DEVELOPMENT OF USER INTERFACE FOR VIBRATION MEASUREMENT

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DEVELOPMENT OF USER INTERFACE FOR VIBRATION MEASUREMENT

KHALISWARAN A/L KERESNAN

Report submitted in partial fulfillment of the requirement for the award of
Diploma of Mechanical Engineering

Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

DECEMBER 2012

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project and in my opinion, this project is adequate in terms of scope and quality for the award of the diploma of Diploma of Mechanical Engineering

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is my own except for the quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any diploma and is not concurrently submitted for award of other diploma.

Signature : ……………………………….

Name : KHALISWARAN A/L KERESNAN

ID Number : MB10106

Date :15 JANUARY 2013

DEDIACATION

To my beloved father and mother

Mr.Keresnan Velu

Mdm.Theruthela Davi Shanmugam

And also sibling

Ulaganathan Keresnan

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ABSTRACT

Today’s industry uses increasingly complex machince, some with extremely demanding performance criteria. Failed machine can lead to economic loss and safety problems due to unexpected production stoppages. Fault diagnosis in the condition monitoring of these machines is crucial for increasing machinery availability and reliability.Fault diagnosis of machinery is often a difficult and daunting task. To be truly effective, the process needs to be analysis to reduce the reliance on manual data interpretation. It is the aim of this research to analysis this process using data from machinery vibrations. This thesis focuses on the development, and application of an analysis diagnosis procedure for rolling elements bearing faults. Rolling element bearings are representative in most industrial rotating machinery. Besides, these elements can also be tested economically in the laboratory using relatively simple test rigs.Novel moden signal processing method were applied to vibration signals collected from rolling elements tests. This included time-frequency signal processing techniques such as FFT.

ABSTRAK

Pada zaman sekarang, industri menggunakan mesin yang semakin kompleks, ada segelintir dengan amat menuntut kriteria prestasi. Kegagalan mesin boleh membawa kepada kerugian ekonomi dan masalah keselamatan yang disebabkan oleh penamatan pengeluaran yang tidak dijangka. Diagnosis kerosakan dalam pemantauan keadaan mesin ini adalah penting untuk menyemak ketersediaan jentera yang semakin meningkat dan kebolehpercayaan.Diagnosis kerosakan jentera sering sukar dan merumitkan. Untuk keberkesanan, proses analisis perlu untuk mengurangkan pergantungan kepada interpretasi data pengguna. Ia adalah matlamat kajian ini untuk menggunakan proses analysis data dari getaran jentera. Tesis ini memfokuskan kepada pembangunan dan aplikasi prosedur diagnosis analisis untuk unsur-unsur berputar mengandungi kesilapan. Galas unsur berputar adalah paling banyak digunakan dalam perindustrian. Selain itu, elemen-elemen ini juga boleh diuji ekonomi di makmal menggunakan pelantar ujian yang agak mudah.Novel moden kaedah pemprosesan isyarat digunakan isyarat getaran dikumpul daripada ujian unsur bergolek. Ini termasuk teknik masa-kekerapan pemprosesan isyarat seperti FFT.

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LIST OF ABBREVIATION

MAX	Measurement and Automation Explorer
RPM	revolution per minute
GUI	graphical user interface
FFT	fast fourier transform
AC	alternating current
CPM	cycles per seconds
Hz	Hertz
N	number of sample
DAQ	data acquisition
LED	light emitter diode
μ	micro
π	Pi
σ	sigma
$\ddot{x}$	acceleration
$\dot{x}$	velocity
x	displacement
n	rotational speed
Sa/s	samples per second

CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

The importance of vibration measurements for maintenance services in industries.
In this day when manufacturers increase their operational profits they assume in the first place that this is because of a good marketing plan. But they forget that an effective maintenance budget is the fact that keeps them on top of the game.

This thesis work will explain all the common maintenance practices used by industries in our days and their economical advantages. The main focus of the thesis is to demonstrate the importance of vibration analysis in detecting failure occur in machining. How vibration measurements are performed in a real world scenario is also part of the thesis.
Of all the parameters that can be measured in the industry, not one of them contains as much information as the vibration analysis. The vibration analysis is one of the most important tests for understanding what is happening in a machine. The level of vibration and the pattern of the vibration tell us something about the internal condition of the rotating component. The vibration pattern can tell us if the machine is out of balance or out of alignment. Also faults with rolling elements and coupling problems can be detected through vibration analysis.

When performing vibration measurements there are four phases involved: detecting if a problem exists, performing an analysis to diagnose the severity of the problem, determining why the problem took place and verifying that the problem is solved once the machine is repaired.

If we can interpret the data obtained from the vibration analysis in a correct way and perhaps change the way the machine is operated or maintained, the machine will become more reliable in the future making the overall process more profitable.

User interface design or user interface engineering is the design of appliances, machines, software applications. Good user interface design facilitates finishing the task at hand without drawing unnecessary attention to itself. Graphic design may be utilized to support its usability. The design process must balance technical functionality and visual elements (e.g., mental model) to create a system that is not only operational but also usable and adaptable to changing user needs. The user interface, in the vibration measurement field of human–machine interaction, is the space where interaction between humans and machines occurs. The goal of interaction between a human and a machine at the user interface is effective operation and control of the machine, and feedback from the machine which aids the operator in making operational decisions. GUIs generally provide users with visual feedback about the effect of each action GUIs allow users to take full advantage of the powerful *multitasking* capabilities of modern operating systems by allowing such multiple programs to be displayed simultaneously. The result is a large increase in the flexibility of analysis in vibration measurement.

1.2 PROBLEM STATEMENT

When a machine does not perform a required function as a result of an incident, this can be described as a failure. In most of the cases failures can be anticipated through a good maintenance plan, but the possibility of unpredictable critical failures is always present. Bearing are single largest cause of machine failures. A continued stress on the bearings causes the fatigue failures, usually at the inner or outer races of the bearings. These failures result in rough running of the bearings that generates detectable vibrations and increased noise levels. Good user interface design facilitates finishing the task at hand without drawing unnecessary attention to itself. The graphical user interface can detect the bearing failure by analysis method. It can determine the bearing life span and level of failure occur. By using an effective graphical user interface, the bearing failure can be detected and reduce it.

