The University of Nottingham

Faculty of Engineering

Department of Electrical and Electronic Engineering

UNITED KINGDOM · CHINA · MALAYSIA

EEEE4077
Project Outline and Planning Report

Electrical Machine Condition Monitoring System

AUTHOR	:	Joel Wong Zi Xu
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MODERATOR	:	Dr Mumtaj Begam
DATE	:	21st Oct 2022

Contents

1. Introduction

As the operation of a motor continues in constant action, the likelihood of its failure increases as its operating conditions degrades and the machine becomes more and more vulnerable to wearing and aging. Based on the research, majority of motors become defective due to faults while only a mere 10% become inoperable due to old age [1]. Detecting faults before the occurrence of permanent damage is the intention of motor condition monitoring or alternatively, motor health monitoring, which is essential in preventing inner mechanical complications and prolonging the life of a motor [2].

Additionally with the advent of Internet of Things (IoT) technology, machines and devices are now able to be connected to exchange data with one another using the internet as its communication host [3]. Such technology has already been interfaced with the concept of motor condition monitoring in order to enhance the accessibility and control aspects of a motor health monitoring system. An example of such a system has proved its availability by allowing its user access to information of the motor, while away, by the usage of an Arduino compatible Wi-Fi module, the ESP8266, which in turn allows the motor monitoring system to pass the data from its motor monitoring sensors onto a webserver and therefore allowing access of its sensor information, via the internet, worldwide [4].

From literature review [1], [5], The condition of a motor is commonly measured through four parameters, these include: firstly, the motor temperature, which are usually used to gauge the condition of the bearing, ambient stator temperature. Secondly, the parameter of current which is used to determine the health of the windings as well as the mechanical system of the motor. Thirdly, the measurement of voltage which is used to judge the condition of the voltage supply as well as the power factor of the motor. Lastly, the intensity of the motor vibration which can be used to reveal issues in air-gap variation, misalignment, broken rotor bars and other mechanical motor faults.

This project focuses on the creation of a condition motoring system for a motor that is capable of detecting faults from the usage of information by sensors. Additionally, the system would also be interfaced with Wi-Fi technology in order to allow the information tracked to be available online and hence anywhere via the access of the internet.

2. Problem Statement

Failure of components awaits the operation of a motor the longer it remains in use as its parts are exposed to the wear and age from working [1]. The failure of parts of the motor vital to its functioning can begin to occur in the stator, rotor as well as upon the eccentricity of the motor where they are the result of the worn damaged parts which can include but are not limited to shorted coil windings, the breaking of rotor bars and the wearing of bearings respectively [6]. Consequently, the machine deteriorates as the faults add up, gradually becoming unreliable or even dangerous for operation. At the level of a large and complex industrial plant, the collection of failures is catastrophic and may result in the waste of millions of dollars for any rehabilitation and at the worst scenarios, a large-scale life-threatening accident [5]. The solution lies at the research of motor condition monitoring where the faults can be detected at the moment of their occurrence or even pre-occurrence and hence avoiding the disasters that may result from such motor failures.

3. Background Information

3.1. Motor Faults

As a motor remains in operation, wearing and aging can occur upon its body and this provides the root for the development of motor faults [1]. A machine fault can be described as any incident occurring within its machinery that obstructs the designed function of the machine [6]. Such faults can be defined into two categories: Internal faults, which includes component failures such as misalignment of motor sheets, coils, coupling, rotors & shaft, broken rotor bars or even damaged bearings whereas external faults are due to interactions with the loading, power supply as well as nearby environment and this includes overloading, environmental overheating, pollution and even unstable voltage [6]. The origin of faults are generally caused by stresses and careless operation, these can stem from several types, for instance, stator or armature faults are often traced to insulation problems which itself may be due to a collection of problems such as overheating of winding or stator core, loose bracing in the end winding, dirt contamination or even leaking from the cooling systems whereas damages of the rotor bar and end-rings mainly occur as a result of overheating, unbalanced magnetic forces, manufacturing issues as well as fatigued parts [7].

Figure 1: Rotor with one and two broken bars [8]

3.2. Measurement of Vibration of Motors

Vibrations generated by motors can be measured via the use of an accelerometer, through this, any vibrations produced as a result of any unintended impact of machinery can be detected; such vibration will appear at its characteristic frequency caused by the interference of the present defect [9]. As machinery failure usually manifests as vibration or as changes in vibration pattern due to their physical nature, vibration of motors is often used to monitor heavy physical defects that are often in rotation such as gears, shaft & rotors, rolling element bearings, journal bearings, flexible coupling as well as electrical machines [5]. The types of faults commonly to be detected via measurement of vibration are shown in **Table 1**:

Table 1: Faults that can be detected with vibration analysis [5]

Item	**Fault**
Gears	Tooth messing faults, Misalignment, Cracked and/or worm teeth, Eccentric gear
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Rolling element bearings	Pitting of race and ball/roller Spalling Other rolling elements defect
Journal bearing	Oil whirl Oval or barrelled journal Journal/bearing rub
Flexible coupling	Misalignment Unbalance
Electrical machines	Unbalanced magnetic pulls Broken/damaged rotor bars Air gap geometry variations Structural and foundation faults Structural resonance Piping resonance Vortex shedding

