CONDITION MONITORING OF ELECTRICAL EQUIPMENT

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ABSTRACT:

The Stockwell transform (ST) analyses stator current data to diagnose different motor issues such as healthy, stator winding phase-phase faults and ground faults.As well as phase to ground faults,ST decomposes current signals into a complex ST matrix, the magnitude of which is used for fault detection. The nature of the fault, whether ground or phase-phase, is determined by zero sequence currents followed by post fault detection. For all sorts of defects, two independent frequency bands are specified to extract the features, which are then input into two different support vector machine (SVM) models for defective phase identification. In both situations, a heuristic feature selection strategy is used to determine the best characteristics for categorization. An average categorization accuracy of 80%-90% was obtained.

MOTIVATION:

The 3 phase transformer is the most commonly used electrical machine in the industry.Condition monitoring is necessary to avoid motor failure. Different fault monitoring for 3 phase transformer can be broadly categorized as model based, signal processing based and soft computing techniques give good analysis of a faulty system even if accurate models are unavailable.several fault identification methods have been developed and been effectively applied to detect machine faults at different stages by using different machine variables such as current, voltage, speed, temperature,efficiency etc.Thus considering safety and economic factors, it is essential to monitor the condition of machines of different sizes such as large and small. Condition monitoring involves taking measurements on a machine in order to detect the faults with the aim of producing both unexpected failures and maintenance costs.an effective condition monitoring scheme is one that provides warning and predicts the faults at early stage.Monitoring system obtains the information about the machine in the form of primary data.it is possible to give vital diagnostic information to equipment operated before it fails. The problem with this approach is that the result requires constant human interpretation.

METHODOLOGY:

A three-phase transformer rating 5 KVA, primary and secondary with 440V, 4A, 50HZ,Shell core type transformer has been used for the experimental study. The winding faults taken into consideration are phase-to-phase and phase-to-ground fault. Current signals are recorded for different cases of these winding faults. For reference, the current signals for a healthy transformer (without fault) are also acquired. The signal acquisition is performed using a National Instruments-based data acquisition system consisting of NI 9178 chassis, NI 9247 current module, and an interfacing LabVIEW software with a personal computer. The current module is integrated in the chassis to connect with the Transformer. The module has a range from 0 to 50 Arms,±147A peak, and withstands over 1250 Arms for one cycle. It has up to 300 Vrms Channel-to-earth and 480 Vrms Ch–Ch CAT III isolation with a maximum sampling rate of 50 kS/s/ch. The sampling frequency for the measurement is set to 6.4 kHz.Theexperimental hardware set-up used for the data acquisition and schematic diagram of the experimental set up is shown in below figures.The faults are emulated in the Transformer by taking out connections from the windingsand the core. For turn-faults, tappings are provided on the three adjacent windings in each phase. These taps are located in the middle of each phase winding. The ground fault is emulated by a tap provided from the core of the transformer.

Figure 1 and Figure 2 shows the Experimental set-up of the project.

Figure 1

Figure 2

- After getting the current signal we have to collect the different sets of data in the excel file.We are collecting the data with Phase to phase fault,phase to ground fault with 25% load, 50% load, 100% load with resistance 30 ohm.

- After collecting the data, we can record the current signals in the labview software. We will use those data for fault diagnosis i.e finding location where we are getting faulty phase Before this minor fault develops into a major one, we can repair the machine and avoid further loss of millions of dollars.

- Two separate frequency bands are defined to extract the features which are fed to two different support vector machine (SVM) models for faulty phase detection for both types of faults (Ground and phase-phase).

SVM is a computational learning technique that is relatively new and is based on statistical learning theory. The best hyperplane in the feature space is chosen in SVM to maximize the classifier's capacity for generalization. The original input space is translated into this high-dimensional dot product space, which is referred to as the feature space. By utilizing optimization theory and appreciating the

insights offered by statistical learning theory, the ideal hyperplane is discovered. Due to the fact that SVM training is done with the dimension of classified data in mind, SVMs have the ability to handle very large feature spaces.
The performance of SVM is not significantly impacted by vectors in the same way that it is by the performance of traditional classifiers. It is therefore noted to be very effective in huge classification.

RESULTS AND DISCUSSION

- Created interface in the labview software through block diagram which is compatible with the experimental setup.

- To begin, we assembled the experimental setup and received similar current and voltage signals in software as described in the research paper.