1.3 PROJECT OBJECTIVE

For this project, a single objective to be achieved as listed below;

i. To develop an user interface for vibration measurement (detect the bearing failure occur)

1.4 PROJECT SCOPE

The scope of this project are listed as follows;

i. Study the fundamental of vibration measurement & common parameters that used for vibration measurement
ii. Design a graphical user interface for vibration measurement
iii. Program the user interface by using Dasylab software

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Vibration measurements give us the information needed to understand why problems have occurred. If we can interpret the data obtained in a correct way and perhaps change the way a machine is operated or maintained, the machine will become more reliable in the future making the overall process more profitable.

Therefore by including vibration measurements into our maintenance plan we can save money and in most of the cases improve the product quality

2.2 FUNDAMENTAL OF VIBRATION

Vibration can be described as the mechanical oscillation about an equilibrium point. In case that you are measuring vibration from the bearing of a machine, you are measuring the response of the bearing housing to the forces generated inside the machine. Those forces relate to all of the rotating elements: the shaft, the balls in the bearing, and the blades on the fan, plus the vibration coming from the process and surrounding machines (Mobius Institute 2005, 21).

2.2.1 Displacement, x

Displacement measurement is the distance or amplitude displaced from a resting position. The SI unit for distance is the meter (m), although common industrial standards include mm and mils. Displacement vibration measurements are generally made using displacement eddy current transducers.

$$x(t) = X \cos\ (\ 2\pi f t - \ \emptyset_x\ ) \tag{2.1}$$

2.2.2 Velocity, ẋ

Velocity is the rate of change of displacement with respect to change in time. The SI unit for velocity is meters per second (m/s), although common industrial standards include mm/s and inches/s. Velocity vibration measurements are generally made using either swing coil velocity transducers or acceleration transducers with either an internal or external integration circuit.

$$v(t) = (2\pi f t)\ X \cos\ (\ 2\pi f t - \left(\emptyset_x\ - \frac{\pi}{2}\right)) \tag{2.2}$$

2.2.3 Acceleration, ẍ

Acceleration is the rate of change of velocity with respect to change in time. The SI unit for acceleration is meters per second2 (m/s2), although the common industrial standard is the g. Acceleration vibration measurements are generally made using accelerometers.

$$a(t) = (2\pi f)V \cos(\ 2\pi f t - \left(\emptyset_v - \frac{\pi}{2}\right)) = (2\pi f)^2 X cos(2\pi f t - (\emptyset_x\ - \pi\ )) \tag{2.3}$$

In this analysis, the sensor accelerometer is used to obtain the reading of acceleration. The fundamental of vibration discuss about acceleration, velocity and displacement with respectively equation. The acceleration is most importance in this analysis, by obtaining the reading to simulate in graphical user interface to show failure of bearing .

2.3 FUNDAMENTAL OF SIGNAL ANALYSIS

2.3.0 Sampling rate

Defines the number of samples per unit of time (usually seconds) taken from a continuous signal to make a discrete signal. For time-domain signals, the unit for sampling rate is hertz (inverse seconds, 1/s, s^{-1}), sometimes noted as Sa/s (samples per second). The inverse of the sampling frequency is the sampling period or sampling interval, which is the time between samples.

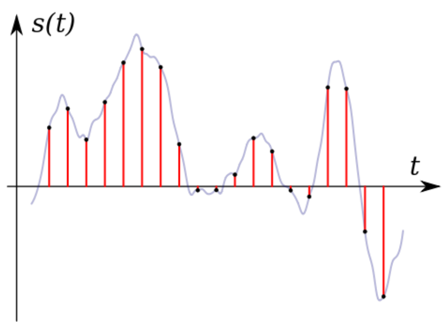

Figure 2.0 Sampling Rate Graph

(Source; Bendat, Julius S. and Piersol, Allan G.,*"Random Data: Analysis and Measurement Procedures"*,Wiley-Interscience,New York, 1971.)

2.3.1 Block Size

Block size in transform coding is a tradeoff between time and frequency resolutions. Although not always explicitly pointed out, a variable block size is a local adaptation aiming to obtain a better projection of the signal on the time-frequency plane. The block size dictates the tradeoff. Larger blocks mean coarser time resolution and narrower subbands, whereas small blocks mean better time localization and worse frequency resolution. Block transforms of variable sizes can be easily applied to images as the problem is simplified to a tiling of the image into rectangular regions

2.3.2 Fast Fourier Transfrom (FFT)

A time domain format can be converted to frequency domain data by using mathematical transform technique called as '(Fast) Fourier Transform', which is named after Jean Fourier. FFT or advanced methods of it allows vibrations analyst to see discrete frequency peaks of vibrating components clearly. A frequency-domain plot is either displacement or velocity or acceleration versus time, unlike amplitude versus time in time domain format

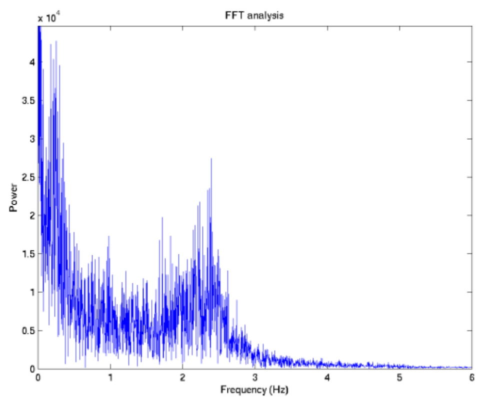

Figure 2.1 FFT Graph

(Source; Roth, P., *"Digital Fourier Analysis"*,Hewlett-Packard Journal, June 1970.)

2.3.3 Frequency Domain

A frequency domain format of vibration profile is a combination of frequencies related to circular rotations or linear movements of parts of machines. Hence these vibration profiles can be considered as a multiple of fundamental frequencies of the parts, equipment or the system. Such frequencies can be expressed in terms (their units are) revolutions per minute

(RPM) or cycles per minute (CPM) or cycles per second (Hertz). To analyze the operation condition of the machine in frequency domain, these fundamental frequencies must be determined first

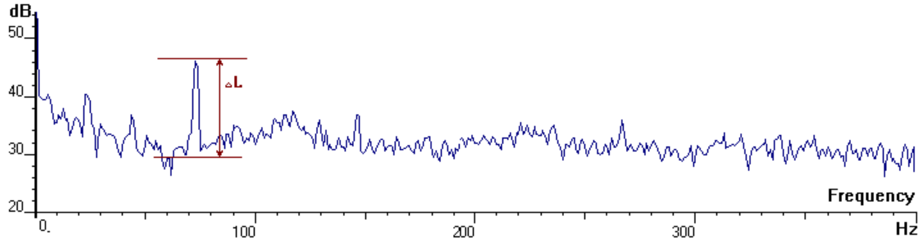

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Figure 2.2 Frequency Domain Graph

(Source; Cooley, J.W. and Tukey, J.W., *"An Algorithm for the Machine Calculation of Complex Fourier Series"*, Mathematics of Computation, Vo. 19, No. 90, p. 297,April 1965.)