3.3. Measurement of Voltage of Motors

The measurement of motor voltage is usually best suited to gauge the health of the supply voltage connected to the motor, via its phasing and balance, as well as the power factor of the motor [1]. Additionally, the measurement of the motor voltage has also been demonstrated to have the ability to replace the measurement of vibration in detecting physical faults as well as physical failure, for instance, a damaged rotor which exhibit high frequency disturbances to the rotor mechanical speed will begin to affect the resultant magnetic field of the air gap as the rotor bar current fail to overcome the disturbance rapidly and hence causing induced voltages in the stator windings to be disturbed, therefore allowing possible detection of damaged rotor via voltage measurement [10].

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To assess the condition of the motor windings as well as to gauge the load undertaken by the motor, the measurement of motor current can be performed [1]. Additionally, the current measured could be transformed into a decibel-frequency range via Fast Fourier Transform to provide information regarding frequencies due to fault which are affecting the general waveform of the current; fault can be detected as the current waveform measured would be different with and without the presence of faults [11], [12].

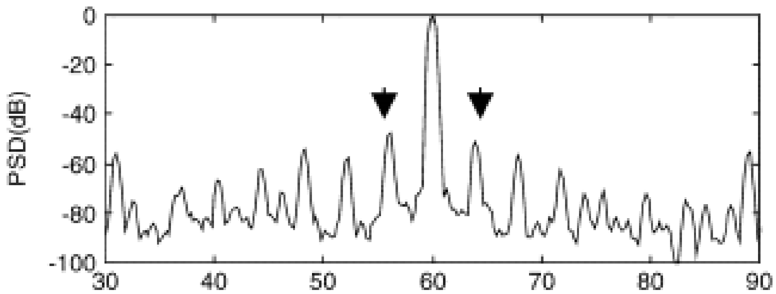

Figure 3: A Plotted Graph of MCSA of a Healthy Motor [8]

3.5. Measurement of Temperature of Motors

The motor temperatures can be determined via the usage of thermocouples, optical pyrometers, thermography, and resistance thermometer [5]. Temperatures measured in a motor are, in normal circumstances, generated from the magnetic losses within the rotor & stator, the resistive losses (I^2R), friction as well as the motor windage [1]. Via temperature analysis, faults related to wearing due to insufficient lubricant can be monitored and prevented where additionally, the detection of overheating, which can subject organic material within the insulation of the stator winding to deteriorate, can also be identified, and mitigated [5].

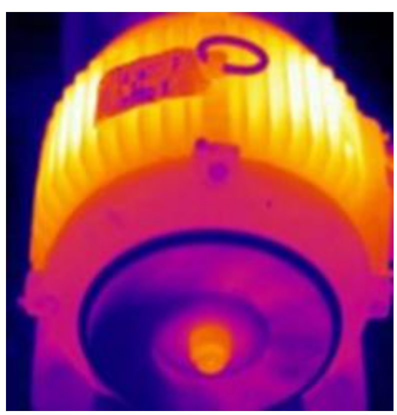

Figure 4: Thermal RGB image of a motor showing levels of temperature throughout motor [13]

3.6. Wave and Spectrum analysis

The most common two ways to analyse and detect faults and failures within a motor is, firstly, by performing a time-domain analysis which is via inspecting the measured data (ie. Voltage, Temperature, Current, Vibration, etc.) from the sensors as a plot against the time as this allows a clear investigation of the direct and raw data from the sensor output; the second method is by converting the time-domain measured data into the frequency domain, typically done using fast Fourier transform (FFT), where faults can be observed due to their specific unique frequencies generated to due to their existence appearing as peaks alongside the expected frequencies of a normal working motor should the motor in evaluation possesses one or more faults [5]. An example of this has been mentioned with the description of MCSA where the current measured could be represented as a decibel-frequency via Fast Fourier Transform [10]. Similarly, another example can be found in the frequency spectrum of the vibrations measured, done using Fourier Transform, where the frequency of each component is known and hence where the peaks appear at the frequency of that particular component, a fault can be confirmed to exist at that particular component [9]. Furthermore, as the existence of noise may be recorded as well such that the frequency spectrum represented might be disturbed and become inaccurate, averaging of the values before the conversion into the frequency spectrum could be done to reduce the presence of noise [11]. From this, it can also be concluded that the use of multiple types of spectrum analysis (ie. Voltage, current, vibration, etc.) can be done for each fault in order to clearly assess the existence of faults and avoid errors.