SCHEMATIC DIAGRAM OF EXPERIMENTAL SETUP

Figure 3 SHOWS HALF-LOAD GROUND FAULT

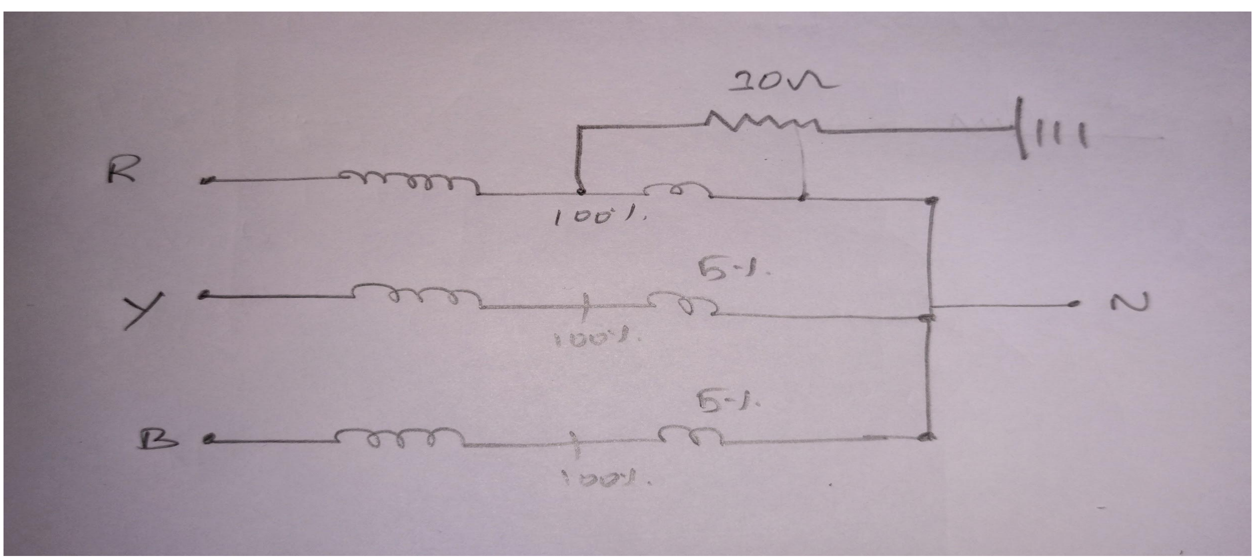


Figure 3

Figure 4 SHOWS Tapping to ground voltage for phase B with 30OHM

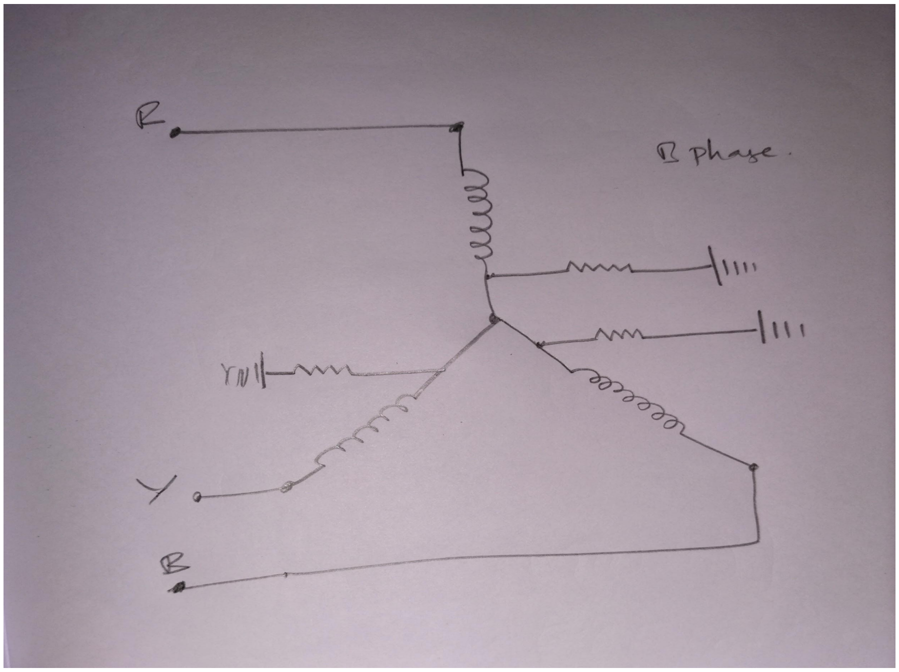


Figure 4

Figure 5 shows Project explorer for labview software

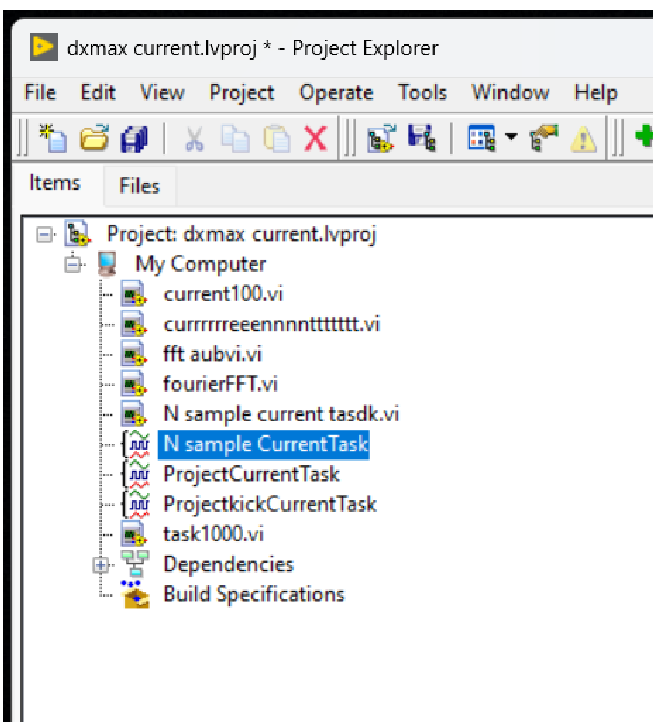


Figure 5

Figure 6 :BLOCK DIAGRAMS FOR THE CURRENT SIGNAL:

