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Generator Damage Recognition Based on Artificial Neural Network

Chang-Hung Hsu, Chun-Yao Lee, Guan-Lin Liao, Yung-Tsan Jou, Jin-Maun Ho, Yu-Hua Hsieh and Yi-Xing Shen

***Abstract*—**This article simulates the wind generator set which has two fault bearing collar rail destruction and the gear box oil leak fault. The electric current signal which produced by the generator, We use Empirical Mode Decomposition (EMD) as well as Fast Fourier Transform (FFT) obtains the frequency range's signal figure and characteristic value. The last step is use a kind of Artificial Neural Network (ANN) classifies which determination fault signal's type and reason. The ANN purpose of the automatic identification wind generator set fault..

***Keywords*—**Wind-driven generator, Fast Fourier Transform, Neural network

I. Introduction

BECAUSE the recent years air pollution as well as the petroleum ran out and so on questions. The green energy's development has been imperative. In Taiwan the wind power had the development potential. But the wind-driven generator equipment haven a long time to put in area where the gale is in vogue. So the wind-driven generator internal and external parts are easy to fault as well as to have phenomena like acid rain corrosion. Because the wind-driven generator parts are numerous, we want to repairs that effectively and make its normal operation. That is must spend a long time. But this time lose the wind energy, will let electric power of forecast and the dispatch in the Electricity company flaw.

Has industry of machines and tools the electric motor structure to be very diverse. The majority electricity generation's methods, is after the electric motor rotation cuts the magnetic line of force. Has the electrical energy after the electromagnetic induction. In this article wind-driven generator equipment is one of them. Therefore if we can by capture generator's electric current signal discovers position of the machines and tools fault. We believed this article studies the method, may be suitable in includes electric motor's any machines and tools. So then may achieve the fast recognition machines and tools fault reason, as well as goal of repair fast.

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C.-H. Hsu is with the Division of Electrical Engineering, Fortune Electric Company Ltd. Tao-Yuan, Taiwan, 320, R.O.C. (E-mail: chshiu@fortune.com.tw).

C.-Y. Lee, G.-L. Liao, Y.-T. Jou, J.-M. Ho, Y.-H. Hsieh and Y.-X. Shen are with the Department of Electrical Engineering, Chung Yuan Christian University, Taoyuan County, Taiwan, 32023. (Phone: +886-3-265-4827; e-mail:CYL@cycu.edu.tw, james70378@gmail.com).

II. Oil leak and bearing fault simulation

A. Gear box oil leak fault simulation

The gear box is in the wind-driven generator system, uses for to control the rotational speed. It's very important machines and tools. So this article simulates the first fault type is gear box's oil leak fault. Finally will discuss around the gear box oil leak, capture whether the electric current signal can reflect this fault [1]- [8].

The first step must gauge electric current of signal the normal gear box revolution. After the gauging finished, the second step is release the oil screw from the gear box. Pursued the vessel accommodate oil, started to carry on the oil leak. The third step has installed the oil leak gear box the platform, starts to carry on the gear box oil leak signal examination, step as shown in Fig. 1.

What the first stage simulates is the external connection gear box's fault. But the second stage will simulate in the generator, big and small bearing's damage fault. By way of carries on the artificial damage directly to the generator internal components, hoped that may collect has the characteristic value electric current signal.

The experiment's beginning wants to use the motor to revolve high speed to the bearing. Creating the bearing tired then initiation fault, but the final bearing not yet the fault, the motor already first burnt out. Therefore the bearing destroys intrinsic wants to be more effective, and cannot damage its trundle the primitive function. Otherwise embarks the machines and tools

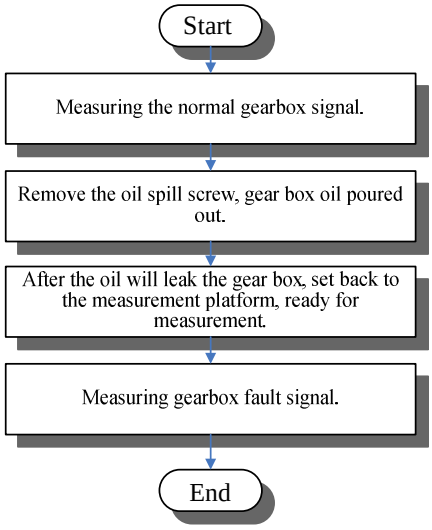

Fig. 1 Gear box oil leak fault gauging procedure

also to have the possibility the bearing function not to be incomplete, let the motor damage. Finally by way of the material collection, decided that carries on the Electrical Discharge machining (Electrical Discharge Machining, EDM) to the bearing.