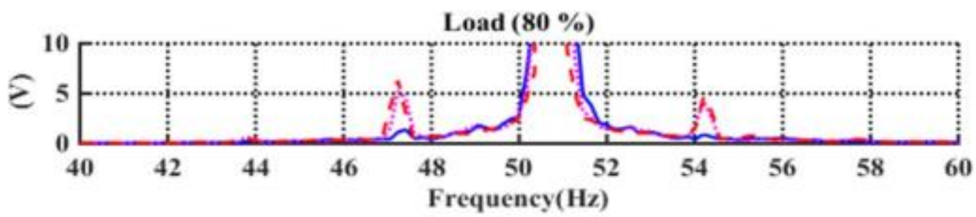

Figure 5: Voltage Frequency Spectrum of a motor with Broken Rotor Bars at 80% of the motor full load [8]

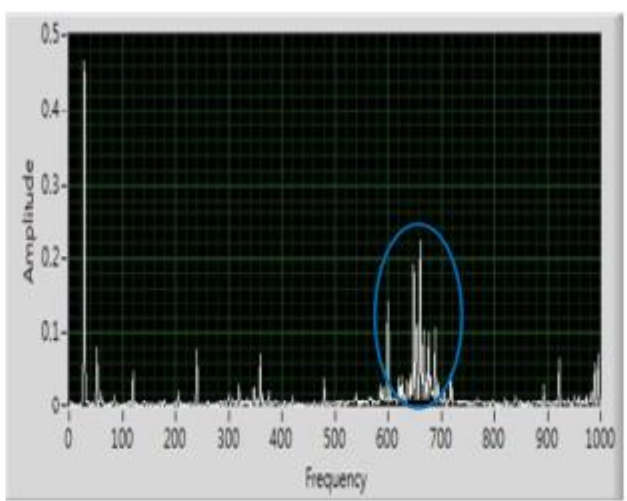

Figure 6: Vibration Frequency Spectrum of a motor indicating fault at the rotor [14]

3.7. IoT Technology

Internet of Things (IoT) can be defined as the connection of devices and objects to share data and to communicate using the internet as a pathway [3]. Through the usage of this technology, complications due to physical components necessary for data transfer between sensors in condition motoring are eliminated, additionally, the absence of wires allows better strategical placement of the sensors onto positions previously inconceivable due the space needed for the physical trail of wires connected [15]. An example of such a system which integrates IoT and Motor Condition Monitoring has been demonstrated to be possible where the system was capable of measurement of Voltage, current as well as vibration along with the fact that it can detect the existence of faults and alert the user anytime at its occurrence, wirelessly to anywhere through an internet connection [4].

4. Aim and Objectives

4.1. Aim

The main focus of this project is to design and program a condition monitoring system for electrical machines with the ability to transfer its recorded information over a wireless transfer data system with a user interface

4.2. Objectives

- Design and develop a condition monitoring system for the electrical machines.
- Analyse the performance by monitoring the condition of electrical machines using the developed system.
- Classify the abnormalities found in monitoring the electrical machines by suing the developed system.
- Develop a wireless transfer data system to integrate with the developed system for user interface.

4.3. Deliverables

- Identify the parameters of the electrical machines that will be used for condition monitoring.
- Design the condition monitoring system by integrating with the electrical and mechanical sensors.
- Test the developed system to ensure the condition of the machines is monitored based on the relevant parameters.
- Develop a wireless transfer data system to transfer the monitored parameters for user interface.

5. Proposed Methodology

- **Literature review and Research:** At the initial stages of the project, the essentials of motor condition monitoring would need to be understood. The various types of faults occurring within a typical motor as well as the methods utilized for faults detection would need to be familiarized for the identification of failures. Additionally, concepts related to IoT technology and software would need to be read upon for the basis of a wireless transfer data system. Lastly, a study upon tutorials would need to be carried out in order for the proper usage of the different sensors and modules
- **Integration of Sensors to the Motor:** The identification of errors stems pivotally from the positioning of the sensors to the right connection relative to the motor in evaluation in order for accurate detection of faults
- **Programming Wireless Transfer of Data from Sensors:** Coding of a program as well as strategic integration of a Wi-Fi module to acquire and manage information gathered by the sensor to display over to the user of the system, wirelessly
- **Simulating Faults:** Motors have to be physically manipulated in order to mimic the condition of a faulty motor so as to assess the validity of the constructed condition monitoring system via comparison of detected data and faulty pattern of information from reviewed literature
- **Classifying Faults:** Information from different sensors have to be integrated cohesively both physically and through the developed program in order to determine the pattern of data that will occur when measured by different sensors for each specific fault

6. Industrial Relevance

On the scale of large industrial manufacturing plants, failure of machines such as a motor within its complex process would risk expensive operating costs due to maintenance of incapacitated components, the loss of possible production that could have been without the occurrence of failed machines as well as putting the lives of operation crew members in serious endangerment [5].

To prevent such complications, logically, the failure or faults of the machine must be detected at its occurrence or even prior to it. In condition monitoring of motors, failures such as stator winding and rotor faults can be reliably detected as each type of fault appear with distinct characteristics such as when measured with a vibration sensor (accelerometer), current sensor or even a voltage sensor which means that faults have the possibility of being instantly identified and hence preventing resulting consequences [8], [9]. To further ensure proper monitoring of a large complex plant, several types of strategic maintenance of the components could be carried out of which motor condition monitoring could be advantageous to. Firstly, there exists a predictive type of maintenance known as Condition-based maintenance which is maintenance done where restoration of a part is initiated due to noticeable wearing detected as result of a change in its monitored parameter [5]. Other types of maintenance include proactive maintenance which is based on analysis of failure as well as preventative maintenance which include checkups once every duration in a set time; the implementation of such strategies has been analyzed to eliminate factory downtime as well as in assisting the avoiding of mistakes which directly leads to enhancing the efficiency of a plant to its fullest potential [16].

