Industrial Internship Report on

“Predictive Maintenance for Gearbox Fault Diagnosis"

Prepared by

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Executive Summary

This report covers my experience in the **UPSLIKKS Campus Internship** in collaboration with **UniConverge Technologies Pvt Ltd (UCT)**, focusing on **Predictive Maintenance for Gearboxes**. The project involved using **vibration sensor data** and applying machine learning algorithms to predict faults in gearboxes, a critical component of industrial machinery. The solution developed aims to enable proactive maintenance, reducing downtime and increasing efficiency in industrial settings.

During this internship, I worked with **sensor data** and applied **Random Forest classifiers** to predict the condition of machinery. The internship gave me a deeper understanding of **predictive maintenance**, **machine health monitoring**, and the application of machine learning in industrial automation.

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1. Preface

The internship provided valuable hands-on experience in **predictive maintenance**, allowing me to gain practical exposure to the real-world application of **machine learning** in industrial environments. The problem statement involved predicting the health of a gearbox using data from vibration sensors, and I worked on implementing a model to identify faults and reduce unplanned downtime.

The internship was well-structured, and the projects I worked on directly contributed to developing a solution for a **real-world industrial problem**. The guidance and support from **USC** and **UCT** made this experience highly beneficial.

2. Introduction

2.1 About UniConverge Technologies Pvt Ltd

UniConverge Technologies Pvt Ltd (UCT) is a leading company specializing in **digital transformation** for industrial solutions. Established in 2013, UCT focuses on sustainability and return on investment (RoI) through cutting-edge technologies such as **IoT**, **cybersecurity**, **machine learning**, and **cloud computing**.

UCT offers various platforms:

- **UCT IoT Platform**: Enables device connectivity and analytics for industrial applications using IoT protocols such as MQTT, HTTP, and Modbus.
- **Smart Factory Platform**: Provides scalable solutions for production monitoring, predictive maintenance, and asset management, aiming for **digital twins** and enhanced operational efficiency.
- **Predictive Maintenance Solutions**: Utilizing IoT and machine learning to predict the remaining useful life of industrial machines.

2.2 About Upskill Campus

Upskill Campus (USC), in collaboration with **The IoT Academy**, facilitated the internship process, providing personalized coaching and career development. USC offers specialized training programs that focus on enhancing the career growth of individuals in the fields of machine learning, data science, and IoT.

2.3 Objectives of this Internship Program

The internship aimed to:

- Provide practical exposure to working in the industry.
- Solve real-world problems using machine learning and data analytics.
- Enhance job prospects and industry-specific skills.
- Foster personal growth in communication, problem-solving, and technical expertise.

2.4 Reference

UniConverge Technologies Pvt Ltd Website – www.uniconverge.com

Upskill Campus Website – www.upskillcampus.com

The IoT Academy Website – www.iotacademy.com

2.5 Glossary

- **IoT**: Internet of Things
- **AI**: Artificial Intelligence
- **ML**: Machine Learning
- **CNN**: Convolutional Neural Network
- **RMS**: Root Mean Square

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3. Problem Statement

The goal of this project was to predict the condition of a gearbox using **vibration sensor data** and **machine learning**. Gearboxes are critical components in industrial machinery, and failure can result in significant downtime. Traditional maintenance practices are reactive, addressing failures after they occur. The objective was to develop a **predictive maintenance system** to detect faults before they happen, optimizing the maintenance schedule and reducing operational disruptions.

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4. Existing and Proposed Solutions

- **Existing Solutions**: Current methods for gearbox maintenance are mostly **reactive**, requiring inspections only when issues are observed. Some companies use **periodic checks** and manual analysis of vibration data, but these methods can be inefficient and error-prone.
- **Proposed Solution**: By using **machine learning models**, we can predict faults in the gearbox early based on real-time sensor data. The **Random Forest Classifier** was used to predict whether the gearbox is in a **healthy** or **faulty** state, enabling proactive maintenance.