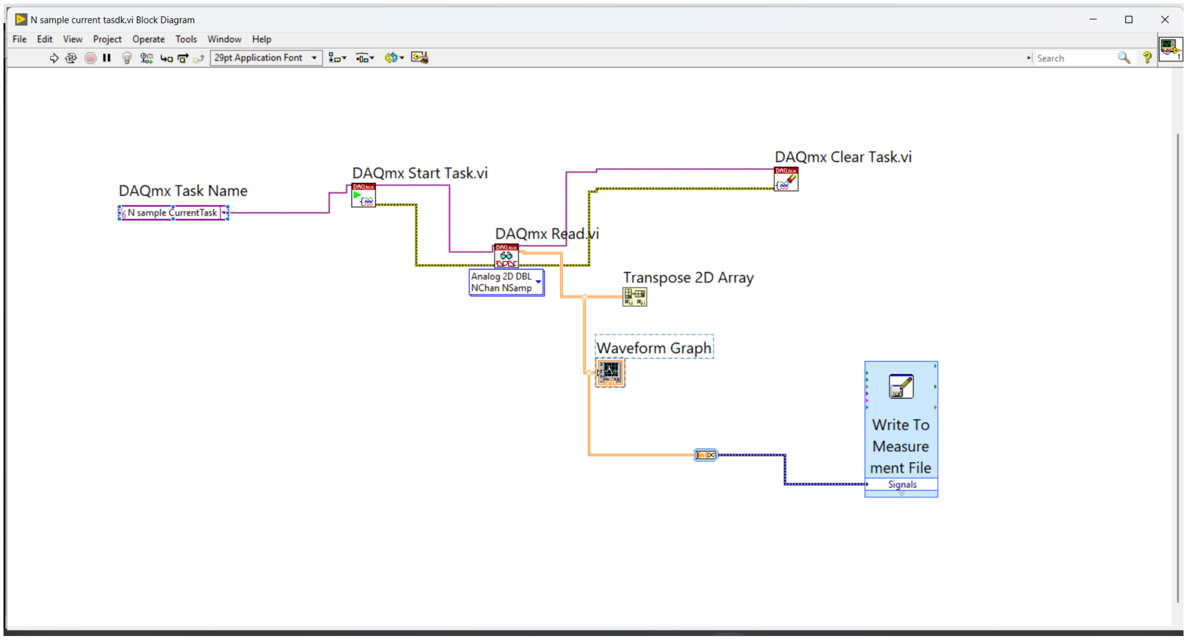


Figure 6

Figure 7 and Figure 8 shows BLOCK DIAGRAMS FOR THE FFT:

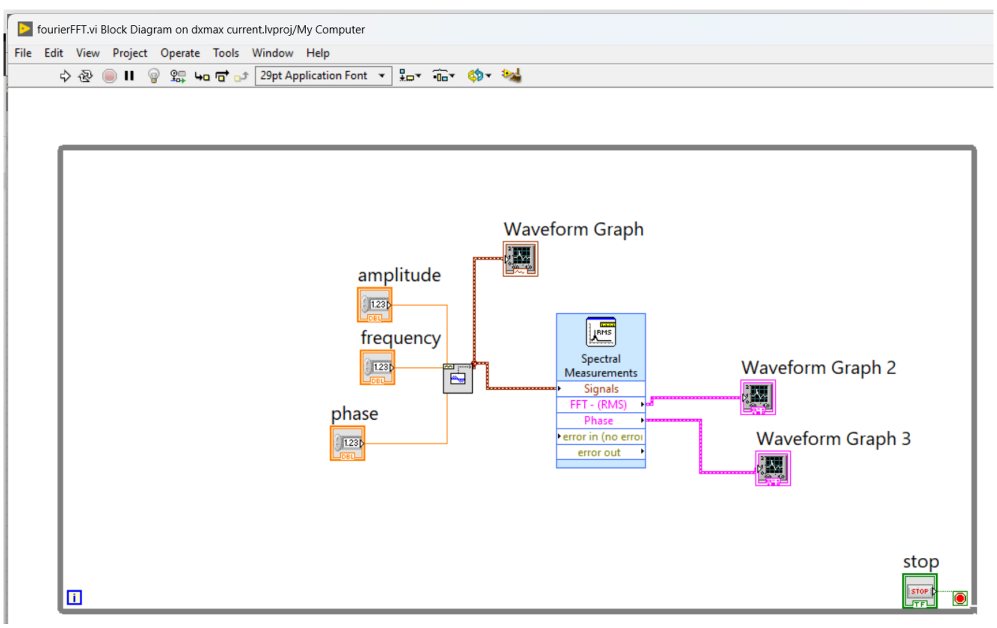
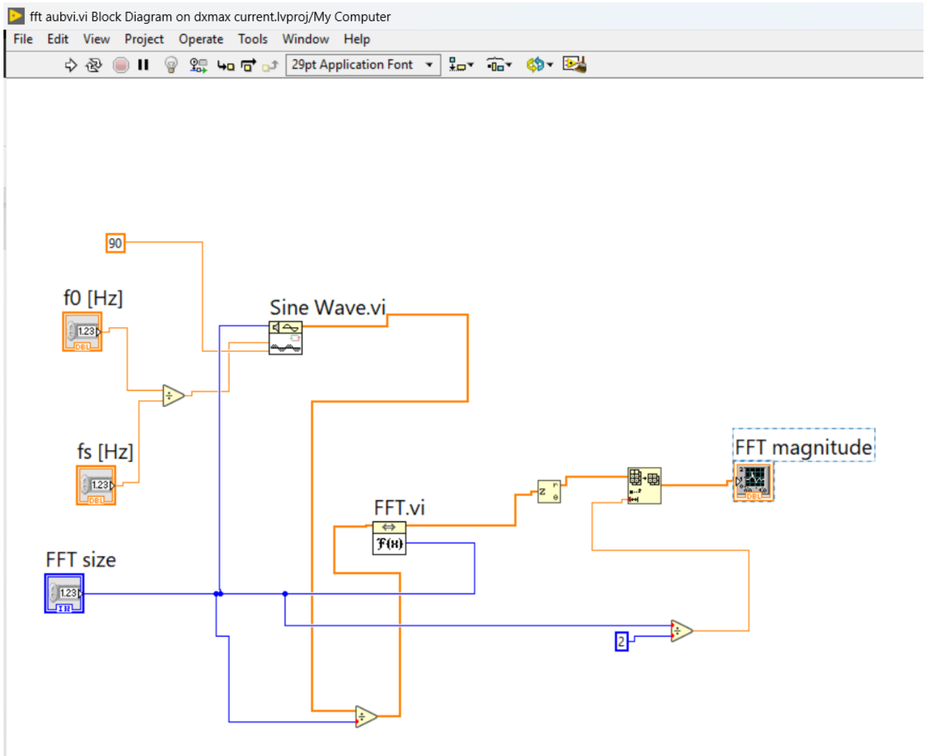