Additionally, the rise of IoT and its integration means condition monitoring does not have to be physical presence based as the information from sensors can be passed via the internet and hence allowing workers to monitor motors even while away from the workplace [4].

7. Risk and Mitigations

In this project, several types of sensors and modules are implemented to create a sensor system, each with its own unique set of programming code for the manipulation of its sensor, as such, the combination of all sensors and its individual programming to exchange data may prove to be time-consuming and difficult. To ease the process, certain sensors should be programmed and worked on first before integrating other sensors to prevent a chaotic combination of programming. Furthermore, there could exist a limit to the type of fault that can be allowed to be simulated for testing purposes due to the dangerous nature of certain failure such as, but are not limited to, high current short circuit of the stator winding as well as high speed rotation of broken rotor bars. To avoid serious injury, the use of personal protective equipment (PPE) such as safety googles could be utilized as well as performing the simulated of faults during the presence of the supervisor to prevent accidents due to inexperience.

8. Project Timeline

In the Autumn semester, the focus of tasks will be on Literature review upon the various types of faults, the ways to detect them as well as forming the basis of wireless transfer of data from sensors. Later, the integration of sensors to the motor would be carried out before the simulation of faults can be done to confirm the validity of the measurement of the sensors as well as to record motor fault behaviour. In the Spring Semester, the development of a wireless data transfer program with the ability to classify motor faults can be worked upon based on the work from the previous semester before the final task of motor fault classification from the data of various sensors will be carried out. More details of the time plan can be found in the **Gantt Chart** in the appendix.