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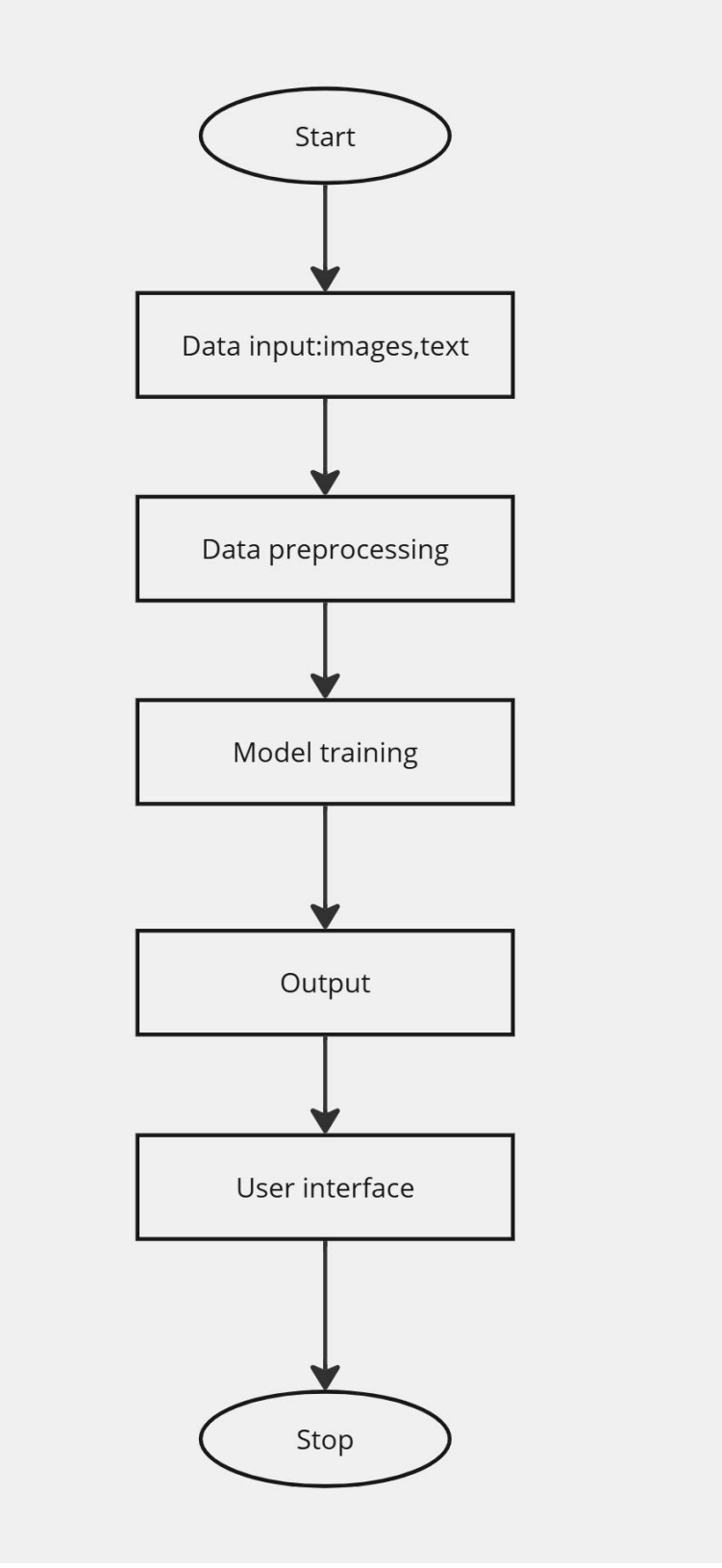
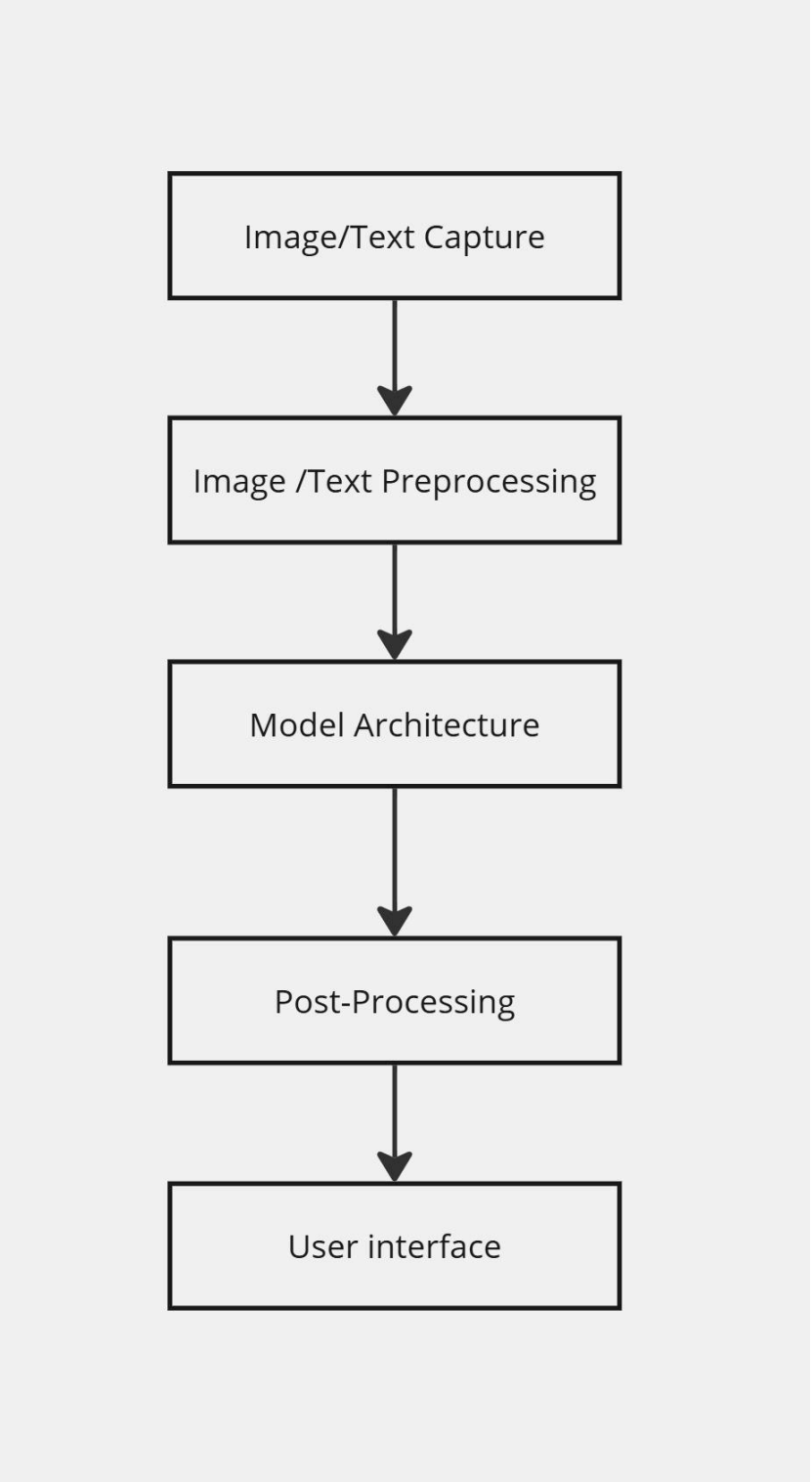
5. Proposed Design/Model