2.3.4 Time Domain

In the time domain format the vibrations data is plotted as amplitude versus time. Examples of basic formats are shown in previous figures and example for a real time industrial system is shown in following figure.

Time domain formats are usually used for reciprocating and linear movement machineries.

They are also useful in overall evaluation and analysis of a system to study subtle changes in operations. On the flip side, to interpret the data from time domain efficiently, is quite a tedious task. The vibrations data in time domain format is complexly integrated. It represents the mixed spectrum of all the sources of the system at a particular instant of time. Hence, it is very difficult to find out the specific spectrum of a particular source

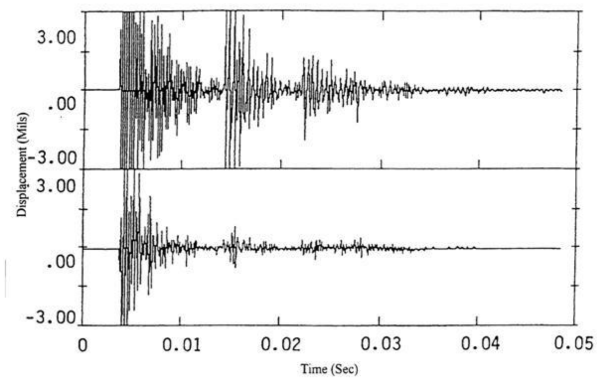


Figure 2.3 Time Domain Graph

(Source; Otnes, R.K. and Enochson, L.,*"Digital Time Series Analysis"*, John Wiley, 1972.)

2.4 Standard Parameter of Vibration Measurement

2.4.1 Variance, μ

The variance is a measure of how far a set of numbers is spread out. It is one of several descriptors of a probability distribution, describing how far the numbers lie from the mean (expected value). In particular, the variance is one of the moments of a distribution. This parameter shows the mean value of analysis data of bearing failure.

$$\mu = \int x\, f(x)\, dx \tag{2.4}$$

2.4.2 Standard deviation, σ

It shows how much variation or "dispersion" exists from the average (mean, or expected value).probability distribution is the same as that of a random variable having that distribution. This parameter show the average mean value of analysis data of bearing failure.

$$\sigma = \sqrt{\int_{\mathbf{X}} (x-\mu)^2 \, p(x)\, dx}, \quad \text{where} \quad \mu = \int_{\mathbf{X}} x\, p(x)\, dx,$$

(2.5)

2.4.3 Root Mean Square (RMS)

The root mean square (RMS) value of a vibration signal is a time analysis feature, which is the measure of the power content in the vibration signature. This features is good for tracking the overall noise level, but it will not provide any information on which component it failing. It can be very effective in detecting a major out of balance in rotating system. This parameter show the noise level of analysis data of bearing failure.

$$f_{\mathrm{rms}} = \lim_{T\to\infty} \sqrt{\frac{1}{T}\int_0^T [f(t)]^2 \, dt}. \qquad (2.6)$$

In the analysis, the variance is used to detect the mean value of bearing failure meanwhile standard deviation is used to detect the average mean value of bearing failure. Both of this parameters shows the level of bearing failure occur in each revolution. The RMS is used to detect the noise level in bearing failure. This parameter is used to shows the noise level that occur each revolution.

2.5 BASIC PROGRAMMING

A *program* is a set of step-by-step instructions that directs the computer to do the tasks you want it to do and produce the results you want. Programming helps you understand computers. The computer is only a tool. If you learn how to write simple programs, you will gain more knowledge about how a computer works. Writing a few simple programs increases your confidence level. Many people find great personal satisfaction in creating a set of instructions that solve a problem. Learning programming lets you find out quickly whether you like programming and whether you have the analytical turn of mind programmers need. A set of rules that provides a way of telling a computer what operations to perform is called a programming language. In general, BP converts problem solutions into instructions for the computer. That is, the programmer prepares the instructions of a computer program and runs those instructions on the computer, tests the program to see if it is working properly, and makes corrections to the program. The programmer also writes a report on the program. These activities are all done for the purpose of helping a user fill a need, such as paying employees, billing customers, or admitting students to college.

The programming activities just described could be done, perhaps, as solo activities, but a programmer typically interacts with a variety of people. For example, if a program is part of a system of several programs, the programmer coordinates with other programmers to make sure that the programs fit together well.

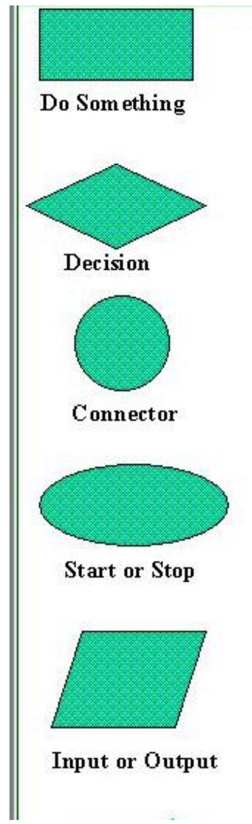


Figure 2.4 of Flow Chart Icon

2.6 DASYLAB SOFTWARE

Sensitive instruments and machines such as integrated circuit wafer scanners often contain motion systems that control displacements of one micron or less. This dynamic makes the machines particularly sensitive to even minute environmental vibrations, so it's essential that the equipment contains high stiffness support frames to handle all incidental shock and vibration programs for vibration testing based on the DASYLab software package. Vibration testing is a search for the source of a noise, shake, or vibration. Engineers measure the frequency of the vibration and look for components that are rotating at the same frequency at that particular vehicle speed to determine the source of the sound or vibration, such as a tire, the transmission, or the engine The engineers also used FFT equipment that came in large boxes and were particularly difficult to manage on the factory floor. With increasing vehicle production, QA needed to modernize and replace the X-Y plotters and FFT boxes to accelerate the process, save more data, and distribute the data faster