Figure 7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FFT magnitude
FFT.vi
FFT size
2

Figure 8

SIMULATIONS OF CURRENT SIGNALS:

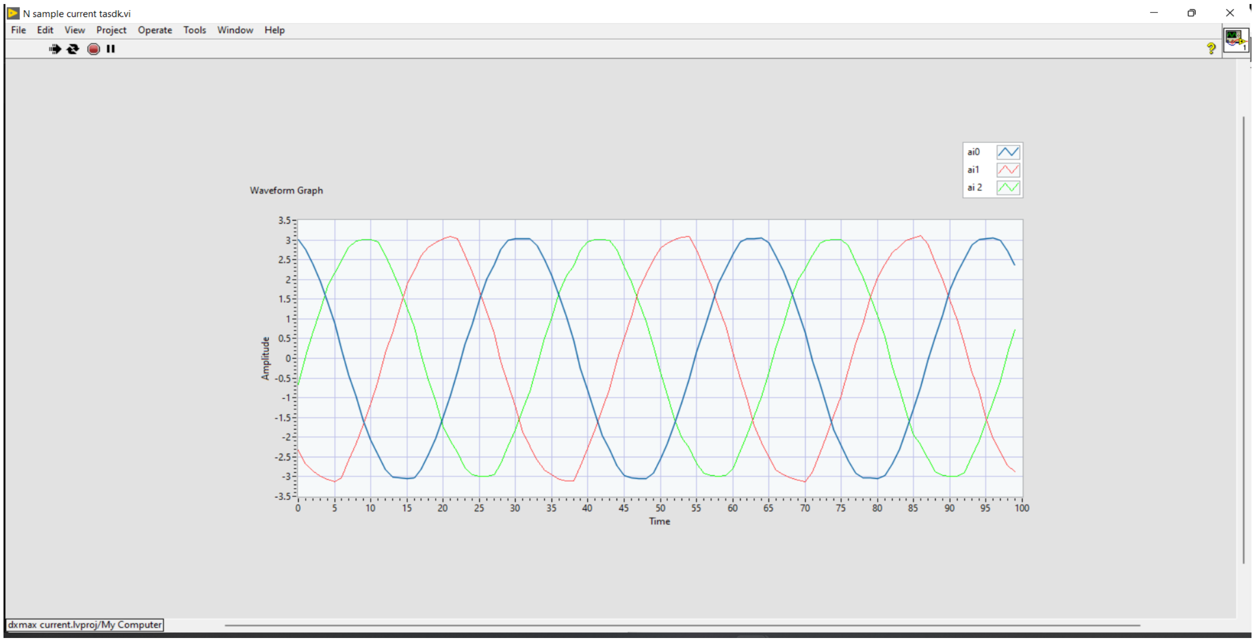


Figure 9

Figure 9 shows HEALTHY CURRENT SIGNAL

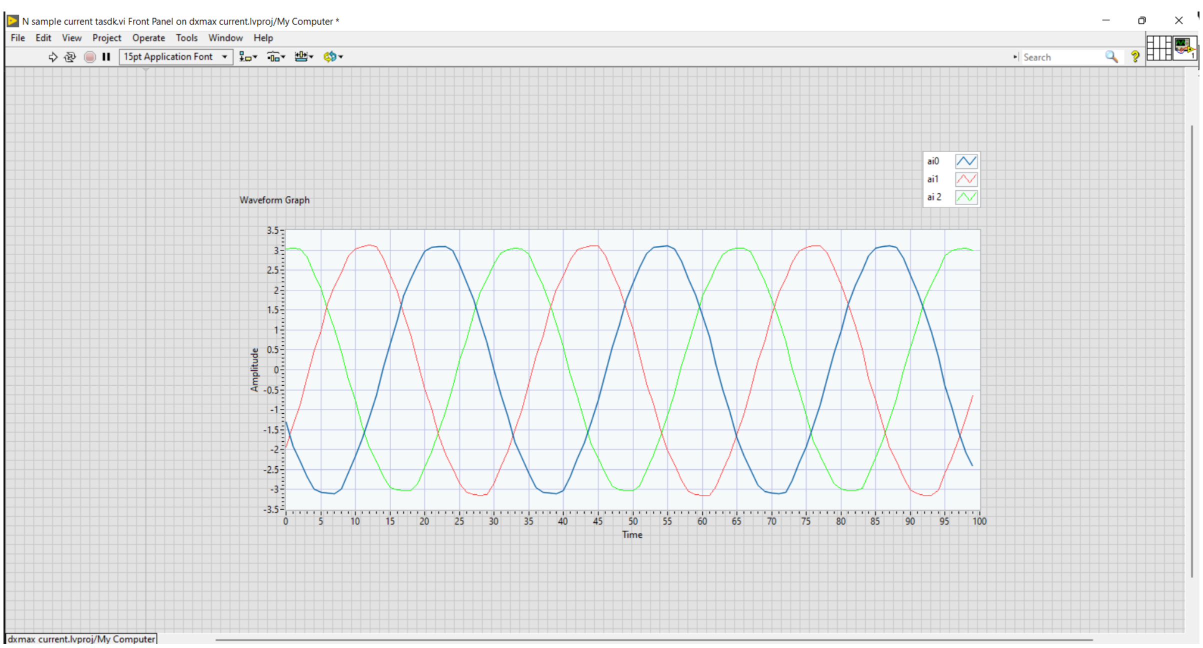


Figure 10

Figure 10 shows GROUND FAULT CURRENT SIGNAL

