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**APPLICATION OF ACOUSTIC SIGNAL FOR COMPARISON OF
FAULT OF MISALIGNMENT WITH NO DEFECT BEARING**

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Abstract: Condition of misalignment in the bearing has a great impact on speed transmission. Defects in the bearing may lead to decrease in transmission efficiency, jerk, noise. We have implemented methods based on acoustics to identify bearing defects due to missing ball. The proper methodology is selected for this experimental work. The analyses are done on bearing under varying speeds at different conditions. The bearing with 8 balls surrounded by the bush is attached to the motor shaft. A mike is used to record the acoustic signals generated by the bearing assembly. The acoustic signals generated by the bearings are recorded by placing the mike in front of the rotating bearing. In this project we are analyzing the effect of misalignment of bearing on the spectrum of acoustic signals and developed a method to identify such defects.

Keywords: Bearing; Condition monitoring; fft; acoustic signal; frequency;

I. INTRODUCTION

The rolling element bearing is the most important part of any rotating machine. Bearing fault detection is a typical problem in rotating machinery. Several statistical method and classical spectral analysis have been applied for bearing condition monitoring. Vibration monitoring is the most widely used method for bearing diagnosis where signal are normally processed in time or frequency domains. Noise and vibration signal from machine can contain vital information about the internal process and can provide valuable information about a machine running condition. Noise signal are measured in a reason proximity to the external surface of the machine while vibration signals are measured on the surface of the machine. Most noise and vibration analysis instruments utilize a Fast Fourier Transform (FFT) which is a special case of the generalized Discrete Fourier Transform. It converts the vibration signal from time domain representation to its equivalent frequency domain representation. This frequency domain representation of the time history is called frequency spectra. When a machine is in good condition their noise and vibration frequency spectra will have some characteristic shape. As fault begin to develop the spectra start to change. In contrast to vibration signal acoustic signals from a machine can be measured at a distance sufficiently from a vibrating machine surface with help of microphones. This allow the acoustics signal to be measured for machines working at a condition(extreme temperature and humidity) which is not suitable for vibration measuring sensors, like proximity transducers or accelerometers. Results suggested that vibration analysis by acoustic signals are very effective for the early detection of faults and may provide a powerful tool to indicate the various types of progressing faults in bearing and in predictive maintenance.

II. FAULT DIAGNOSIS OBJECTIVES

In our work we shall develop a technique to diagnose the faults in rotating components (such as bearings) of machine. An experimental setup is being developed to acquire the acoustic signal of rotating components. Different types of faults will be introduced in rotating components. Acoustic signal corresponding to the fault will be recorded. These signals will be processed using digital signal processing techniques in Matlab environment. Depending on the characteristics of the raw acoustic signal obtained from experiment, conventional filters based on Fourier Transform, Fast Fourier Transformation (FFT) and other techniques will be used to extract the useful information. By using these functions original acoustic signal can be expanded in terms of ortho-normal basis function of sine and cosine waves of infinite duration; however the Continuous Wavelet Transform can do it for finite duration as well. One of the great advantages of using wavelet transform is that the time information is not lost. The problem undertaken has practical importance in operation, on-line inspection, failure prediction and maintenance of rotating components.

III. ACOUSTIC SIGNAL

Acoustics is the interdisciplinary science that deals with the study of sound, ultrasound and infrasound (all mechanical waves in gases, liquids, and solids). The science of acoustics spreads across so many facets of our society - music, medicine, architecture, industrial production, warfare and more. Art, craft, science and technology have provoked one another to advance the whole, as in many other fields of knowledge. Acousticians had extended their studies to frequencies above and below the audible range, it became conventional to identify these frequency ranges as "ultrasonic" and "infrasonic" respectively, while letting the word "acoustic" refer to the entire frequency range without limit.

IV. METHODOLOGY

- (a) Design the system for acquisition of acoustic signal. A system has to be developed to record the audio signal in the frequency range of 20Hz to 20KHz. MIKE will act as sensor and will be interfaced with the computer. The acoustic signal will be recorded and stored in the computer for the different conditions.
- (b) Processing of acquired acoustic signal: The acoustic signal will be processed in MATLAB environment in order to improve the signal-to-noise ratio. Information of the fault in bearing i.e. having no defect, misalignment, looseness, missing ball, missing ball & looseness, misalignment & looseness and combined all these effects of the faults stated before will be extracted from the signal by plotting the scalogram of the signal.
- (c) Analysis of processed signal: The processed signal will be analyzed for fault detection in rotating components. A correlation of defects in terms of energy or operational frequency of rotating components can be found out.