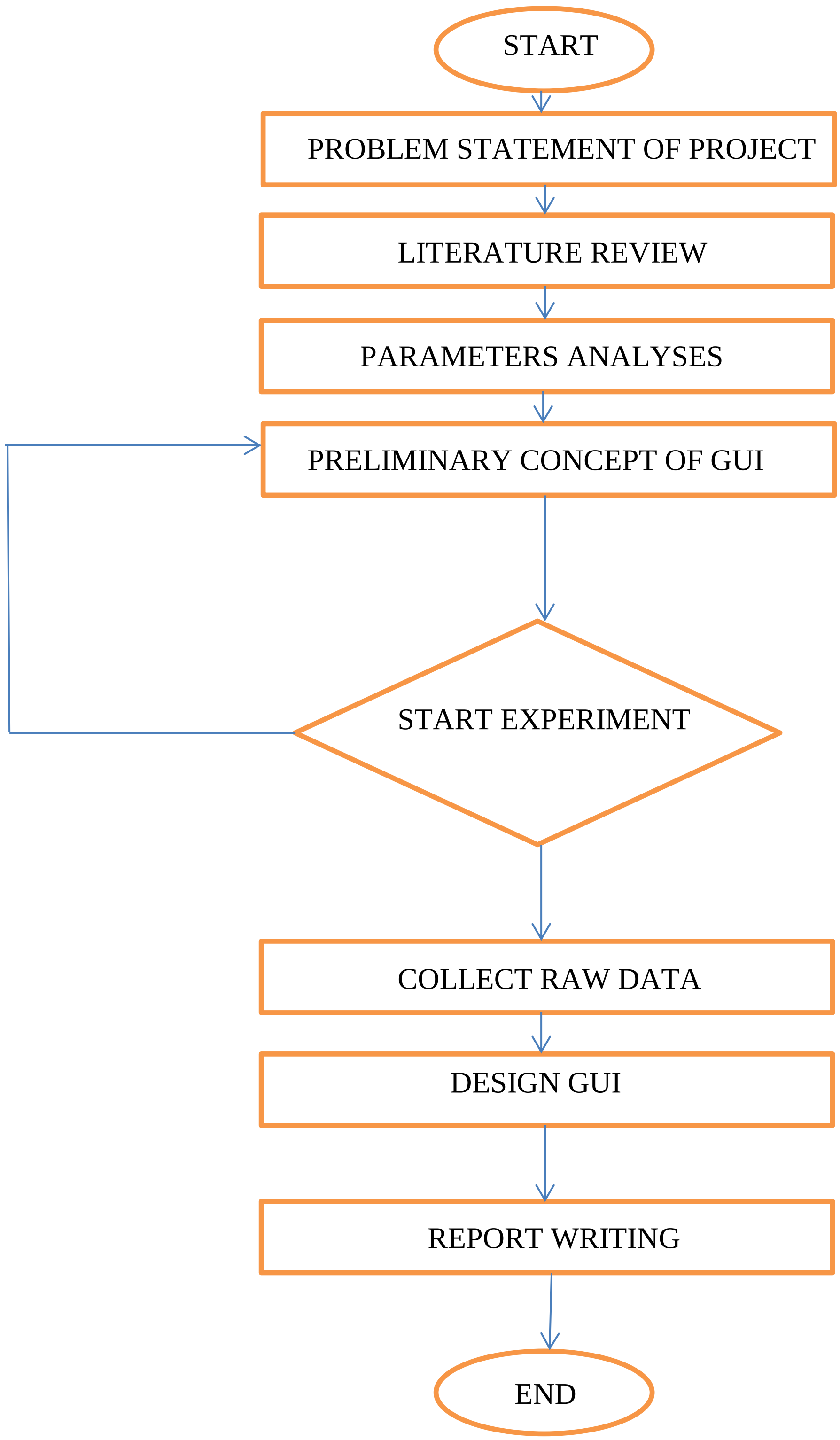
CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This section will briefly describes the way of analysis the data from experiment with the material selection for making graphical user interface to determine the best and accurate result for this study. The variables and performance parameters also will be explained other than problem setup. So, all the value data from the experiment will be obtain for bearing failure and finally are able to suggest the suitable graphical user interface.

3.2 FLOW CHART



3.2.1 Problem Statement of Project

The main problem is the failure occur in machining especially bearing. The objective is develop an user interface to overcome this failure occur.

3.2.2 Literature Review

The literature review contains of fundamental of vibration, fundamental of signal analysis, standard parameters of vibration measurement, basic programming and dasylab software. This literature review be a guideline to obtain the analysis and GUI.

3.2.3 Parameter Analysis

The parameter of this analysis are variance, standard deviation and RMS. It had been studied from fundamental and get references from the journal to continue this project.

3.2.4 Preliminary Concept of GUI

Before using the real bearing test rig, the analysis used generator as medium to collect the data and simulate the software. The result of this analysis been used to generate three different concept of GUI.

3.2.5 Start Experiment

As the result from preliminary concept been approved, the analysis start with real bearing test rig. The experiment starts with using sensor, A/D converter and data acquisition.

3.2.6 Collect Raw Data

From the experiment, the raw data generates from the bearing failure is recorded. Generates the raw data into block size, FFT , and filter to simulate the failure and compare it .

3.2.7 Design GUI

With the simulated data, the GUI design will take place according to user's creativity.

3.2.8 Writing Report

Finally, as the GUI been approved and achieved the objective the overall report of this thesis will be wrote onwards.

