

PREDICTIVE MAINTENANCE

Deliverables

Predictive Maintenance monitors the structure or a piece of equipment's performance while it is in use. Data is gathered over time to track the condition of the equipment and identify anomalies or potential defects so that they can be repaired before a failure occurs. There are several classifications that has been checked to find out the target. The target can be no failure or failure and its type.

The dataset contains various columns which are the key attributes to determine the target. They are:

1. UID (Unique Identifier) - It ranges from 1 to 1000.
2. ProductID – This consists of letter L, M, H. L – Low, M – Medium, H – High. These denote quality variants and variant specific serial number.
3. Air temperature (K) – The values are ranged between 2K to 300K.
4. Process temperature (K) – Normalized to a standard deviation of 1K, added to the air temperature plus 10K.
5. Rotational speed (rpm) - calculated from power of 2860W and overlaid with a normally distributed noise.
6. Torque (Nm) – The torque values are normally distributed around 40 with an If = 10Nm and no negative value.
7. Tool wear [min] – Quality variants H/M/L add 5/3/2 minutes of tool wear to the used tool process.

The targets are:

1. No failure (0) – Indication of all the data points are in the correct range
2. Failure (1) – Determining the type of failure.
 - Power failure – Sudden drop or fluctuation in multiple parameters can lead to power interruption. Sudden drop in speed, torque, and tool wear but the temperatures are being constant can indicate power failure.
 - Tool wear failure – Gradual increase in tool wear can be an indication of tool wear failure. If air, process temperature, rotational speed and torque remain relatively stable and if tool wear increases constantly, then there might be a tool wear failure.
 - Overstrain failure – Abrupt changes in torque, rotational speed or tool wear while temperatures remain stable. High torque and rotational speed with increasing in tool wear could create overstrain.

These key attributes will help in the detection of tool failure and has to be looked after carefully.

Challenges

1. Downtime Impact: Halts production, affecting schedules.
2. Predictive Maintenance: Lack leads to unplanned downtime.
3. Complexity: Complex machines need specialized skills.
4. Obsolete Equipment: Older machines prone to breakdowns.
5. Parts Sourcing: Difficulty in obtaining timely spare parts.
6. Skill Shortage: Shortage of skilled technicians.
7. Software Glitches: Software issues disrupt operations.
8. Overloading: High demand stresses machines.
9. Wear and Vibration: Wear due to continuous use.
10. Neglected Maintenance: Lack of upkeep causes failures.
11. Environmental Impact: Harsh conditions affect performance.
12. Aging Infrastructure: Older facilities lack support.
13. Data Integration: Challenges in real-time data use.
14. Downtime Cost: Lost production and revenue.

Solution Methodology

1. Asset Collection: Identify critical equipment for monitoring.
2. Connectivity: Set up the integration of components for data transmission.
3. Data Management: Store and preprocess the data.
4. Anomaly Detection: Use analytics to spot deviations from normal behaviour.
5. Alerts: Set thresholds for alerts based on anomalies.
6. Predictive Models: Develop models to forecast failures.
7. Maintenance planning: Create schedules based on predictive insights.
8. Workflow integration: incorporate predictive data to maintenance workflows.
9. Training: Train staff to interpret and act on predictive insights.
10. Feedback loop: Continuously refine models and procedures.

Business impact:

1. Downtime: Stops production, causing revenue loss.
2. Productivity: Reduces efficiency and underutilizes labor.
3. Costs: Incurs repair expenses and potential overtime.
4. Delays: Missed orders and penalties from late deliveries.
5. Inventory: Accumulates excess finished goods.
6. Quality: Increases defects, impacting customer satisfaction.
7. Resource Allocation: Diverts attention from strategic goals.

8. Safety: Poses risks to workers and potential liabilities.
9. Morale: Lowers employee motivation and job satisfaction.