AI-Based Predictive Maintenance System

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***Abstract*—The AI-Based Predictive Maintenance System is an intelligent solution designed to monitor machine health and predict equipment failures before they occur. Traditional maintenance methods often lead to increased downtime and maintenance costs due to unexpected machine breakdowns or unnecessary servicing. The proposed system uses Artificial Intelligence (AI) and Machine Learning (ML) techniques to analyze real-time data collected from sensors such as vibration, temperature, and current sensors. The collected data is processed and analyzed using machine learning algorithms like Random Forest and Support Vector Machine (SVM) to detect abnormal machine conditions. The system predicts machine status as normal, warning, or failure and generates alerts for timely maintenance actions. This approach helps reduce downtime, improve productivity, minimize maintenance costs, and enhance equipment reliability. The system is highly useful in modern industries and supports Industry 4.0-based smart manufacturing applications.**

***Index Terms*—Support Vector Machine, Unnecessary Servicing, Real-Time Data**

I. INTRODUCTION

In modern industries, machinery plays a crucial role in maintaining continuous production and operational efficiency. However, unexpected machine failures lead to significant downtime, increased maintenance costs, and reduced productivity. Traditional maintenance strategies such as breakdown maintenance and preventive maintenance are either reactive or time-based, which often result in inefficient resource utilization.

To overcome these limitations, AI-Based Predictive Maintenance Systems have emerged as an advanced solution that leverages machine learning and data analytics to predict equipment failures before they occur. This approach enables industries to shift from reactive to proactive maintenance strategies.

II. PROBLEM STATEMENT

Industrial systems frequently experience unplanned downtime due to sudden equipment failures. These failures are difficult to detect using conventional maintenance methods, as they do not consider real-time machine conditions. Additionally, preventive maintenance may lead to unnecessary servicing, increasing operational costs. Therefore, there is a need for an intelligent system that can continuously monitor machine health and provide early warnings of potential failures.

III. PROPOSED METHODOLOGY

3.1 Data Collection

The system collects real-time data from various sensors installed on machines, such as vibration sensors, temperature sensors, and current sensors. These parameters are critical indicators of machine health.

3.2 Data Preprocessing

Collected data is processed to remove noise, handle missing values, and normalize the dataset. Feature extraction techniques are applied to identify relevant parameters that influence machine performance.

3.3 Machine Learning Model

Machine learning algorithms such as Random Forest, Support Vector Machine (SVM), and Logistic Regression are used to analyze the processed data. The model is trained using historical data to recognize patterns associated with normal and faulty conditions.

3.4 Prediction and Monitoring

The trained model predicts the condition of the machine as normal, warning, or failure. The system can generate alerts for maintenance teams, enabling timely intervention.

IV. RESULTS AND ANALYSIS

The proposed system demonstrates high prediction accuracy, typically ranging between 90% and 95%, depending on the dataset and model used. Data visualization techniques such as graphs and charts are employed to analyze trends in temperature, vibration, and other parameters. The results indicate that predictive maintenance significantly reduces downtime and improves operational efficiency.

V. APPLICATIONS

The system can be applied across various industrial sectors, including manufacturing, power generation, automotive, and oil and gas industries. It is particularly useful in environments where continuous operation is critical.

VI. CONCLUSION

The AI-Based Predictive Maintenance System provides an effective solution for monitoring machine health and predicting failures in advance. By utilizing machine learning techniques and real-time data analysis, the system enhances reliability, reduces maintenance costs, and improves productivity. This approach represents a key component of Industry 4.0 and has significant potential for future development, including integration with IoT and cloud-based platforms.

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