3.3 Graphical User Interface Design

3.3.1 Concept 1

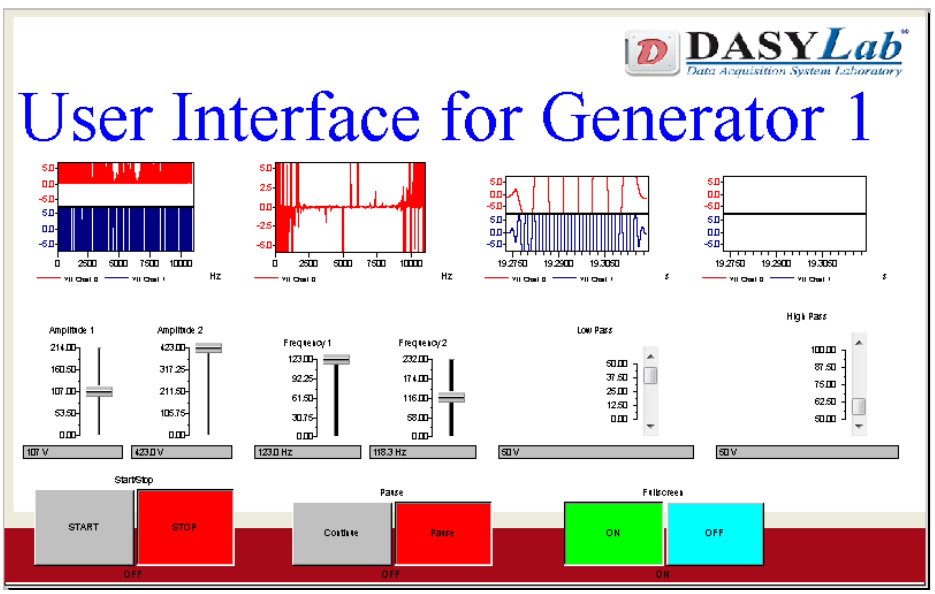


Figure 3.0 Layout 1

In the layout 1, the 1st graph is transfer graph. It shows the reading obtain from raw data into data window and move on to transfer window. The graph with change according to the amplitude and frequency of generator changes. The 2nd graph is reading from both chancel be divided into an arithmetic module. The 3rd graph is a in between low and high pass data.

The data from data window connected to low pass and high pass module and generates the graph. The 4th graph is the filtered data from high and low pass data. The filtered data will show the differences between high and low pass data after and before filtered.

3.3.2 Concept 2

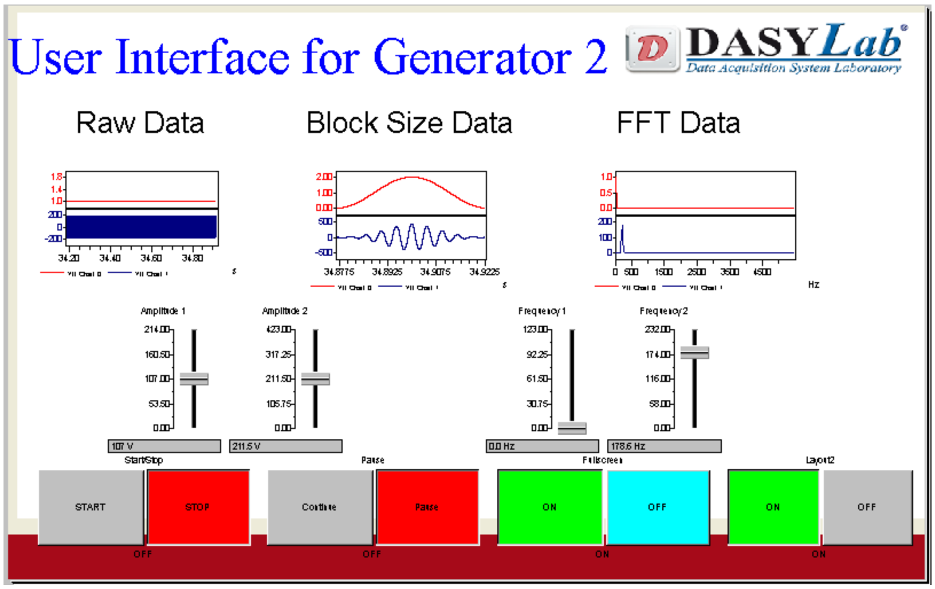


Figure 3.1 Layout 1

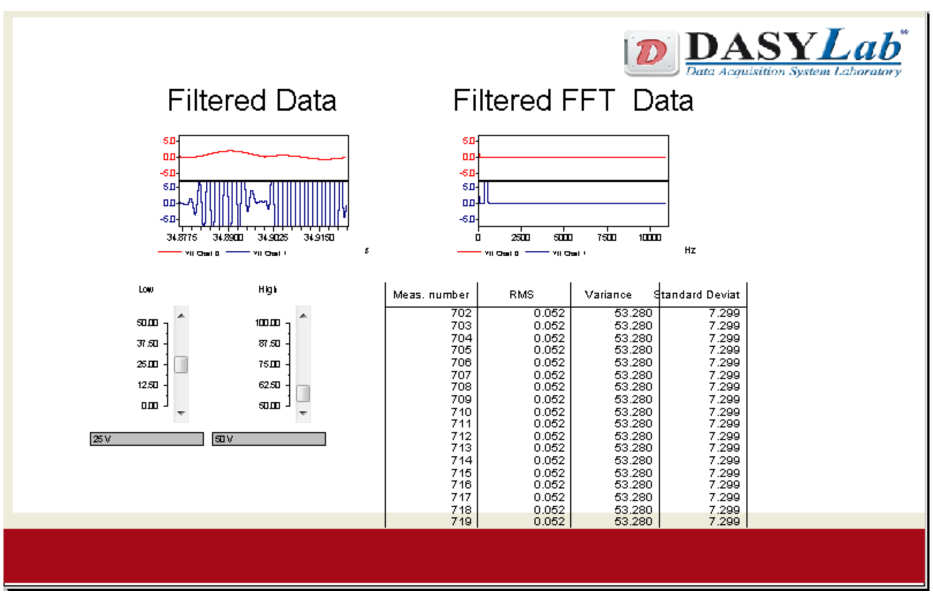


Figure 3.2 Layout 2

In the layout 1, the 1st graph is raw data. The reading obtain from the generator with specific value. It changes when the amplitude and frequency changes. The 2nd graph is the block size data. The data generates from raw data connected into data window show the data.The 3rd graph is the FFT graph, the data generates from raw data connected into FFT module show the data.

In the layout 2, the 1st graph is the filtered data. It had been filtered from block size data. The data show the differences between block size data and filtered data before and after the filtered. The graph will change according the amount of pass filtered. The 2nd graph is the filtered FFT data. It had been filtered from FFT data. The data show the differences between FFT data and filtered FFT data before and after the filtered. The graph will change according the amount of pass filtered.