B. Electrical Discharge Machining explanation

The Electrical Discharge Machining is the processing using the electrical energy transform to the heat energy. Lead to the processing work piece to melt rapidly one thermal property processing method. Carries on the electrical discharge machining, has the transition arc discharge phenomenon in the electrode and in the processing auxiliary pole tiny gap, produces the hot work to use. Because the processing discharges the function produces the electric discharge mark, carries on repeatedly then may process completes. Thus it may be known the electrical discharge machining with processing degree of hardness has nothing to do with. So long as is the material which may electrify may process.

III. Signal Gauging

Because the wind-driven generator actual test has many accidents changes, that will result the profile to produce the extra noise. The wind generator has the opportunity under high speed revolving to create the danger, therefore the power changes by the power gauge provides, and controls the rotation essential factor by the power gauge control panel. Various part link by way of the coupler.

First after power gauge control motor rotational speed, the generator starts to revolve the electricity generation. It's creating the electric current signal after the load box. Capture the electric current signal which using the signal pick-up produces and transmits to the computer. By the Lab View program to store up and to divide the input the electric current signal. Finally then may obtain we test with the primitive signal, flow as shown in Fig. 2.

IV. The Characteristic Value Capture

A. Empirical Mode Decomposition tenable condition

In order to satisfy the signal (narrow band) as well as the instantaneous frequency asymmetrical will not have the nonessential vibration for the narrow bandwidth because of the profile. Because and the majority examination signals all are the misalignment signal. If therefore obtains the intrinsic modality function, needs to meet the following condition:

1. In the date, the local maximum and the local minimum as well as zero cross spot number wants equal or differs most much.
2. No matter what in lights the envelope curve with under envelope curve the mean value is zero for a while.
3. The signal must have a maximum value and a minimum value at least.
4. Two extreme value's time differences are the partial characteristic time criteria.

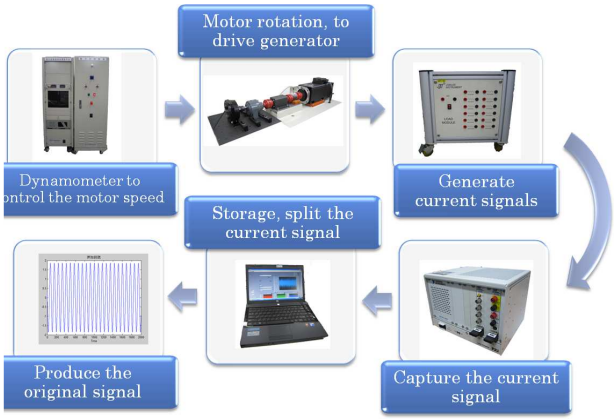

Fig. 2 Signal measurement process

5. If the signal does not have the extreme value only then the counter-point, may do the signal the differential, finally obtains the result again by integral.

B. Intrinsic Mode Functions stop condition

Because must remove excessively many or few the similar intrinsic modality function. Therefore cannot let an intrinsic modality function unlimited straight production, must set up the stop the standard. The stop condition sets up way, in these five methods. This article uses the standard deviation (SD) takes the stop criterion, but limits based on model SD size standard. When SD getting smaller, finally the size is smaller than 0.3, then stops having the intrinsic modality function, as shown in Fig. 3 and computing process, as shown in Fig. 4.

C. Introduction of Fast Fourier Transform

Fast Fourier transforms, to be Discrete Fourier Transform fast calculating method, may also use in calculating is separated the re transition. Generally speaking, is separated the time order of complexity which Fourier transforms is O(n^2), transforms only needs O (n log n) the time order of complexity after fast Fourier, then may calculate the same answer.

D. Fast Fourier transforms calculating method

Fast Fourier transforms has many different type calculating methods: As well as many kinds of calculation ways, but majority common spots for carry on the operation using the value periodicity as well as the symmetry. Therefore same cycle as well as symmetrical value abbreviation, but reduces the time which largely Fourier operates.

V. Artificial Neural Network

A. Artificial neural network structure

In order to simulate the biological neural network, the kind of artificial neural network altogether has three levels. These three level's relative relations.

B. Type of Artificial neural network

This article uses the Supervised Learning Network but actually, belongs to a surveillance type study network's link. We will provide the input layer and the output layer material, but between the question and the answer relates linking, hands over by the kind of neural network trains voluntarily obtains, finally we will test the data substitution which uses already to train in

again the good kind of neural network, may know its accurate value as well as the classified result.