9. Appendix

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Gantt Chart

Year 4 Individual Project Gantt Chart

Supervisor: Ir. Ts. NANDAN GANESH JEYABALAN

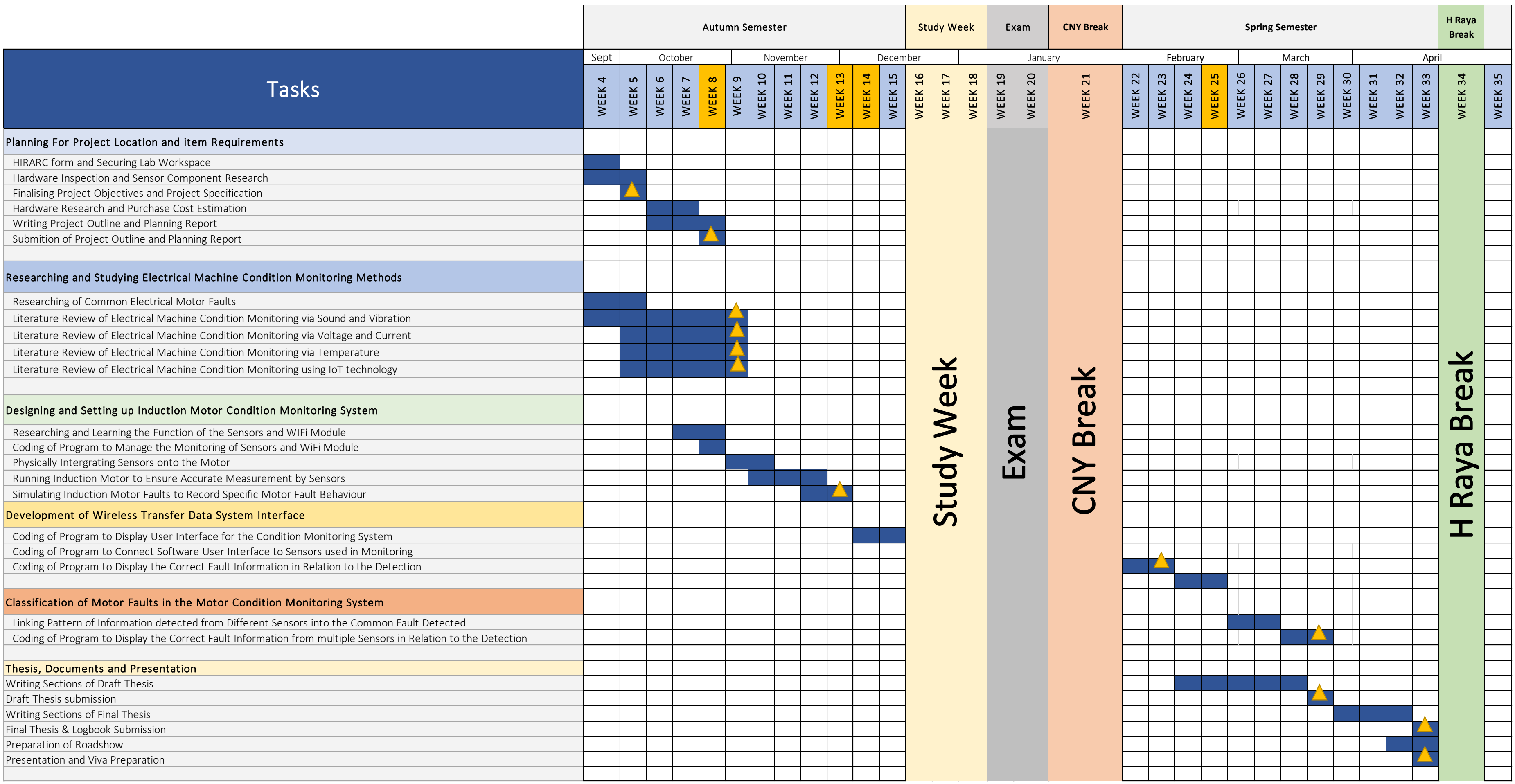
Project Code: NJ-MEng-21-02

Student Name: Joel Wong Zi Xu

Student ID: 20208685

Legends: Week of Moderator Meeting:

Milestone:



Project Specifications

Project Code		**NJ-MEng-22-02**
Supervisor		**Ir. Ts. Nandan Ganesh Jeyabalan**
Moderator		**Dr Mumtaj Begam**
Project Description		**Project Title: Electrical Machine Condition Monitoring System** The term reliability is a criterion that must be considered when selecting an electrical machine and its drive system for a particular load. As the cost of machines and drives varies proportionally to their reliability status, studies have been conducted throughout the world to achieve one ultimate goal – to produce a machine and drive system with higher reliability and minimum cost spent in manufacturing it. Therefore, condition monitoring is an important part in ensuring the performance and life span of the electrical machines maintained and improved. This project aims to design an Electrical Machine Condition Monitoring System in order to better monitor the performance and improve the overall efficiency of the electrical machines.
Project Objectives		1. Design and develop a condition monitoring system for the electrical machines. 2. Analyse the performance by monitoring the condition of electrical machines using the developed system. 3. Classify the abnormalities found in monitoring the electrical machines by suing the developed system. 4. Develop a wireless transfer data system to integrate with the developed system for user interface.
Project Deliverables		1. Identify the parameters of the electrical machines that will be used for condition monitoring. 2. Design the condition monitoring system by integrating with the electrical and mechanical sensors. 3. Test the developed system to ensure the condition of the machines is monitored based on the relevant relevant parameters. 4. Develop a wireless transfer data system to transfer the monitored parameters for user interface.
Target Discipline *(You may check both)*		☑ Electrical and Electronic ☐ Mechatronic

<table>
<tr><td>HW/SW/Research Ratio</td><td></td><td><table><tr><th>HW</th><th>SW</th><th>Research/Investigation/Design/Math</th></tr><tr><td>50</td><td>30</td><td>20</td></tr></table></td></tr>
<tr><td>Lab Space Requirements</td><td></td><td>☒ Fixed Space

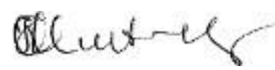
☐ Ad-hoc Space

☐ Others. Please state.</td></tr>
<tr><td>Software (This is software usually supportedin the Software Lab)</td><td></td><td>Python, Arduino Programming Codes</td></tr>
</table>

Prepared By:

Ir. Ts. Nandan Ganesh Jeyabalan
30th of September 2022
(Supervisor)

Reviewed By:



Dr Mumtaj Begam
12 Oct. 2022
(Moderator)

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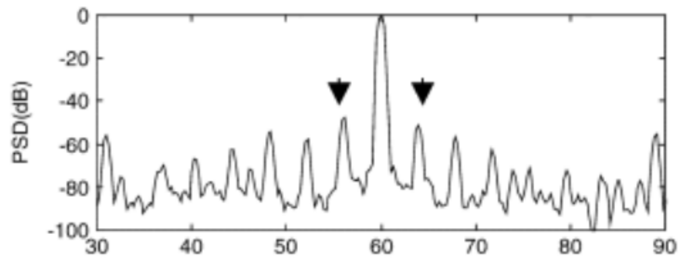

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3.5. Measurement of Temperature of Motors

The motor temperatures can be determined via the usage of thermocouples, optical pyrometers, thermography, and resistance thermometer [5]. Temperatures measured in a motor are, in normal circumstances, generated from the magnetic losses within the rotor & stator, the resistive losses (I^2R), friction as well as the motor windage [1]. Via temperature analysis, faults related to wearing due to insufficient lubricant can be monitored and prevented where additionally, the detection of overheating, which can subject organic material within the insulation of the stator winding to deteriorate, can also be identified, and mitigated [5].

