Design of Condition Monitoring System with User-Interface for Electrical Machines

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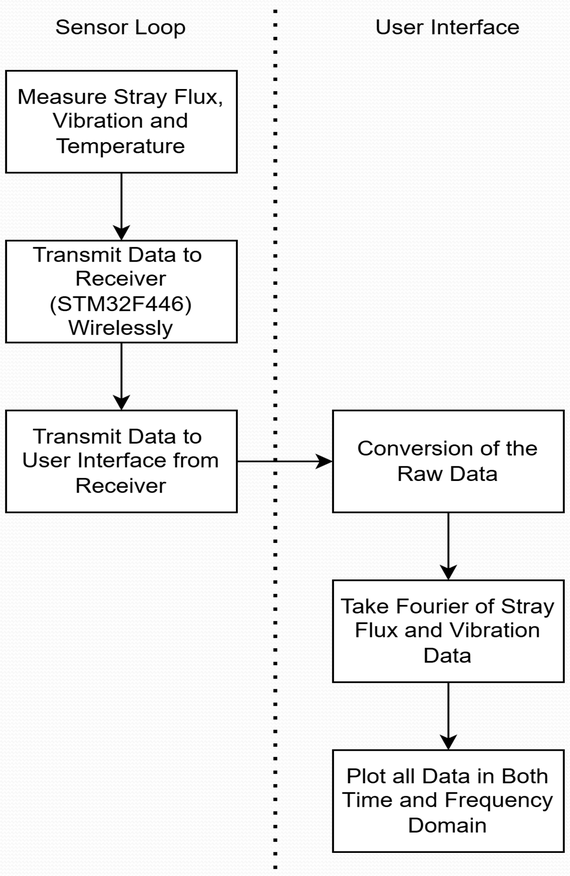
1 INTRODUCTION

This project develops an innovative sensor system combining magnetic flux, vibration, and temperature measurements for early fault detection in electrical machines.

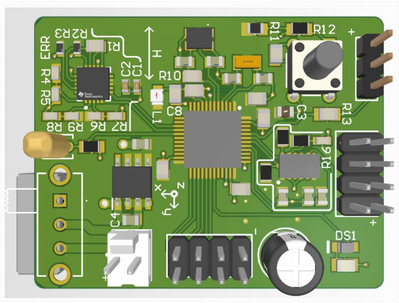
It enables real-time wireless data transfer and advanced analysis via FFT and Wavelet methods through a user-friendly interface.

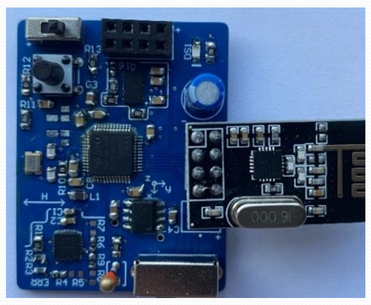


2 METHOD

Circuit Design:

The sensor system was designed around a multi-layer PCB integrating a DRV425 fluxgate sensor, ADXL345 accelerometer, and an NTC thermistor. As a microcontroller STM32F103 is used.





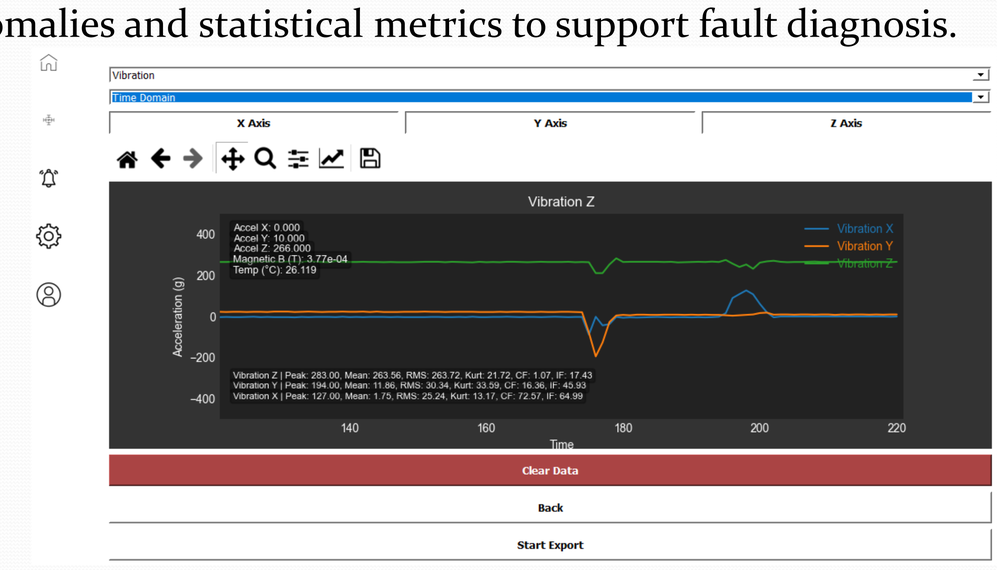
Communication Infrastructure:

Collected sensor data are formatted by the STM32 microcontroller and transmitted wirelessly using the NRF24L01 module. A dedicated receiver unit forwards the data via UART to the user interface, enabling real-time monitoring.