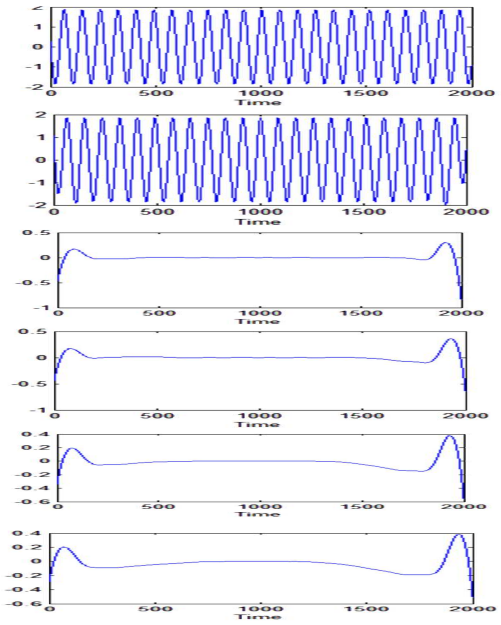

Fig. 3 Intrinsic mode functions graph

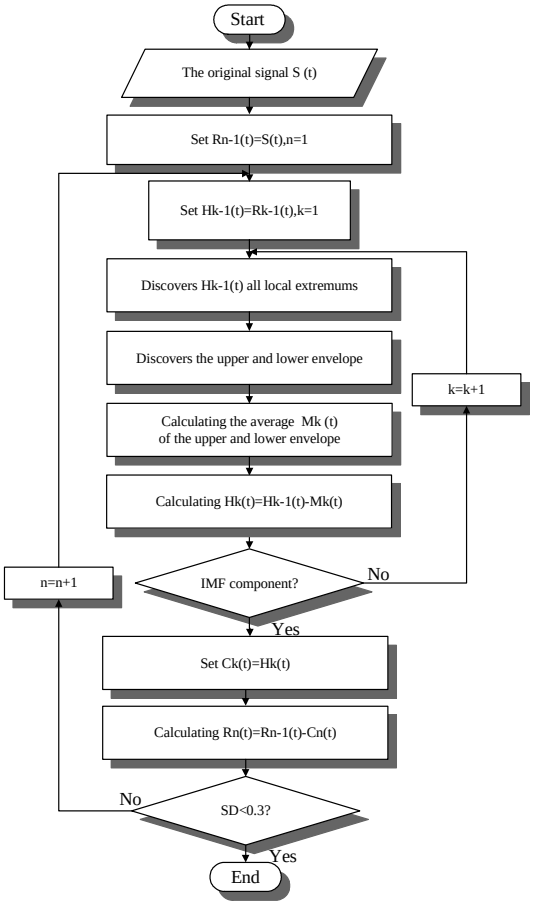

Fig. 4. Empirical mode decomposition operation flow

C. Artificial neural network training

Artificial neural network's training number of times is not more better, if the study number of times are excessively many, will have the unnecessary study miscellaneous news, will create the training excessive phenomenon, the accuracy will instead reduce. But if the training insufficiency will cause each level to link the development not to be mature, will be unable to achieve the good forecast effect. Therefore the training number of times should be suitable well, avoids the phenomenon occurrence which trains excessively.

VI. Wind Generator Set Signal Identification

A. Signal collection

To identify the wind-driven generator signal, must first collect the ration the first signal, but this article applies the fourth chapter of institute to state the method, has collected 50 compared to the normal electric current signal, as well as 50 oil leak fault electric current signal.

B. Obtains the Intrinsic Mode Functions

By empirical mode decomposition(EMD), the collection existence information intrinsic mode functions(IMF). The first primitive signal collects after the wind generator, draws about envelope curve which decided after the biggest minimum value, may obtain the average envelope curve after the computation. Repeatedly carries on the above movement, and obtains the intrinsic modality function, as shown in Fig. 5, when finally obtains when intrinsic modality function standard deviation (SD) is smaller than 0.3, then may stop the movement.

C. Fast Fourier transforms

If only have Intrinsic Mode Functions, is unable to provide the accurate characteristic value to carry on the identification, therefore under a step will carry on fast Fourier to the intrinsic modality function to transform, from the signal frequency range composition, capture the characteristic value which we need. After extracting under the normal state the characteristic value, with the same way, under the collection oil leak condition's characteristic value, carries on again finally two characteristic values the comparison as shown in Fig. 6.