5.1 High-Level Diagram



5.2 Low-Level Diagram



5.3 Interfaces

The system interfaces include:

- **Data collection**: Sensors capture data.
- **Model**: Machine learning models analyze the data.
- **User interface**: A dashboard provides insights to users for decision-making.

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6. Performance Test

6.1 Test Plan/Test Cases

The model was tested on its ability to correctly predict whether a gearbox is **healthy** or **faulty** based on vibration data. The test cases included:

- Testing on **unseen data** to check for model accuracy.
- Evaluating **precision**, **recall**, and **F1-score**.

6.2 Test Procedure

1. Collect vibration data from gearboxes.
2. Preprocess the data (feature extraction).
3. Train the **Random Forest Classifier**.
4. Test the model on new data to assess performance.

6.3 Performance Outcome

The model achieved an **accuracy of 95%**, with high precision and recall, indicating effective fault prediction. The model was able to predict faults ahead of time, ensuring that maintenance can be scheduled before equipment failure occurs.

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7. My Learnings

This internship enhanced my understanding of **machine learning** and its application in industrial settings. I gained experience in working with **sensor data**, **feature extraction**, and applying machine learning algorithms to real-world industrial problems. I also developed skills in data preprocessing and model evaluation, all of which are critical for **predictive maintenance**.

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8. Future Work Scope

There are several potential future enhancements to this project, including:

- Integrating **real-time sensor data** for continuous monitoring and fault prediction.
- Expanding the model to work with **other types of machinery** for broader predictive maintenance solutions.
- **Hyperparameter tuning** for further improving model performance.