V. EXPERIMENTAL SET UP

In our project we are analyzing the common faults like no defect, misalignment, these effects in bearing arrangement. Arrangement is tested at varying speed conditions. We also try to analyze the combined effect if more than one fault is present. The bearing with 8 balls is attached to the motor shaft frames and with the help of bush. A 160 watt motor (maximum speed 1350rpm) drives the bearing arrangement. Speed of motor can be adjusted by regulator. A mike (frontech mike) is used to record the acoustic signal generated by bearing assembly. A known signal of 1 KHz is produced. Signal frequency at computer screen (using scalogram) as recorded by mike also shows of 1 KHz. In one set of reading bearing and shaft does not have any kind of fault. During the experiments, Bearing with rotating shaft was set to operate at 300rpm, 600rpm, 900rpm.. The acoustic signals generated by the bearing are recorded for 1 second duration by placing the mike near the rotating bearing. After recording the signal in computer a low pass equiripple FIR filter is applied up to frequency 150Hz. The following result has been taken by the experiments. The complete experimental setup for fault detection is shown in figure:



VI. RESULT

In fig.6.1(a), 6.2(a), 6.3(a) shows that there is energy band dark in colour. The fig.6.1 (a) is for no defect at 300 rpm. In fig 6.2(a) as we increase speed from 300 to 600 rpm we get energy band regular and bright in colour. Similar evidence can be seen in 6.3(a) which at 900 rpm for no defect.

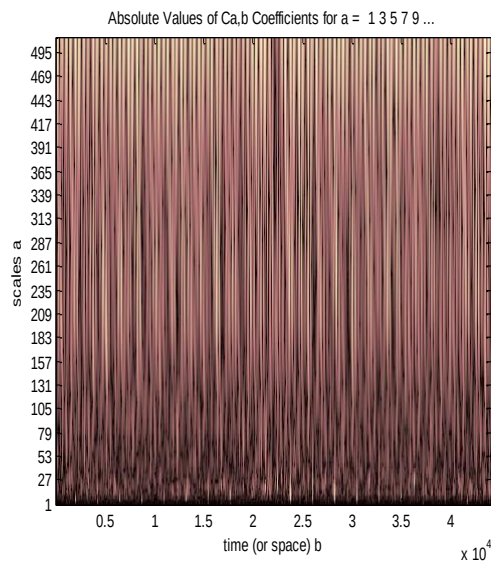


Fig 6.1(a)

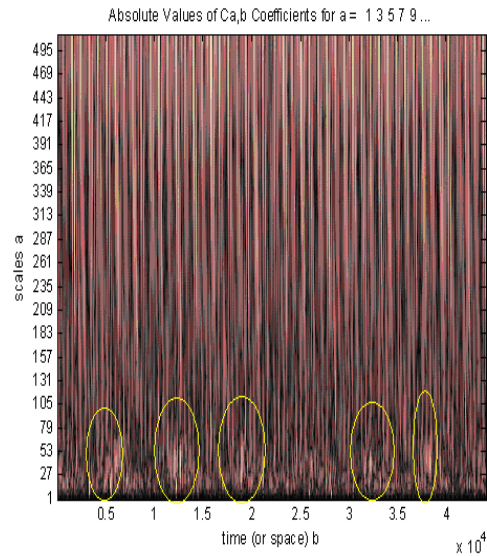


Fig 6.1(b)

Fig 6.1: COMPARISION BETWEEN NO DEFECTAND MISALIGNMENTS AT 300 RPM

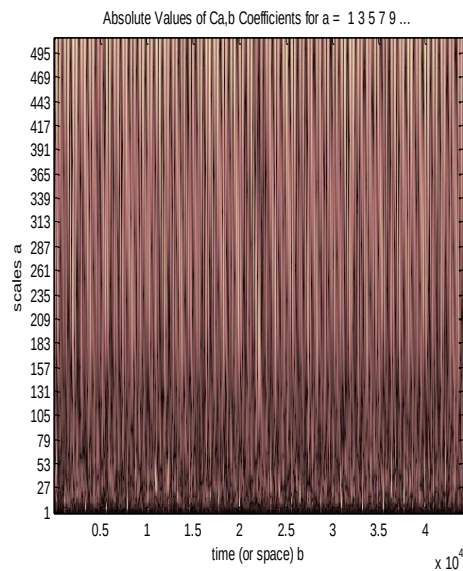


Fig 6.2(a)