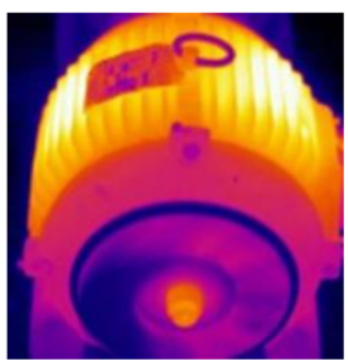

Figure 4: Thermal RGB image of a motor showing levels of temperature throughout motor [13]

3.6. Wave and Spectrum analysis

The most common two ways to analyse and detect faults and failures within a motor is, firstly, by performing a time-domain analysis which is via inspecting the measured data (ie. Voltage, Temperature, Current, Vibration, etc.) from the sensors as a plot against the time as this allows a clear investigation of the direct and raw data from the sensor output; the second method is by converting the time-domain measured data into the frequency domain, typically done using fast Fourier transform (FFT), where faults can be observed due to their specific unique frequencies generated to due to their existence appearing as peaks alongside the expected frequencies of a normal working motor should the motor in evaluation possesses one or more faults [5]. An example of this has been mentioned with the description of MCSA where the current measured could be represented as a decibel-frequency via Fast Fourier Transform [10]. Similarly, another example can be found in the frequency spectrum of the vibrations measured, done using Fourier Transform, where the frequency of each component is known and hence where the peaks appear at the frequency of that particular component, a fault can be confirmed to exist at that particular component [9]. Furthermore, as the existence of noise may be recorded as well such that the frequency spectrum represented might be disturbed and become inaccurate, averaging of the values before the conversion into the frequency spectrum could be done to reduce the presence of noise [11]. From this, it can also be concluded that the use of multiple types of spectrum analysis (ie. Voltage, current, vibration, etc.) can be done for each fault in order to clearly assess the existence of faults and avoid errors.

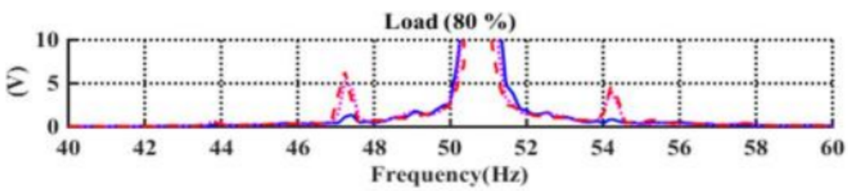

Figure 5: Voltage Frequency Spectrum of a motor with Broken Rotor Bars at 80% of the motor full load [8]

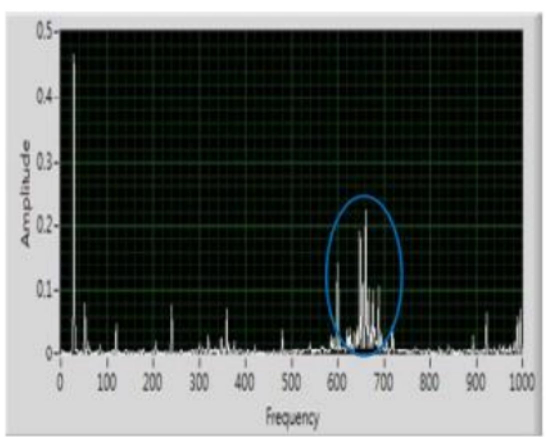

Figure 6: Vibration Frequency Spectrum of a motor indicating fault at the rotor [14]

3.7. IoT Technology

Internet of Things (IoT) can be defined as the connection of devices and objects to share data and to communicate using the internet as a pathway [3]. Through the usage of this technology, complications due to physical components necessary for data transfer between sensors in condition motoring are eliminated, additionally, the absence of wires allows better strategical placement of the sensors onto positions previously inconceivable due the space needed for the physical trail of wires connected [15]. An example of such a system which integrates IoT and Motor Condition Monitoring has been demonstrated to be possible where the system was capable of measurement of Voltage, current as well as vibration along with the fact that it can detect the existence of faults and alert the user anytime at its occurrence, wirelessly to anywhere through an internet connection [4].

4. Aim and Objectives

4.1. Aim

The main focus of this project is to design and program a condition monitoring system for electrical machines with the ability to transfer its recorded information over a wireless transfer data system with a user interface

4.2. Objectives

- Design and develop a condition monitoring system for the electrical machines.
- Analyse the performance by monitoring the condition of electrical machines using the developed system.
- Classify the abnormalities found in monitoring the electrical machines by suing the developed system.
- Develop a wireless transfer data system to integrate with the developed system for user interface.

4.3. Deliverables

- Identify the parameters of the electrical machines that will be used for condition monitoring.
- Design the condition monitoring system by integrating with the electrical and mechanical sensors.
- Test the developed system to ensure the condition of the machines is monitored based on the relevant parameters.
- Develop a wireless transfer data system to transfer the monitored parameters for user interface.

