperature above the temperature that has been the setting.

In the program has been made that if the temperature reaches a specified level above the alarm light will change color on the display will light. This meant that there was a warning when the temperature reaches a high. Limit alarm indicating a high temperature can be set back by changing the program.

The next test is a test program to see the results of the temperature monitoring system and analysis of the compressor motor. Temperature sensor placement system on the compressor shown in Fig 10. and the results of temperature sensor readings on the motor with the motor compressor testing on the good and bad are shown in Table 2

Fig 10. Experiment Measurement of the temperature in the Compressor Motor

Table 2. Temperature sensor readings on the motor with the motor compressor testing on the good and bad Condition

Temp 1 (°C)	Temp 2 (°C)	Temp 3 (°C)	Test time (minutes)	Notification
58.67	57.72	40.53	10	bad motor condition
42.16	54.17	41.50	10	good motor condition

In the program has been made that if the temperature reaches a specified level above the alarm light will change color on the display will light. This meant that there was a warning when the temperature reaches a high. Limit alarm indicating a high temperature can be set back by changing the program. Experiments on the compressor motor is detected that the temperature conditions in the motor that has a bad condition tend to be patterned rose or higher than the motor with Good condition.

The next test was to test the tool results in electric motors of vibration monitoring systems and computer-based.

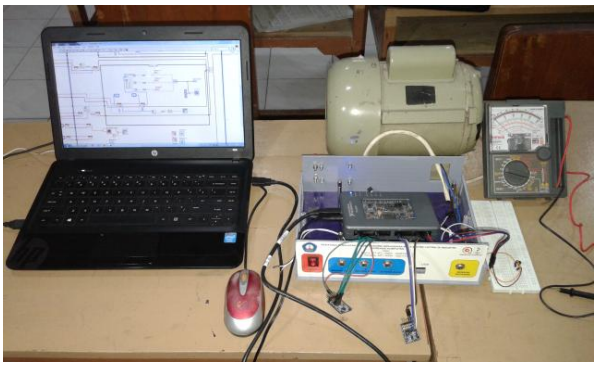

Fig 11. Testing of vibration sensors on the electric motor

Programs are created using Labview programming language. Photos how to test the vibration sensor on the electric motor and the display program shown in Fig 11 and Views vibration monitoring system program with Labview software shown in Fig 12.

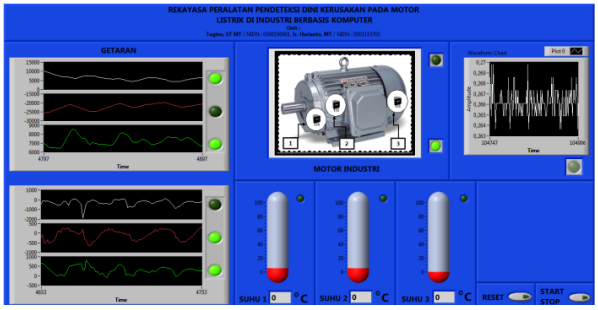

Fig 12. Views vibration monitoring system program with Labview software

Until the time of writing this paper the research is still ongoing. Research lasted for 2 years. The first year focuses on the temperature sensor and the second year focuses on the vibration sensor. the testing of vibration sensors is still in the testing phase for each sensor to obtain the performance of the vibration sensor

5. CONCLUSION

1. After doing the design, manufacture and testing of the electric motor temperature and vibration monitoring based computer then obtained that the tool has been able to work as expected.
2. On testing shows that the temperature monitoring devices will be able to detect if there is any discrepancy in the motor which will cause a rise in temperature, if such increases exceed the limit that has been setup then the tool will turn on the alarm and blinker.
3. The results of this study can be used to help detect early occurrence of early damage to the electric motor which can cause the temperature pattern that tends to rise and unstable, so that it can endorse the program of maintenance on the electric motor.

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