3.3.3 Concept 3

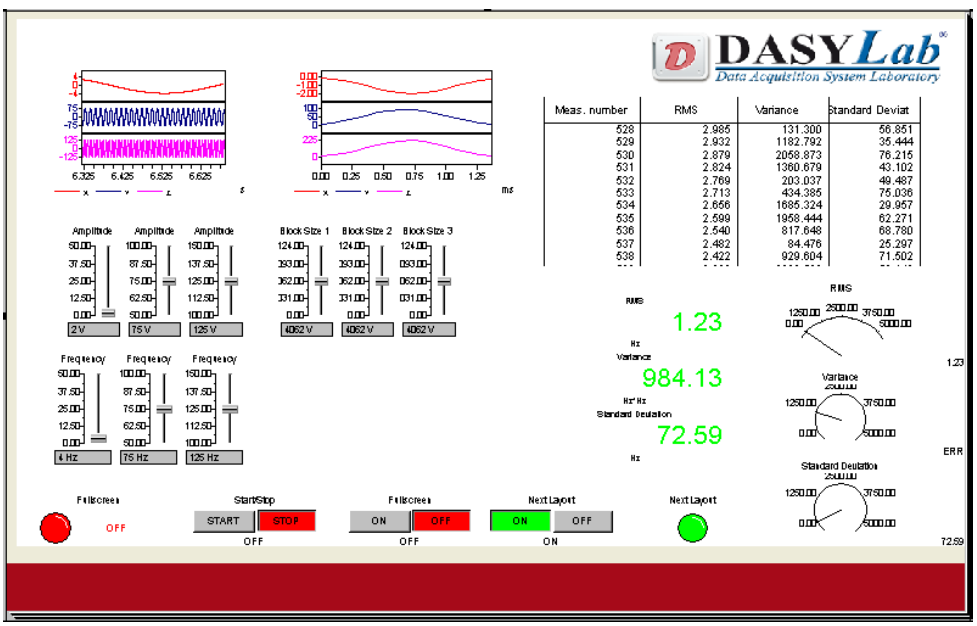


Figure 3.3 Layout 1

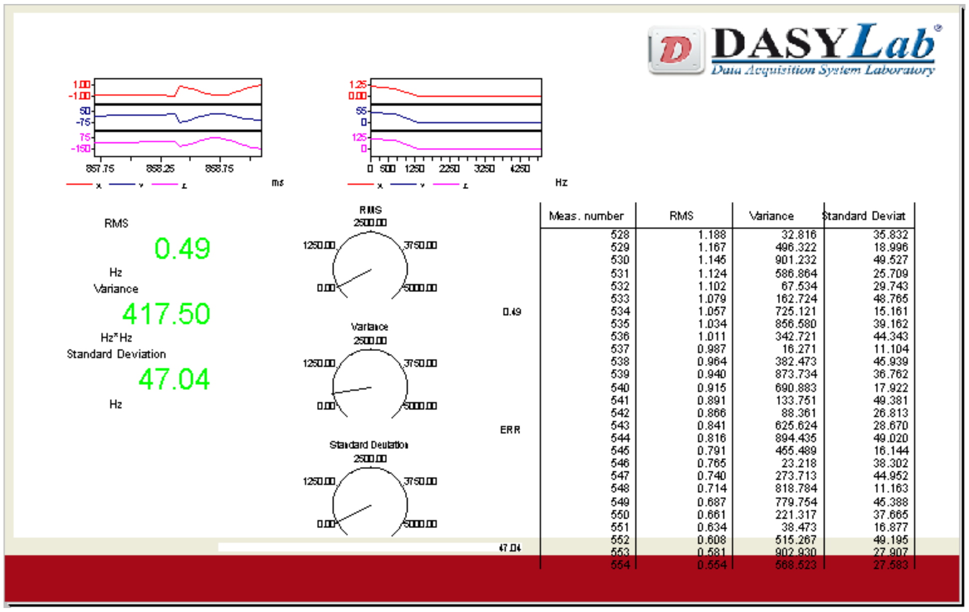


Figure 3.4 Layout 2

In layout 1, the 1st graph is raw data graph. The data obtain from generator with specific value. It will changes with the amplitude and frequency of generator changes. The 2nd graph is the block size data. The data will changes according to the block size chooses in the block size slider. As the block size changes the reading of RMS, variance and standard deviation will changes accordingly and shown in the digital meter, analog display and list .

In layout 2, the 1st graph is the low and high pass data. It connected from block size data and merge into low and high pass graph. The 4th graph is he filtered FFT data. The data is generates from FFT connected to filtered FFT data. It show the differences of FFT data and filtered FFT data before and after filtered. The results also show in digital meter, analog display and list according. The result in layout 1 and layout 2 will be difference and can compare the RMS, variance and standard deviation before and after filtered.

3.4 DATA ACQUISITION FOR MEASURING DATA

3.4.1 Sensor (Accelerometer)

An accelerometer is a device that measures proper acceleration. The proper acceleration measured by an accelerometer is not necessarily the coordinate acceleration (rate of change of velocity). Accelerometers can be used to measure vibration on cars, machines, buildings, process control systems and safety installations. They can also be used to measure seismic activity, inclination, machine vibration, dynamic distance and speed with or without the influence of gravity. Applications for accelerometers that measure gravity, wherein an accelerometer is specifically configured for use in gravimetry, are called gravimeters.

Figure 3.5 Accelerometer

3.4.2 A/D Converter

An analog-to-digital converter (abbreviated ADC, A/D or A to D) is a device that converts the input continuous physical quantity to a digital number that represents the quantity's amplitude. The conversion involves quantization of the input, so it introduces a small amount of error. The inverse operation is performed by a digital-to-analog converter (DAC). Instead of doing a single conversion, an ADC often performs the conversions ("samples" the input) periodically. The result is a sequence of digital values that have converted a continuous-time and continuous-amplitude analog signal to a discrete-time and discrete-amplitude digital signal.