5. Proposed Methodology

- **Literature review and Research:** At the initial stages of the project, the essentials of motor condition monitoring would need to be understood. The various types of faults occurring within a typical motor as well as the methods utilized for faults detection would need to be familiarized for the identification of failures. Additionally, concepts related to IoT technology and software would need to be read upon for the basis of a wireless transfer data system. Lastly, a study upon tutorials would need to be carried out in order for the proper usage of the different sensors and modules
- **Integration of Sensors to the Motor:** The identification of errors stems pivotally from the positioning of the sensors to the right connection relative to the motor in evaluation in order for accurate detection of faults
- **Programming Wireless Transfer of Data from Sensors:** Coding of a program as well as strategic integration of a Wi-Fi module to acquire and manage information gathered by the sensor to display over to the user of the system, wirelessly
- **Simulating Faults:** Motors have to be physically manipulated in order to mimic the condition of a faulty motor so as to assess the validity of the constructed condition monitoring system via comparison of detected data and faulty pattern of information from reviewed literature
- **Classifying Faults:** Information from different sensors have to be integrated cohesively both physically and through the developed program in order to determine the pattern of data that will occur when measured by different sensors for each specific fault

6. Industrial Relevance

On the scale of large industrial manufacturing plants, failure of machines such as a motor within its complex process would risk expensive operating costs due to maintenance of incapacitated components, the loss of possible production that could have been without the occurrence of failed machines as well as putting the lives of operation crew members in serious endangerment [5].

To prevent such complications, logically, the failure or faults of the machine must be detected at its occurrence or even prior to it. In condition monitoring of motors, failures such as stator winding and rotor faults can be reliably detected as each type of fault appear with distinct characteristics such as when measured with a vibration sensor (accelerometer), current sensor or even a voltage sensor which means that faults have the possibility of being instantly identified and hence preventing resulting consequences [8], [9]. To further ensure proper monitoring of a large complex plant, several types of strategic maintenance of the components could be carried out of which motor condition monitoring could be advantageous to. Firstly, there exists a predictive type of maintenance known as Condition-based maintenance which is maintenance done where restoration of a part is initiated due to noticeable wearing detected as result of a change in its monitored parameter [5]. Other types of maintenance include proactive maintenance which is based on analysis of failure as well as preventative maintenance which include checkups once every duration in a set time; the implementation of such strategies has been analyzed to eliminate factory downtime as well as in assisting the avoiding of mistakes which directly leads to enhancing the efficiency of a plant to its fullest potential [16].

Additionally, the rise of IoT and its integration means condition monitoring does not have to be physical presence based as the information from sensors can be passed via the internet and hence allowing workers to monitor motors even while away from the workplace [4].

7. Risk and Mitigations

In this project, several types of sensors and modules are implemented to create a sensor system, each with its own unique set of programming code for the manipulation of its sensor, as such, the combination of all sensors and its individual programming to exchange data may prove to be time-consuming and difficult. To ease the process, certain sensors should be programmed and worked on first before integrating other sensors to prevent a chaotic combination of programming. Furthermore, there could exist a limit to the type of fault that can be allowed to be simulated for testing purposes due to the dangerous nature of certain failure such as, but are not limited to, high current short circuit of the stator winding as well as high speed rotation of broken rotor bars. To avoid serious injury, the use of personal protective equipment (PPE) such as safety googles could be utilized as well as performing the simulated of faults during the presence of the supervisor to prevent accidents due to inexperience.

8. Project Timeline

In the Autumn semester, the focus of tasks will be on Literature review upon the various types of faults, the ways to detect them as well as forming the basis of wireless transfer of data from sensors. Later, the integration of sensors to the motor would be carried out before the simulation of faults can be done to confirm the validity of the measurement of the sensors as well as to record motor fault behaviour. In the Spring Semester, the development of a wireless data transfer program with the ability to classify motor faults can be worked upon based on the work from the previous semester before the final task of motor fault classification from the data of various sensors will be carried out. More details of the time plan can be found in the **Gantt Chart** in the appendix.