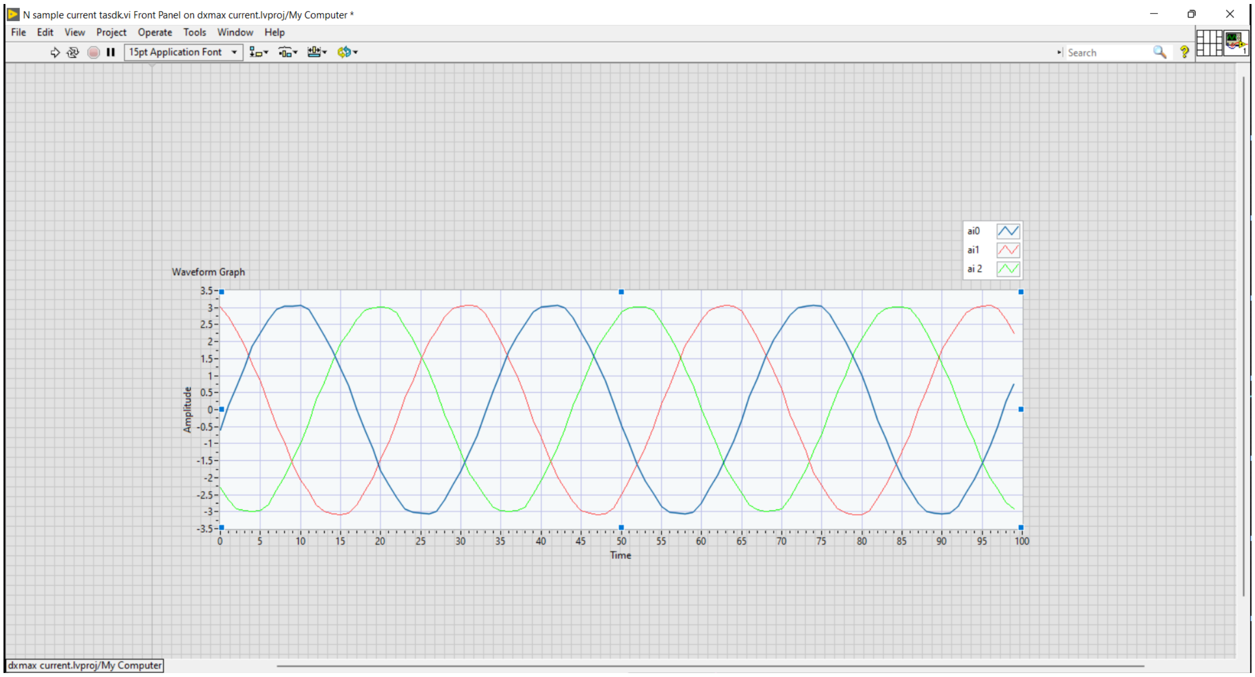


Figure 11

Figure 11 shows PHASE-PHASE FAULT CURRENT SIGNAL

We got the similar results that are mentioned in the research paper.

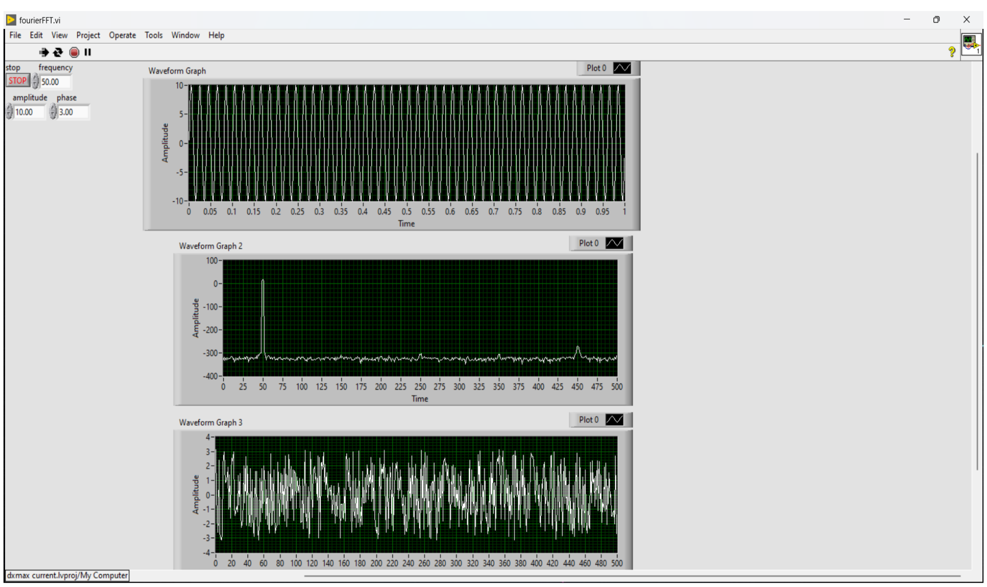


Figure 12

Figure 12 and Figure 13 shows FAST FOURIER TRANSFORM SIMULATIONS FOR THE HEALTHY SIGNAL WITH FREQUENCY 50HZ AS WE CAN OBSERVE PEAK THERE.

