PC 기반 전동기 고장 진단 시스템의 구현

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Implementation of PC based Motor Fault Diagnosis System

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Abstract - This study is for implementation of PC based Motor fault diagnosis system. By using harmonics and current signals of the motor, this system diagnoses the motor condition by accumulated harmonic contribution rate. In this proposed system that was composed of 5 parts. A sensor, connection box, evaluation board, device server, and main computer are those.

There were two types of sensor, one was harmonic sensor the other was current sensors. The signal was acquired by sensor, and transferred to evaluation board. Second one is connection box. Because the output type of sensor and input type of evaluation board is different, connection box was necessary. Third one was evaluation board. The signal from the sensor was converted to digital signal in evaluation board. And this signal was transferred to device server. Fourth one was device server. Device server transferred the data from evaluation board to main computer. And the last one was other parts controlled by main computer. In main computer, there were communication and diagnosis algorithms. The result was derived by main computer. In the result, there were 12 categories and 5 levels of motor conditions.

The proposed system had some advantages comparing with stand alone type commercial motor fault diagnosis system. The first, by using remote access it was easier to get the conditions of motor. The second, there was no need to handle the sensors when users measured the motor signals. By this property, no one was necessary at motor location site. The third, this system was less restricted by times and places than commercial stand alone type diagnosis system. Therefore users can operate this system only using the main computer. Once the sensors are installed at the motor, users doesn't need to move to check up the condition of motors. Moreover, if there is ethernet hub, many motors can be not only diagnosed at once but also decreased its cost.

1. Introduction

The research for harmonic has been doing for many years. There are many publications, broadcastings, articles about the harmonic too. So the interest of this has been increasing. Particularly it is proved that the harmonic is very harmful to electric devices. Therefore many people want to reduce or remove the harmonic of electric devices. But until now it is well known that it is almost impossible to remove the harmonics perfectly[1]-[6].

There is a commercial motor fault diagnosis system, KS-1000, that diagnoses motor conditions by analyzing harmonics. It is very epoch-making event, so we think it is valuable to study more about this system.

In KS-1000, There are one harmonic and two current sensors in this equipment. By using these sensors, one measures the harmonic and current signals. And by itself algorithm, analysis the measured data. The result of this equipment is divided 12 categories and 5 levels. Twelve categories are as follows:

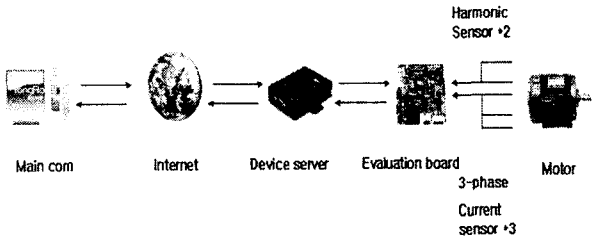
① Bearing, Axis, Foundation
② Winding Insulation
③ Damage of Axis, Housing
④ Airgap
⑤ Coupling, Axis Unbalance
⑥ Axis Damage, Dirt
⑦ Abnormal Rotation Axis, Valve wear
⑧ Damage of Gear Belt
⑨ Smoothing Condenser
⑩ Control PC Board
⑪ Power Element
⑫ Driver PC Board.

Each items in the categories can be evaluated 5 level conditions from A to C. The level A implies very good condition. Level B, from B1 to B3, implies normal conditions. The level C implies that it is needed to be repaired or replaced the part of motor. The precision rate of this equipment is over 90%. So the result of this equipment is very reliable. By Diagnosis the motor condition, it is very useful to prevent the motor fault and manage the motor operation.

2. PC based motor fault diagnosis system

2.1 Construction of proposed system

This system is consist of one computer, device server, evaluation board, and sensors.



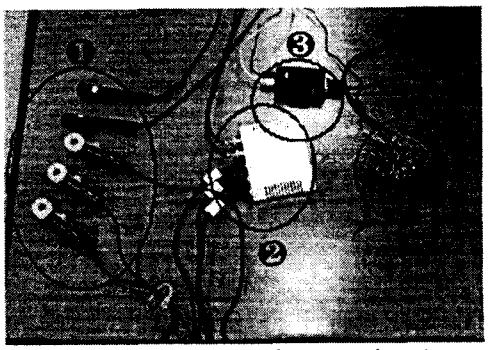
<Figure 1> Construction of proposed system

The first, there was one main computer which was connected to internet. In this computer, there were motor condition diagnosis and communication program which is based on TCP-IP protocol. This computer was operated by users and it controls the whole system.