9. Appendix

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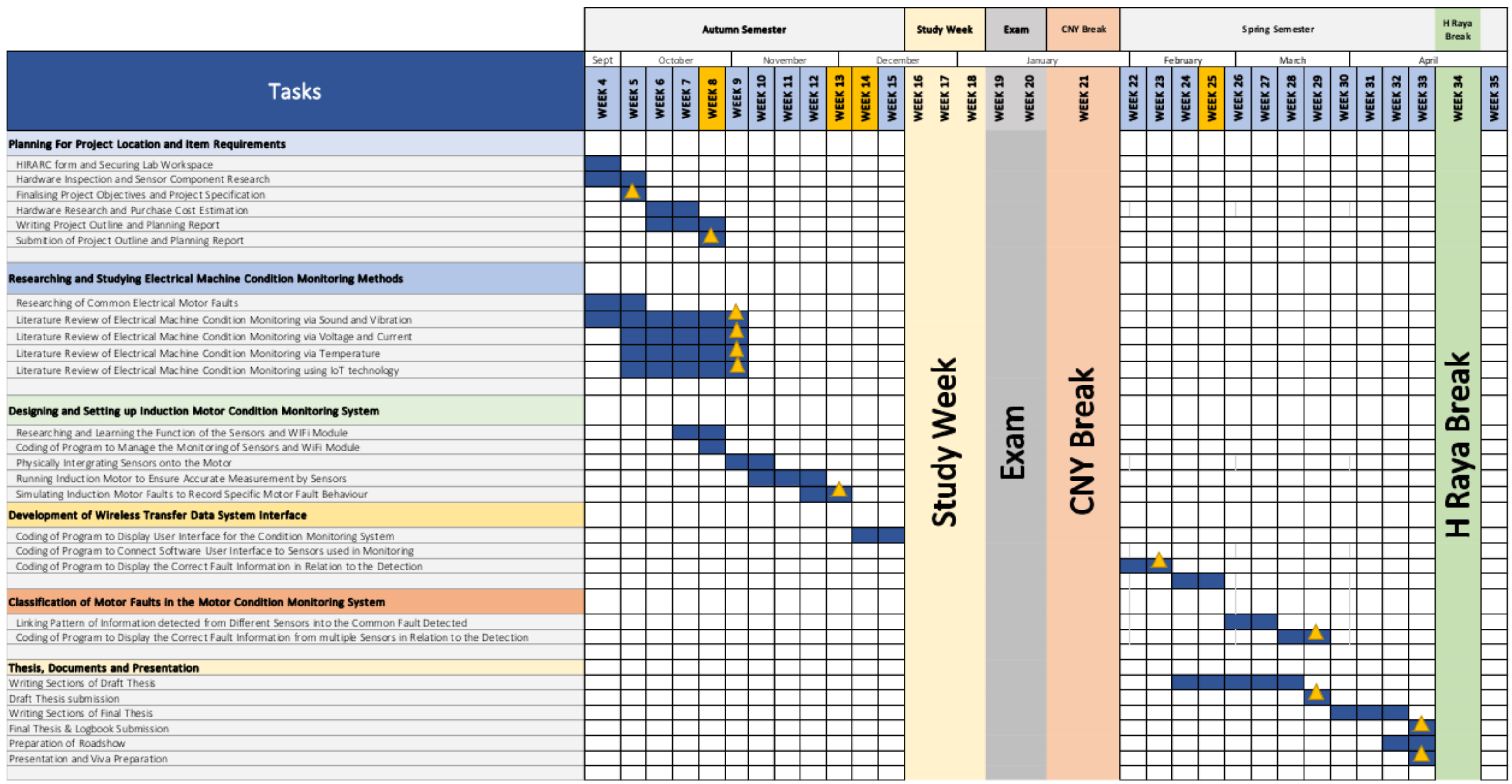
Gantt Chart

Year 4 Individual Project Gantt Chart

Supervisor: Ir. Ts. NANDAN GANESH JEYABALAN
Project Code: NJ-MEng-21-02

Student Name: Joel Wong Zi Xu
Student ID: 20208685

Legends: Week of Moderator Meeting: Milestone:



Project Specifications

Project Code	**NJ-MEng-22-02**
Supervisor	**Ir. Ts. Nandan Ganesh Jeyabalan**
Moderator	**Dr Mumtaj Begam**
Project Description	**Project Title: Electrical Machine Condition Monitoring System** The term reliability is a criterion that must be considered when selecting an electrical machine and its drive system for a particular load. As the cost of machines and drives varies proportionally to their reliability status, studies have been conducted throughout the world to achieve one ultimate goal – to produce a machine and drive system with higher reliability and minimum cost spent in manufacturing it. Therefore, condition monitoring is an important part in ensuring the performance and life span of the electrical machines maintained and improved. This project aims to design an Electrical Machine Condition Monitoring System in order to better monitor the performance and improve the overall efficiency of the electrical machines.
Project Objectives	1. Design and develop a condition monitoring system for the electrical machines. 2. Analyse the performance by monitoring the condition of electrical machines using the developed system. 3. Classify the abnormalities found in monitoring the electrical machines by suing the developed system. 4. Develop a wireless transfer data system to integrate with the developed system for user interface.
Project Deliverables	1. Identify the parameters of the electrical machines that will be used for condition monitoring. 2. Design the condition monitoring system by integrating with the electrical and mechanical sensors. 3. Test the developed system to ensure the condition of the machines is monitored based on the relevant relevant parameters. 4. Develop a wireless transfer data system to transfer the monitored parameters for user interface.
Target Discipline ***(You may check both)***	☑ Electrical and Electronic ☐ Mechatronic

<table>
<tr><td>HW/SW/Research Ratio</td><td><table><tr><td>HW</td><td>SW</td><td>Research/Investigation/Design/Math</td></tr><tr><td>50</td><td>30</td><td>20</td></tr></table></td></tr>
<tr><td>Lab Space Requirements</td><td>☒ Fixed Space

☐ Ad-hoc Space

☐ Others. Please state.</td></tr>
<tr><td>Software (This is software usually supportedin the Software Lab)</td><td>Python, Arduino Programming Codes</td></tr>
</table>

Prepared By:

Ir. Ts. Nandan Ganesh Jeyabalan
30th of September 2022
(Supervisor)

Reviewed By:

Dr Mumtaj Begam
12 Oct. 2022
(Moderator)

Electrical Machine Condition Monitoring System

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