D. Data standardization

Although may see from the frequency range composition normally with the fault difference, but if carries on the automatic determination with the kind of nerve network. The graph-like material is unable with the kind of nerve network to carry on the analysis. Must therefore the characteristic value which obtains, by the data way output, can let a kind of nerve carry on the classification. Therefore to obtain the data carries on the standardization. After the standardization, transforms the data mode the frequency range chart to indicate that its rule for first three behavior characteristic value data information, but fourth behavior characteristic value type label. When the label is 1, indicates this data for the normal use time characteristic value. If the label is 2, indicates this data for the oil leak condition under

characteristic value. After data standardization, we then may start to carry on a kind of nerve the classification.

E. Artificial neural network classification

After data standardization, this article uses the

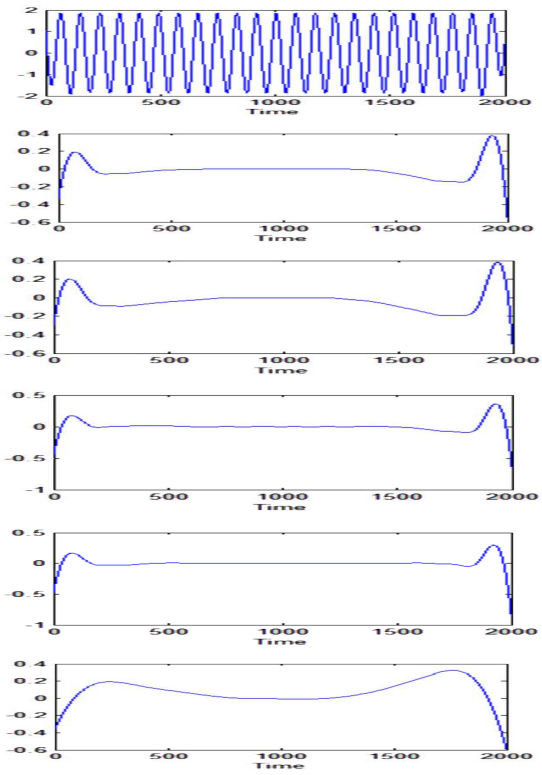

Fig. 5 IMF generate schematic drawing

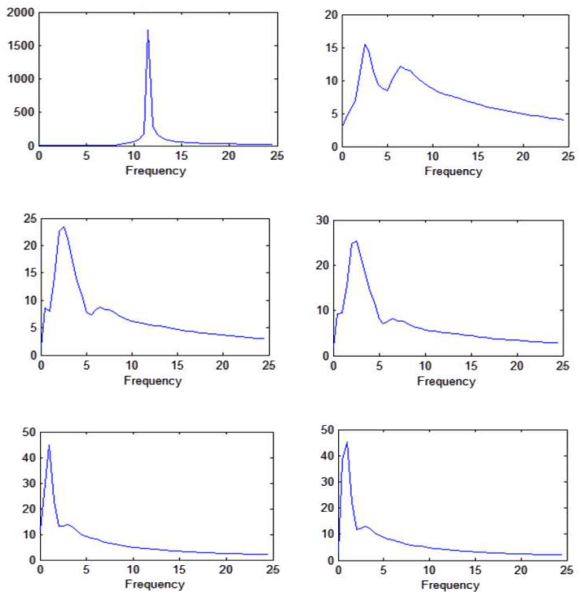

Fig. 6 Current characteristics of Oil leak value

Back-Propagation Neural Network carries on the classification and the identification but actually. After data substitution, might obtain the identification result. The data substitution's way is, each 50 data, the division is 10 makes the training, other 40 make the test. Finally obtains the normal 40 data for writers to foresee accurately, 40 are recognizes successfully completely. But the oil leak 40 data for writers foresee accurately, some 38 recognize successfully, some 2 identification defeat. But training of curve of error.

F. Identification flow and success ratio

In addition using above analysis and the classified way, the primitive signal which capture may recognize crash the type, as well as figures out the identification rate. Three kind of signal each 50, middle do take 10 as the unit to test the material, then carries on intersects compared to rightly, other 40 to train the material, the identification result and identification rate.

VII. Conclusion

The wind generator set, the bearing collar and the rail destruction and the gear box oil leak fault were simulated in this article. We used empirical mode decomposition (EMD) as well as fast Fourier transform (FFT) to obtain the frequency range the signal figure and capture the characteristic value by using the electric current signal. We realize that the artificial neural network (ANN) can classify the fault signal's type precisely and serves purpose of the automatic identification wind generator set fault through the work of this article.

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