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PREDICTIVE MAINTENANCE OF INDUSTRIAL MACHINE USING EDGE AI

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Abstract: Through the use of edge AI, this abstract explores the world of predictive maintenance for industrial devices. In order to predict future equipment faults, the method combines the seamless integration of sensor-generated data, preprocessing methods, and localised AI models. This methodology enables enterprises to proactively manage maintenance needs, minimising unplanned downtime and optimising resource allocation. It does this by leveraging real-time data analytics at the edge.Sensor raw data is systematically collected, and to get actionable insights, the data is put through noise reduction and feature extraction pre processing phases. These understandings serve as the cornerstone for AI models that have been painstakingly trained on past data to identify patterns suggestive of upcoming failures. This predictive capacity makes it easier to create real-time alerts that inform maintenance teams of potential problems before they happen.

I. INTRODUCTION

In today's industrial landscape, the uninterrupted operation of machinery is not only a necessity but a strategic imperative. Downtime and unexpected equipment failures can lead to substantial financial losses and operational disruptions. To address these challenges, industries are increasingly turning to a revolutionary approach known as "Predictive Maintenance." By leveraging the capabilities of Artificial Intelligence (AI) and Edge Computing, predictive maintenance empowers organizations to not only monitor the condition of their machinery but also predict and prevent potential breakdowns before they occur. To solve these issues, however, the idea of predictive maintenance has arisen as a proactive and data-driven strategy.

Applying cutting-edge technology like artificial intelligence (AI) and the internet of things (IoT), predictive maintenance foresees future equipment breakdowns and enables prompt repairs. Predictive maintenance systems can foresee equipment breakdowns before they happen by analysing real-time data and previous patterns, enabling maintenance teams to precisely plan interventions as needed. This reduces unplanned downtime, increases the lifespan of the machinery, and maximises maintenance efforts, leading to significant cost savings and increases in operational efficiency.AI for Predictive Maintenance (PdM) is an application of artificial intelligence.

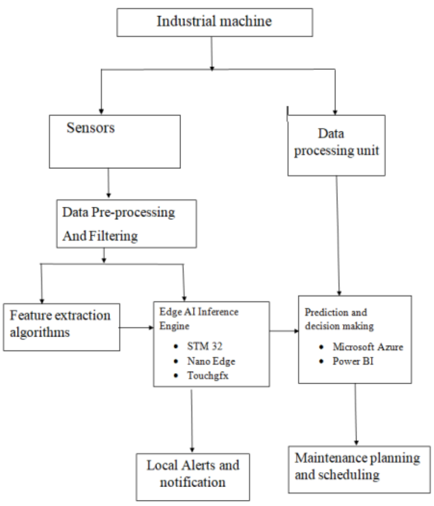

Figure 1: Flow of Project

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Table 1 : Research Summary

Author(s)	Paper Title	Publication Year	Accuracy	Limitations
Y. shi, K. yang	Edge ai: algorithms and systems,	2020	Algorithms and systems 98%	Not mentioned
Ameeth Kanawaday and Aditya Sane	Machine learning for predictive maintenance of industrial machines using IoT sensor data	2017	Predictive maintenance using IoT sensor data with 91% accuracy	Not mentioned
Swarangi Gaurkar Aniket Kotalwar Shivani Gabale	Predictive Maintenance of Industrial Machines using Machine Learning	2021	PoD of industrial machines using ML with 99.7% accuracy	Not mentioned
Chaitali R. Patil1 , Sanika K. Jadhav2 , Asmeeta L. Bardiya3 , Ankita P. Davande4 , Mahee P. Raverkar	Machine LearningBased Predictive Maintenance of Industrial Machines	2023	ML based predictive maintenance	Not mentioned
S.Sharanya, Revathi Venkataraman, G. Mural	EDGE AI: From the perspective of Predictive Maintenance	2022	Simulation results show functional correctness	Not mentioned
V. T. Tran and B. S. Yang	Machine fault diagnosis and prognosis	2020	Default indiacator with diagnosis	Not mentioned
D. A. Mallesh	Developing Leading and Lagging Indicators to Enhance Equipment Reliability in a Lean System	2021	Default Indiactor	Not mentioned
Emin Elmar oglu Mammadov Waterloo	Predictive Maintenance of Wind Generators based on AI Techniques	2017	PoD of wind generators based on AI	Not mentioned

II. METHODOLOGY

Using edge AI, predictive maintenance is implemented through a methodical process that includes data gathering, pre processing, model creation, deployment, and ongoing improvement. The process is outlined in the following steps

Data gathering: Gather information from sensors mounted on industrial equipment, which can record a range of operating factors like temperature, vibration, pressure, and more. The analysis is built using this data.