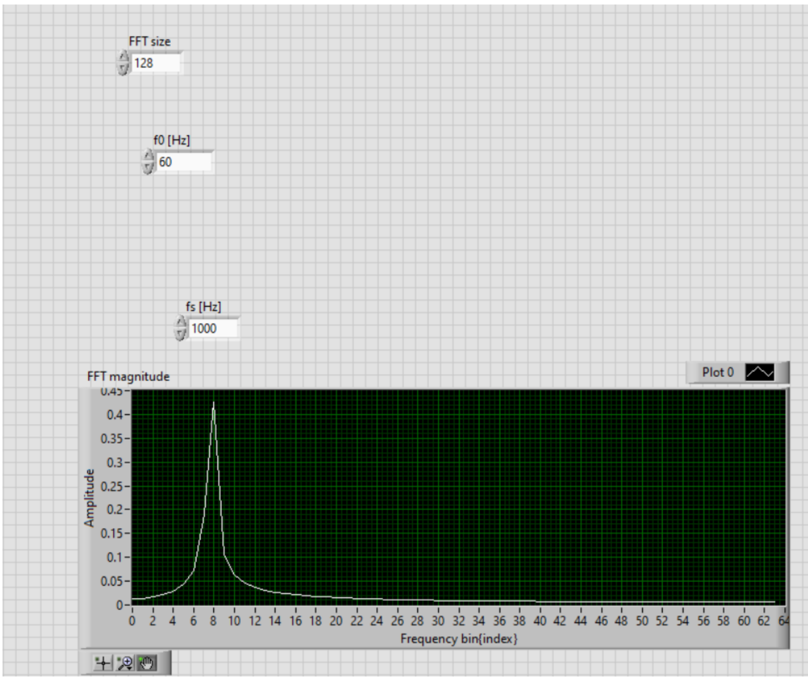
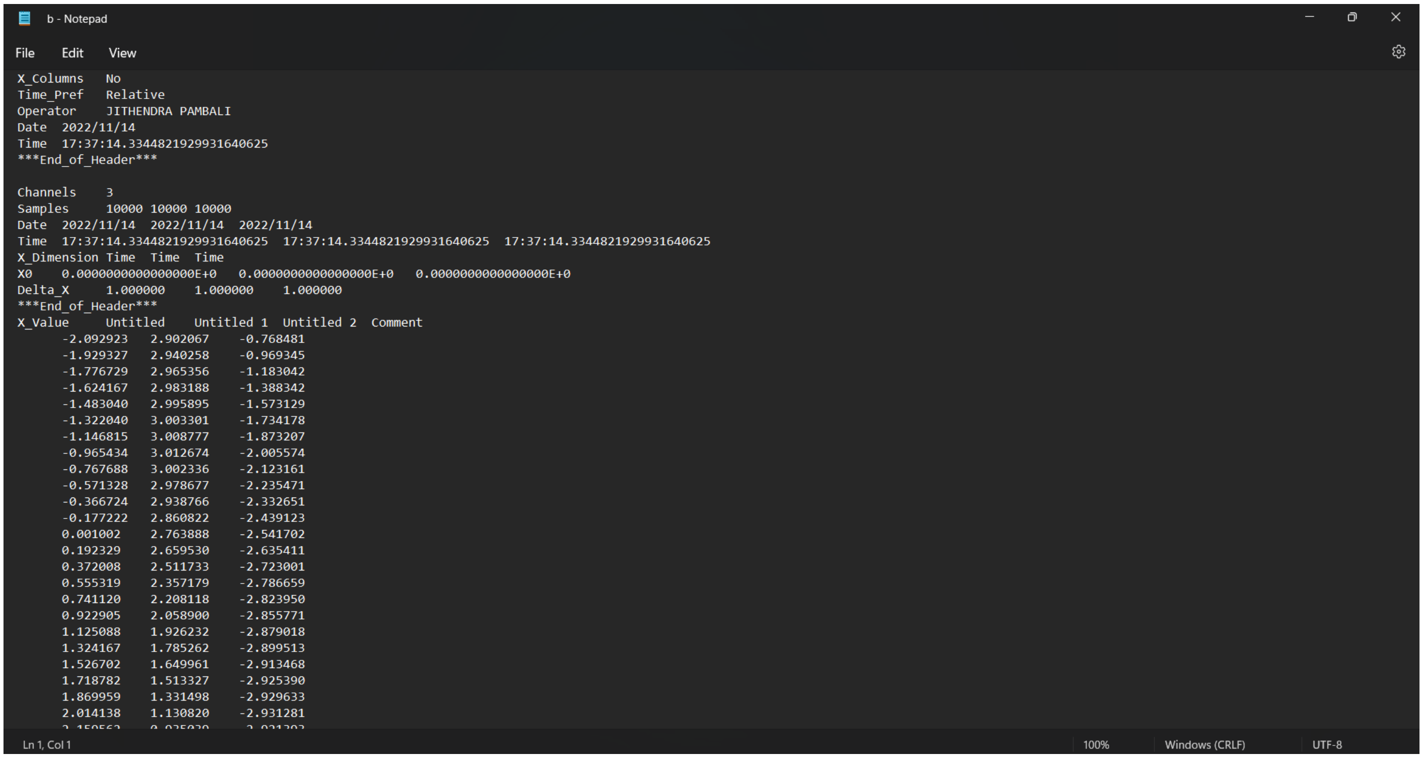