Sample Data Format (PACKET): **#X#Y#Z#DRV#NTC**
Ex: #120#-45#980#2345#1833

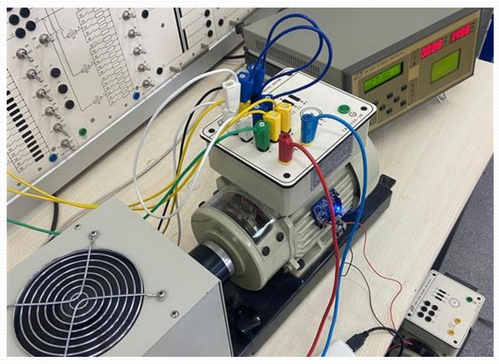
User Interface:

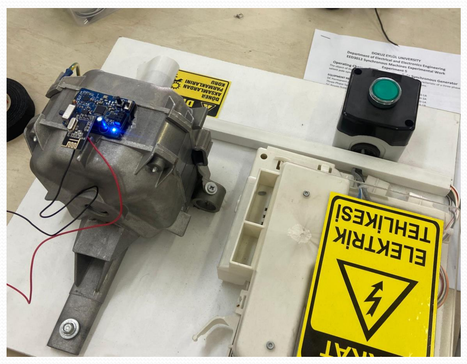
A Python-based graphical interface built with PyQt5 provides secure login, live sensor visualization, and advanced analysis tools such as FFT and wavelet transforms. The interface displays anomalies and statistical metrics to support fault diagnosis.



TEST RESULTS 3

The sensor was tested on 3 phase wound rotor motor at 1490 rpm. Communication and data collection were successful.

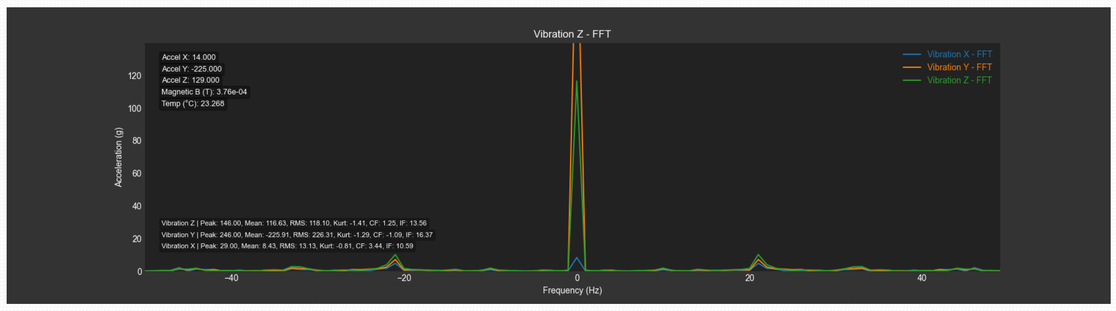




Expected vibration frequency = $\frac{1490}{60} = 24.83$ Hz

Plotted vibration frequency = 21.93 Hz

Further improvements will focus on signal data resolution and clearity to decrease error.



COST ANALYSIS 4

Cost Type	Price
Capacitors, Resistors, Connectors, etc.	125,71 ₺
Sensors (DRV, ADX, NTC)	797,4 ₺
IC's (STM, Regulator, NRF)	153,94 ₺
Printed Circuit Board Manufacturing	70 ₺
Total	1147 ₺*

CONCLUSION 5

This project presents a compact and multifunctional sensor system for real-time fault detection in electrical machines. Using DRV425, ADXL345, and NTC sensors, magnetic flux, vibration, and temperature are monitored simultaneously with wireless communication. Advanced signal processing techniques like FFT and Wavelet Transform enabled accurate and early diagnostics.

Supported by TÜBİTAK 2209-A, further work will enhance system reliability and bring it closer to industrial application and commercialization.

REFERENCES 6

[1] T. Goktas, M. Arkan and V. Gurusamy, "A Comparative Study of Current, Vibration and Stray Magnetic Flux Based Detection for Parallel Misalignment Fault in Induction Motors," 2021 IEEE 13th International Symposium on Diagnostics for Electrical Machines, Power Electronics and Drives (SDEMPED)
[2] Broken rotor bar fault detection of the grid and inverter fed induction motor by effective attenuation of the fundamental component Article in IET Electric Power Applications

*Total cost is calculated for a single product

We would like to express our sincere gratitude to our Advisor Assoc. Prof. Dr. Taner Göktaş, who guided us throughout this project.