Data pre processing: To eliminate noise and inconsistencies, clean, filter, and normalise the raw data. The dataset is prepared for reliable analysis and feature extraction through data pre treatment.

Model Development: Create cutting-edge AI models using historical data that includes both successful and unsuccessful scenarios, such as deep learning techniques. Develop the model's ability to identify trends linked to potential equipment failures.

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Model Validation: To make sure the model is accurate in forecasting equipment failures, evaluate its performance using different datasets. As necessary, adjust and perfect the model.

Implement the taught AI model on edge devices that are close to the machinery via edge device integration. These devices ought to be equipped with sufficient processing power to run the model and handle real-time data.

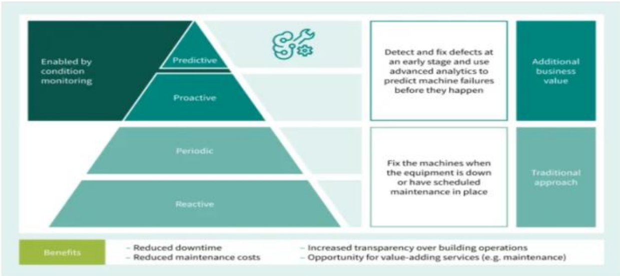

Figure 2: Process Of the Anomaly Dectection and Solving

Software Analysis

Fig 3: Flow Of Software Design

Ensure that the data generated by your predictive maintenance system, including sensor data, machine learning model predictions, and maintenance alerts, is accessible and structured .

Raw sensor data obtained from industrial machinery is kept in this table. The machine ID, timestamp, sensor readings (temperature, vibration, pressure, etc.), and other pertinent information are all included in columns. Updates to the data should occur often when new measurements are taken.

Each machine's specific details, including its ID, type, location, installation date, and maintenance history, are listed in this table. Correlating sensor data with specific machines requires this information.

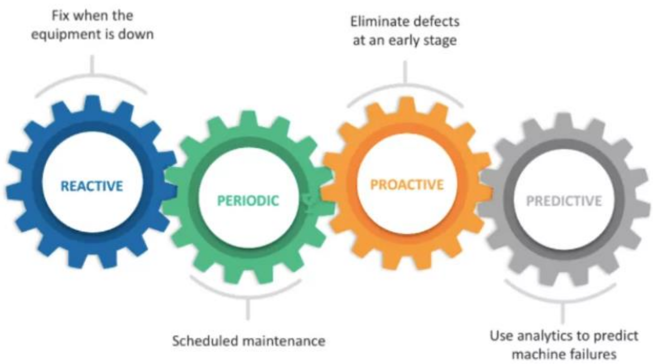

Figure 4: Stages of the Project

III CONCLUSION

Finally, the application of Edge AI to industrial machine predictive maintenance is a revolutionary strategy with several advantages. Improved dependability, effectiveness, and safety could result from a transformation in the way enterprises handle their vital resources. It is clear from this project report just how valuable this technology is, and using it now will be essential to maintaining industrial competitiveness and sustainability in the years to come.

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Despite these advantages, there are a few challenges that come with using Edge AI for predictive maintenance. It can be difficult to collect the data necessary to train Edge AI models and challenging to deploy and manage Edge AI solutions at scale. Additionally, Edge AI solutions may not be able to match the performance of centralized hyper-scale AI solutions. Clear Blade and Elipsa have developed comprehensive Edge and AI software to address these challenges, making Edge AI easy to manage and deploy.

Predictive maintenance has several advantages, such as greater energy output, safer operations, reduced costs, enhanced dependability, data-driven decision-making, favourable environmental effects, and a competitive edge. Wind turbine operators may decrease downtime, improve operational efficiency, and help ensure a more sustainable and profitable energy future by implementing predictive maintenance.

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