The second, there was device server. The device server transfers the data from an evaluation board to the main computer. It is always turned on to transfer the data.

The third, there was an evaluation board. This evaluation board converts the analog signal to digital signal. And transfer the processed data to device server.

Finally, there are sensors. There are 2 harmonic sensors and 3 current sensors. These sensors acquire the signals from motor.

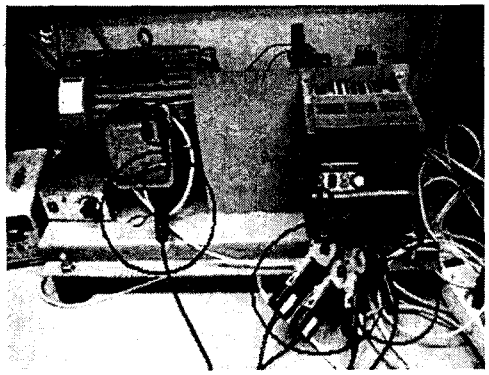


<Figure 2> Components of proposed system

Figure 2 shows that some components of the proposed system. The components and their specifications are as follows:

① Sensors: harmoic and current sensors
② Connection box: BNC type
③ Evaluation board: Analog Devices, ADUC832
④ Device server: SENA, LS100

Proposed system is really implemented as shown in Figure 2.



<Figure 3> Method of measuring signals

Figure 3 shows the method of measuring the signals from the motor[7]-[8].

① Harmonic sensor at load part

② Current sensors

③ Harmonic sensor at inverter part

2.2 Result comparison

< Table 1 Result comparison >

	Category	KS-1000	Proposed system
Harmonic	Bearing/Axis/ Foundation	B1	C
	Winding Insulation	A	A
	Damage of Axis/Housing	B1	B2
	Airgap	B1	B2
	Coupling/Axis Unbalance	A	A
	Axis Damage/Dirt	B1	B2
	Abnormal Rotaion Axis/ Valve wear	A	B1
	Damage of Gear/Belt	B2	B2
	Smoothing Condenser	A	A
	Control PC Board	B1	B3
	Power Element	B1	B1
	Driver PC Board	A	A
3-phase current	U	8.3A	7.5A
	V	8.0A	7.3A
	W	7.9A	8.1A
	Average	8.0A	7.6A
	Unbalance rate	5.06%	7.7%

2.3 Analysis of the result

There are some differences in results between two systems that are KS-1000 and proposed system. For example, in harmonic result, the condition for category of Bearing/Axis/Foundation was level B1 in KS-1000, but in this proposed system, that was level C. And the respect of current result, the phase U was 8.3[A] in KS-1000, but in the proposed system that was 7.5[A].

There are some causes which make two results differently.

The first, different resolution bits between KS-1000 and the proposed system. There was 10 resolution bits CPU in KS-1000, but resolution bits in the evaluation board was 12bits. The signal was quantized and binary encoded differently. The input data of two system were different, So there were some possibility to derive the different result.

The second, there was no gain controller in the proposed system. Therefore the signal was amplified by software in the proposed system. The signal from the sensor was very small. In case there was gain controller, the signal was able to be amplified.

Finally, there were different noise level between two systems. Because there was different amplification rate between two systems, noise was also differently amplified. For example, in the proposed system, very small signal would be ignored. But in KS-1000, there was gain controller, that signal was also amplified, so this was also the input of the KS-1000. Therefore there were different noise level in the two systems, the result would be effected by the noise.

3. Conclusion

This study is about implementation of motor fault diagnosis system. The proposed system consisted of five parts. Each part was sensor, connection box, evaluation board, device server and main computer. The sensors had a role that acquired the harmonic and current signals from the motor. The connection box had a role only connection between the sensors and the evaluation board. The evaluation board converted the signal, and transferred the processed data to the device server. The device server transferred the data from the evaluation board to the main computer. Communication of device server was based on TCP-IP protocol so the data transferred through the internet.

There were communication program and motor fault diagnosis algorithm in the main computer. The communication program had a role that communicated between the device server and the main computer. And using the motor fault diagnosis algorithm with harmonic and current signal from the motor, main computer derived the result as 12 categories and 5 levels.

We implemented a pc based motor fault diagnosis system. The proposed system can be utilized to monitor the condition of motors.

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