Figure 13

Similarly we will get the fast fourier transform simulations for the ground fault and phase to phase faults.

And we got the current values data with various frequencies in the notepad file which you can see in the Figure 14 screenshot.



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Time_Pref    Relative
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Time  17:37:14.334482192993164062５
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Samples      10000 10000 10000
Date  2022/11/14  2022/11/14  2022/11/14
Time  17:37:14.3344821929931640625  17:37:14.3344821929931640625  17:37:14.3344821929931640625
X_Dimension Time  Time  Time
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Delta_X      1.000000    1.000000    1.000000
***End_of_Header***
X_Value      Untitled    Untitled 1  Untitled 2  Comment
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      -1.624167   2.983188    -1.388342
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      0.001002    2.763888    -2.541702
      0.192329    2.659530    -2.635411
      0.372008    2.511733    -2.723001
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      0.922905    2.058900    -2.855771
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SELECTED FREQUENCY RANGES USEFUL FOR DETECTING THE FAULTY PHASE

Faulty Phases	Useful frequency ranges	Selected frequency ranges
Phase-A	300-350 Hz	280-350 Hz,
Phase-B	90-120 Hz, 280-350 Hz	100-120 Hz,
Phase-C	100-160 Hz, 190-240 Hz	190-240 Hz

Figure 15

We got a similar frequency range which varied for faulty phases A, B, C as 270-320 HZ , 90-120HZ and 80-130HZ.

TOTAL CURRENT DATA SET RECORDED UNDER VARIOUS TRANSFORMER CONDITIONS

Condition	Phase-A	Phase B	Phase C	Total
Healthy	-	-	-	5
Phase-o-phase -faults	10	10	10	30
Ground faults	20	20	20	60

Figure 16

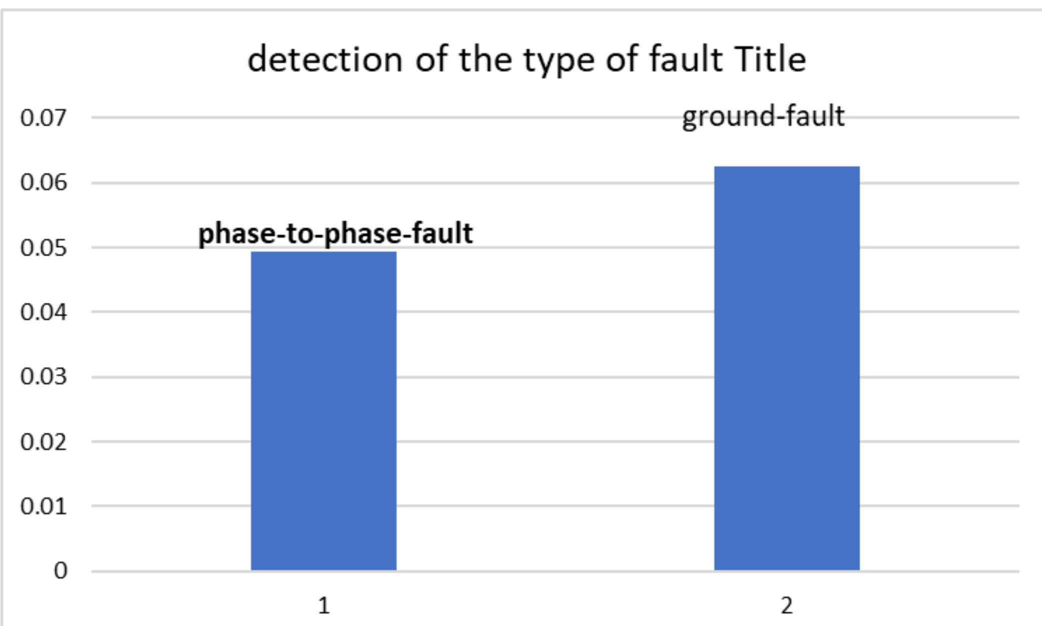

Figure 17

Figure 17 shows Fault index for discriminating phase-to-phase-faults and ground faults in stator windings.