CHAPTER 4

RESULT & DISCUSSION

4.1 Dasylab Module Design

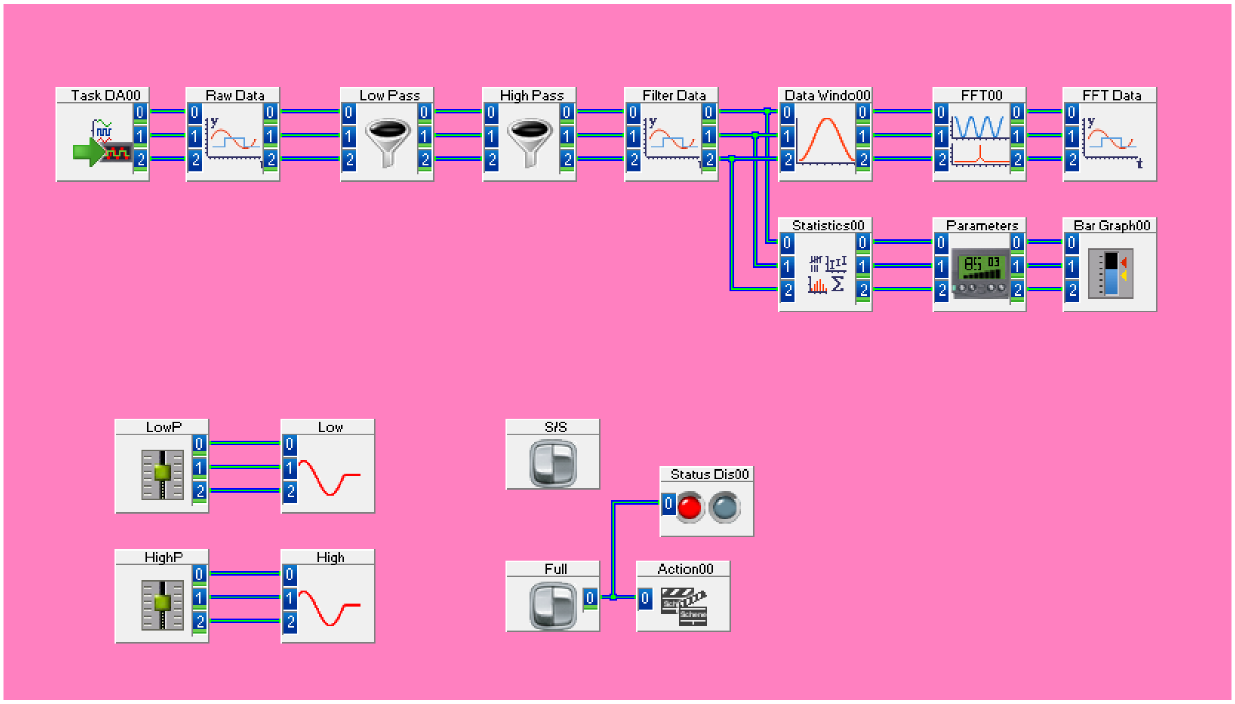


Figure 4.0 Module Design

The task DA00 receive the data from bearing acceleration obtain from MAX. The data will show in y/t chart. The data will be autoscaling and the raw data will be connected to low pass module. The low pass module will specific the max and min value of pass and connected to high pass module. As before the high pass module will specific the max and min value of pass. The lead to the 2nd graph of filter data. The data will connected to statistics module to convert into RMS, variance and standard deviation parameter. The parameters will be shown in digital meter and bar graph. Meanwhile the filter data also will be connected to the data window and specify the window and block size. It will connected to FFT module and generates with y/t chart to show the FFT data. The value of high and low pass can change using slider as it latch by Latch module for both high and low pass.

The switch and action module with status display was used in layout setup.

4.2 User Interface Layout

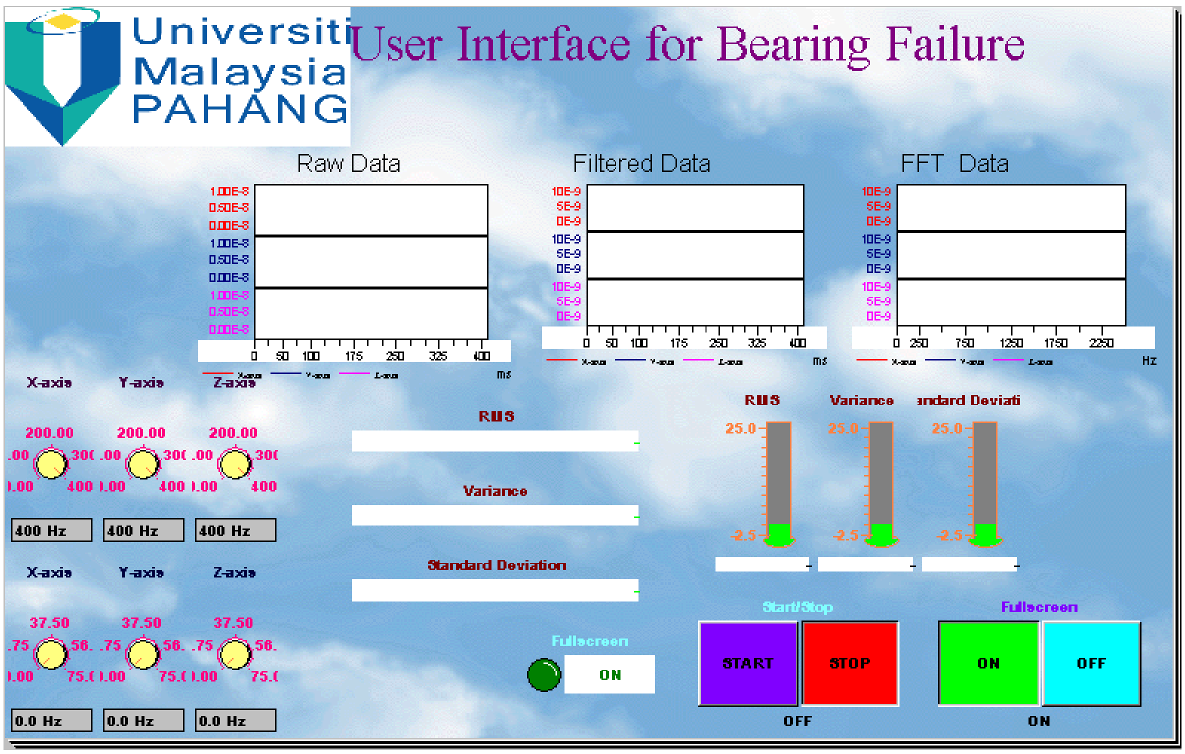
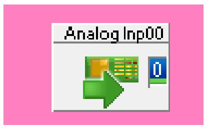


Figure 4.1 Layout Design

In this layout, the raw data will shows the data generates from bearing failure obtain with MAX. The filtered data will changes according to the changes of axis in the slider module on the left of layout . The upper slider is for low pass slider and the lower will be high pass slider. With the slider changes the reading of RMS, variance and standard deviation also changes. The FFT data show the specific data with data window chooses window and block size and changes it into FFT graph. The start/stop button will using to start and stop the graphical user interface reading. The fullscreen button is used to fullscreen and back to window size of the layout. The status display is green if the layout is fullscreen otherwise it will be in red.

