Project Report: Predictive Maintenance of Gearbox

Company: Uniconverge Technologies Pvt. Ltd.

# Background

In the manufacturing industry, gearboxes are critical components that transfer mechanical power and are widely used in heavy machinery. Any unexpected failure in a gearbox can halt operations and result in substantial downtime and repair costs. Predictive maintenance using sensor data provides an effective solution by identifying faults before they lead to major failures.

This project uses real-world vibration data obtained from SpectraQuest’s Gearbox Fault Diagnostics Simulator to predict gearbox conditions under various load scenarios.

# Problem Statement

To develop a machine learning model that accurately distinguishes between a healthy gearbox and one with a broken tooth based on vibration sensor readings. The goal is to assist manufacturing plants in automating predictive maintenance, minimizing downtime, and improving equipment reliability.

# Relevance

This solution is especially relevant in Industry 4.0 environments where predictive maintenance is a key driver for smart factory initiatives. It directly contributes to reducing maintenance costs, increasing safety, and extending the life of industrial equipment.

# Design

- Sensor Setup: Four vibration sensors were used, mounted at different locations on the gearbox.

- Scenarios Covered:

- Healthy gearbox under loads from 0% to 90%

- Broken tooth condition under varying loads

- Data Format: Vibration readings stored in `.txt` format for both healthy and faulty conditions

# Implementation Details

- Data Preprocessing:

- Extracted time-domain features like mean, standard deviation, RMS, min, max, skewness, and kurtosis from each sensor

- Created a consolidated dataset of 8 files (5 faulty, 3 healthy)

- Feature Engineering:

- 28 features per sample (7 per sensor × 4 sensors)

- Model Used:

- RandomForestClassifier from Scikit-learn

- Train-Test split: 80-20 ratio

- Evaluation:

- Confusion Matrix

- Accuracy, Precision, Recall, and F1-Score

# Results

- Accuracy: 100%

- Classification Report:

- Precision, Recall, F1-score = 1.00 for both classes

- Confusion Matrix:

- All healthy and faulty gearboxes were correctly classified

# Learnings

- Learned to handle multi-sensor time series data

- Developed skills in feature extraction from vibration signals

- Gained practical experience with predictive maintenance systems

- Understood the role of machine learning in manufacturing diagnostics

# Future Improvements

- Incorporate frequency domain features (FFT)

- Use deep learning models like LSTMs or CNNs for time series classification

- Deploy model to edge devices for real-time fault detection

# Prepared by

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# Internship Duration

6 weeks

# Guided by

Uniconverge Technologies Pvt. Ltd.

# GitHub Repository

https://github.com/Samarth-Ghare