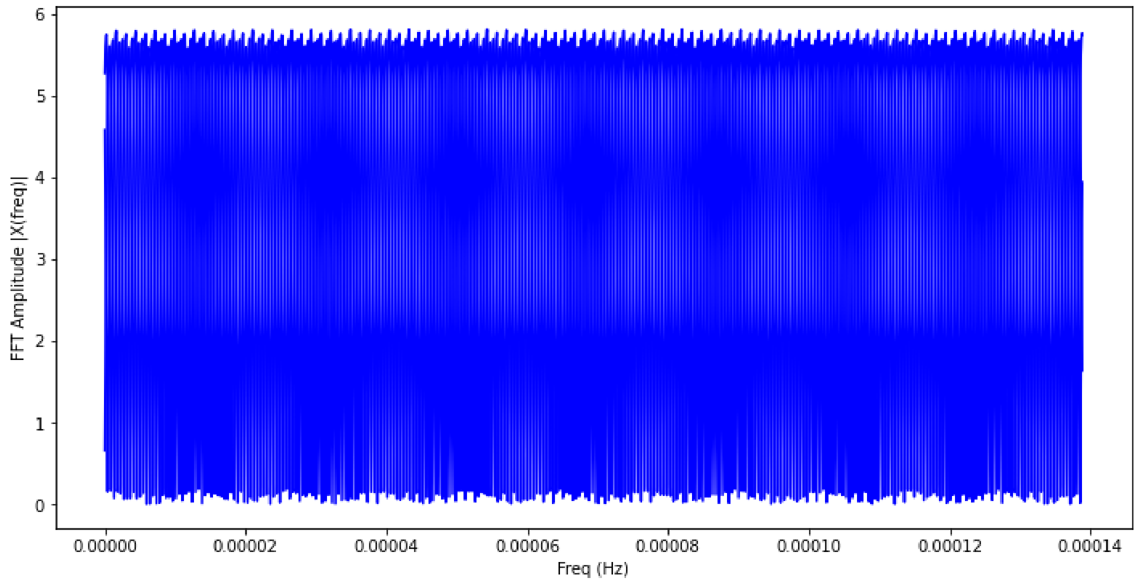

Figure 18

We Transformed the data into frequency domain in figure 18 and also we see some clear peaks in the FFT amplitude figure, but it is hard to tell what they are in terms of frequency.

Figure 19

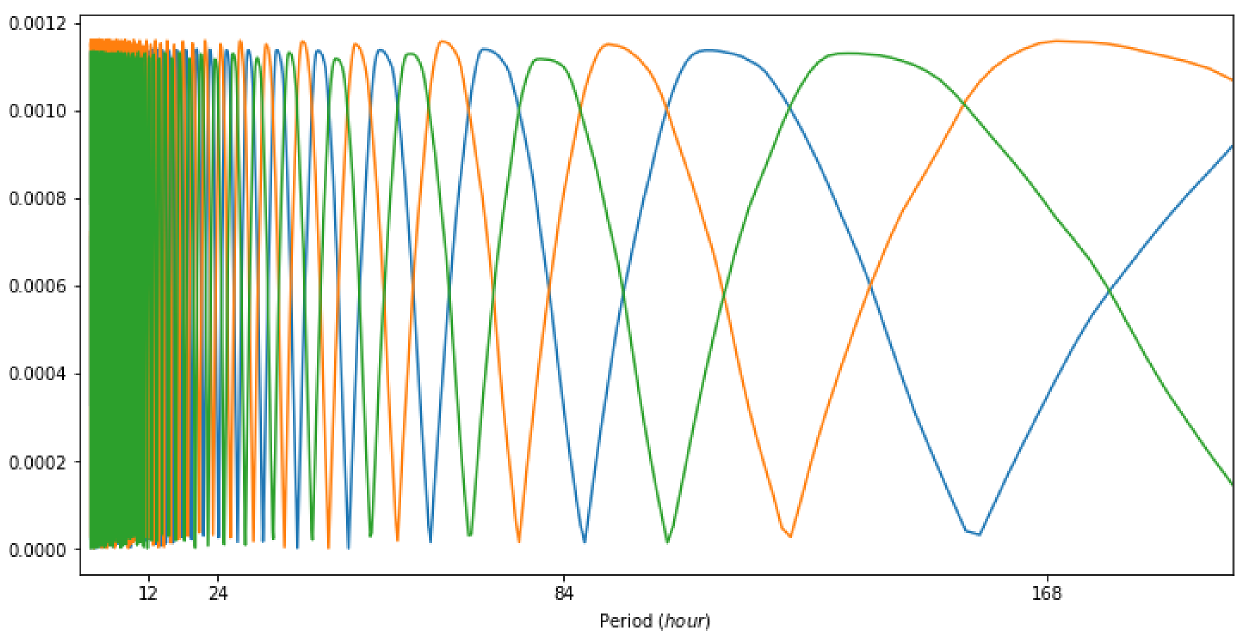

Figure 19 shows Plotting the results using hours and highlighting some of the hours associated with the peaks.

CONCLUSION:

Hence, we conclude that we successfully generated the similar results and simulations that are mentioned in the research paper. We created a fault diagnostic system for detecting, classifying, and locating stator winding problems in a three-phase transformer using ST decomposition of stator currents. By collecting those data we did two types of fault analysis (ground fault and phase-phase fault).The first stage of fault diagnosis utilizes the fault index defined based on this SD to detect the fault.

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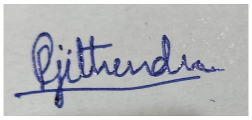
4. A. Siddique, G. S. Yadava, and B. Singh, “A review of stator fault monitoring techniques of induction motors,” IEEE Trans. Energy Convers., vol. 20, no. 1, pp. 106–114, Mar. 2005.
5. .J. Seshadrinath, B. Singh, and B. K. Panigrahi, “Incipient inter turn fault diagnosis in induction machines using an analytic wavelet-based optimized Bayesian inference,” IEEE Trans. Neural Netw. Learn. Syst., vol. 25, no. 5, pp. 3990–1001, May 2014.

SIGNATURES

STUDENTS: **SUPERVISOR**

1. 

2.