4.3 Discussion



NI-DAQmx: Analog Input

Use the NI-DAQmx Analog Input module to acquire data of up to 16 signal inputs.

This module is used to receive the data from MAX application to used in the dasylab software . It can generates the data obtain from MAX and use it in dasylab software.

Y/t Chart Module

Use the Y/t Chart module to display data channels as curves over time. The Y/t chart plots the curve in the Display window from the left to the right. The display window has a menu bar and a function bar to change, to survey, or to output the display during the measurement.

The y/t chart module will show the generates data from the analog input. In the experiment there three y/t chart module and autoscaling. The 1st is raw data, the 2nd is filter data and the 3rd is FFT data. It shows the reading of bearing failure data

Digital Filter Module

Use the Digital Filter module to eliminate disturbing frequency parts in signals with FFT filters

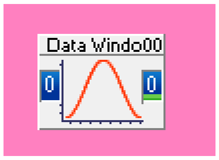
Low Pass

Blocks or dampens signal parts above the limit frequency and lets signal parts below the limit frequency pass.

High Pass

Blocks signal parts below the limit frequency and lets signal parts above the limit frequency pass.

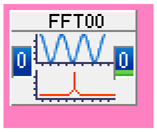
In this experiment both high and low pass filter is used. The low pass filter has the min 0 hz value and max 400 hz value. Meanwhile the high pass filter has the min 0 hz value and max 75 hz value.



Data Window Module

Use the Data Window module to multiply non-periodic signals with a window function. This module prepares data channels for an FFT. Because you can specify the output block size, you can use the Data Window module as a buffer. The output block size is independent of the block size at the input channels.

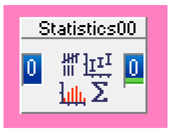
The data window specify the window type and block size used in the experiment. The window flattop is used with 2048 block size is used.



FFT Module: Real FFT of a Real Signal

Use the FFT: Real FFT of a real signal module to transfer up to 16 data channel pairs from the time domain into the frequency domain. You can run a dB evaluation to make small spectral parts visible.

In this experiment the FFT module is used to find the amplitude spectrum from bearing failure. The reading of FFT data is gone through data window first.



Statistical Values Module

Use the Statistical Values module to calculate the statistical characteristic values for each data block, for several data blocks, or for all incoming values of an input channel. The module outputs the calculated characteristic values continuously.

RMS

Specifies for the selected sample the mean square

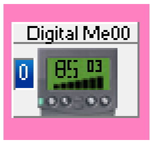
Variance

Specifies the mean sum of the squared deviations from the mean value of the selected sample

Standard Deviation

Specifies for the selected sample the square root of the variance.

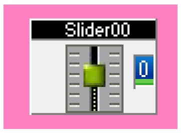
The statistical values module is used for calculate the RMS, variance and standard deviation in this analysis. This module with connected to digital meter and bar graph to show the reading of each parameter.



Digital Meter Module

Use the Digital Meter module to display data channels numerically. The display window has a separate display area for each data channel.

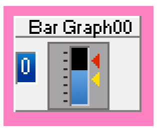
This module show each parameter require in this experiment. The RMS, variance and standard deviation value after filter.



Slider Module

Use the Slider module to manually generate up to 16 signals with scroll bars, slider controls, or dials. The switch window contains an instrument for every activated data channel.

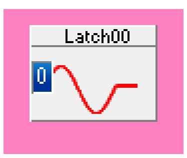
This module is used to change the values of high and low pass filter.



Bar Graph Module

Use the Bar Graph module to display data channels as bar graphs next to each other in the display window.

This module show each parameter require in this experiment. The RMS, variance and standard deviation value after filter.



Latch Module: Set Global Variable

Use the Latch: Set Global Variable module to assign data channel values to global variables.

This module is used to set a variable in the low and high pass filter. Then it will connected to slider module so it can control the values.

Switch Module

Use the Switch module to manually generate up to 16 signals with switches and push buttons. The switch window contains a switch or a push button for each activated data channel.

Two switch module are used in this experiment. First is the start/stop button used in the layout. The second is the fullscreen button connected with status display module. When the start button is pressed the reading in layout will be started and stopped when the stop button is pressed.

Action Module

Use the Action module to define and to execute event-related and module-related functions in the background of DASYLab. In the module dialog box you specify the receiver in the worksheet which executes the action. Then select the action to be executed and the trigger condition. The module has one or more input channels that DASYLab monitors to check whether the condition is fulfilled. The module has no output channels.

This module is used to connect with switch button so it can generates the switch commands.

Status Display Module

Use the Status Display module to display TTL signal levels with lamps or to display the bits of data channels with LEDs

This module will signals the LEDs in the layout. The green light shows it been on and the red light shows it been off.

CHAPTER 5

CONCLUSION

5.1 Conclusion

Vibration analysis methods which utilize high frequency impulsively excited signals provide an effective means of detecting early damage in rolling element bearings. Such methods have an inherent discriminatory capability since in many machines rolling bearings are the only component producing impulses which excite the high frequency resonances.

The aim of this thesis was to develop an user interface that can be used in bearing failure analysis. This GUI provide an easy way for detecting the failure of bearing to determine tool life and the condition of bearing. The requirements for the measurement system were derived from real industry needs.

5.2 Recommendation

1. Incipient fault detection using time-frequency analysis techniques.

This work has been concerned with the development of the overall diagnostics techniques and has not particularly focused on incipient faults. Further work may investigate the sensitivity of the techniques to detecting marginal faults.

This study has been concerned with studying rolling elements bearing faults which represent a fundamental component in rotating machinery. The work can be extended to other rotational components such as fan, pump and motors.

2. Signal processing techniques for feature extraction

The time-frequency analysis method develop and applied in this thesis candidature can be further refined for feature extraction of vibration signals from the point of view :-

i. Reconstruction of time waveforms with less noise
ii. Producing time-frequency graph with better resolutions

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APPENDIX

Grant Chart