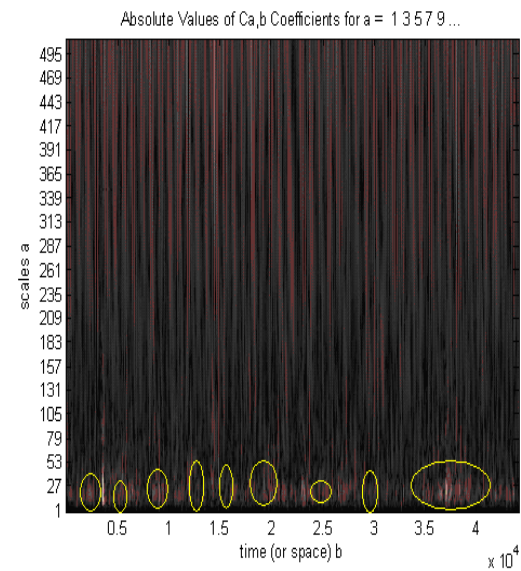


Fig 6.2(b)

Fig 6.2 : COMPARISION BETWEEN NO DEFECTAND MISALIGNMENT AT 600 RPM

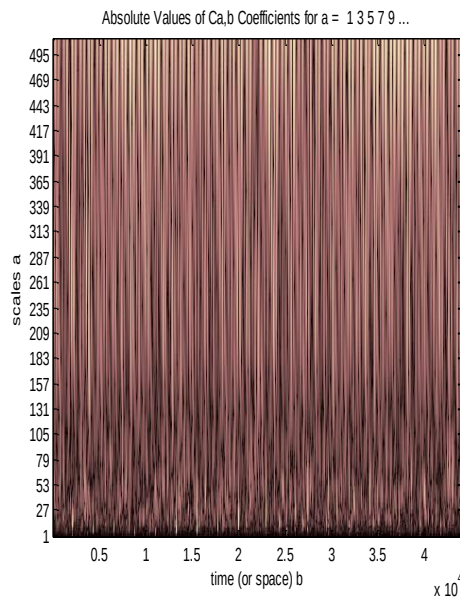


Fig 6.3(a)

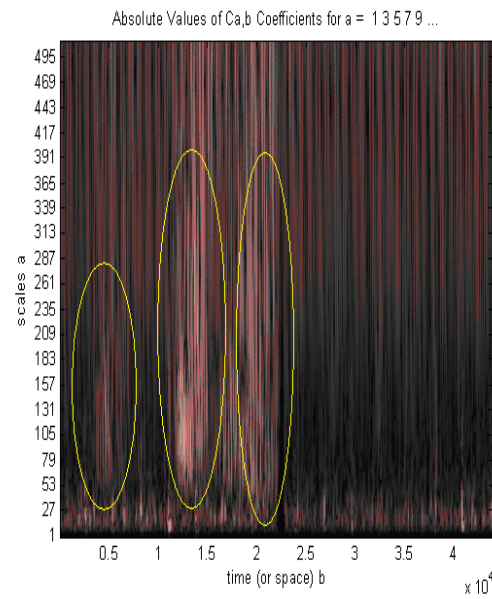


Fig 6.3(b)

Fig 6.3: COMPARISION BETWEEN NO DEFECTAND MISALIGNMENTS AT 900 RPM

In fig. 6.1(b) which shows the result of the defect misalignment at 300 rpm from this fig we can see the regular energy bands which are shown by marked areas. In fig 6.2(b) which is the result at 600 rpm having energy bands bright in color and are shown by marked areas. At 900 rpm the result we get are shown in fig 6.3(b) are not very satisfactory.

VII. DISCUSSION

Processed signals are already shown in figures after analysis of the signals. We have obtained the following results given below. Figurer 6.1(a), 6.2(a) to 6.3(a) shows the results of no defect at 300, 600, 900 rpm respectively. In the case of misalignment which is shown in fig. 6.1(b) we can see the regular bands where energy increases similar thing can be observed in fig. 6.2(b) & 6.3(b) by the marked areas on them. One thing more can be observed if rpm increases the bands are with more energy are coming closer that means the fault is occurring more frequently.

VIII. CONCLUSION

It demonstrate that, although the environment influences acoustic signal for condition monitoring, it does not significantly reduce the extraction of useful diagnostic information. It has been demonstrated that acoustic condition monitoring can effectively be used for detection in bearing arrangement. In this sensor do not alter the behavior of machine due to its non contact type. The developed in this project can be used for the condition monitoring and for the predictive maintenance of the bearing. The method works satisfactorily in rpm range 0-1000rpm. The method developed in the project can be used for the condition monitoring and for predictive maintenance of the many components.

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