Predictive Maintenance: Employing IoT , Kafka and Spark to Prevent Equipment Failures

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Abstract

Smart predictive maintenance is an advanced approach to equipment maintenance that uses technologies such as data analysis, machine learning,and the internet of things (IOT) to predict maintenance needs before a failure occurs.this allows companies to plan maintenance downtimes in a timely manner and reduce unplanned downtime, there by improving equipment availability and overall reliability.the main purpose of intelligent predictive maintenance is to improve the overall reliability and availability of equipment by proactively identifying and addressing potential maintenance issues before they cause downtime or failure.by utilizing data analysis ,machine learning, and IOT technologies, this approach allows companies to predict when maintenance is needed and plan accordingly, reducing unplanned downtime and increasing equipment efficiency. Additionally, it can help to reduce maintenance costs and increase the overall lifespan of equipment.these Iot dashboard would give a live virtual picture of the reliability and availability of equipment.

keywords : Smart predictive maintenance . data analysis . **I**nternet of things (IOT) . machine learning . downtime .dashboard

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1.Introduction

Predictive maintenance became possible with the arrival of Industry 4.0, the fourth industrial revolution driven by automation, machine learning, real-time data, and interconnectivity. Similar to preventive maintenance, The difference is that a company schedules activities based on constant condition monitoring. Once unhealthy trends are identified, damaged parts are repaired or replaced to avoid more costly failures.The big amount of data, collected by industrial systems, contains information about processes, events and alarms that occur along an industrial production line. Moreover, when processed and analyzed, these data can bring out valuable information and knowledge from manufacturing process and system dynamics. By applying analytic approaches based on data, it is possible to find interpretive results for strategic decision-making, providing advantages such as, maintenance cost reduction, machine fault reduction, repair stop reduction, spare parts inventory reduction, spare part life increasing, increased production, improvement in operator safety, repair verification, overall profit, among others.by utilizing data analysis ,machine learning, and IOT technologies, this approach allows companies to predict when maintenance is needed and plan accordingly, reducing unplanned downtime and increasing equipment efficiency.

2. Related work

PdM is a proactive approach to servicing of machines . The difference is that a company schedules activities based on constant condition monitoring. Once unhealthy trends are identified, damaged parts are repaired or replaced to avoid more costly failures.The benefits PdM brings to businesses include lower costs on maintenance operations, prolonged equipment life, reduced downtime, a boost in production capacity, and enhanced safety.

Talosys smart predictive maintenance solution allows you to monitor the operating status of your machines and systems to prevent sudden failures and

downtime. It detects any abnormal vibrations and alerts the designated person. No shutdown of the system is required during installation.

3. Project Description

The development of IoT is providing maintenance machines with massive data that can be accessible in real-time and batch. The story of this work is taking data that came from Kaggle and it contains different values that help decision-makers to Prevent Equipment Failures of machines (product ID, Type, Air temperature [k], processus temperature [k], Rotational speed [rpm], Torque [Nm],Target, Tool wear [min], Failure Type), after that, we use Kafka as an IoT data producer to send this data to a local server (consumer of Kafka).
We use Spark to process this data before handing it to the time-series database, so we divide it into 2 sets, a set that contains normal values and another which contains alert values, after that, we store it all in a MongoDB database to visualize it in tableau desktop.
The architecture diagram for the smart maintenance machine Application is illustrated in Figure below:

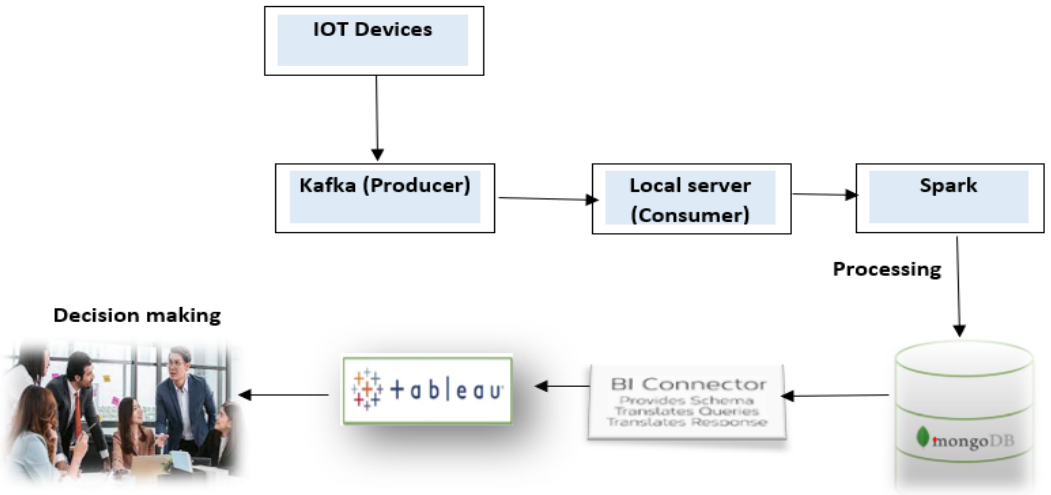

Figure 1 : Smart predictive maintenance architecture

The data visualization and the software tableau desktop takes the data stored in MongoDB and runs queries to show meaningful and concise graphs to users.

4.Discussion

This figure shows the gradual failure of cutting tools due to regular operation by every product type low (50%), Medium (30%) and high (20%).

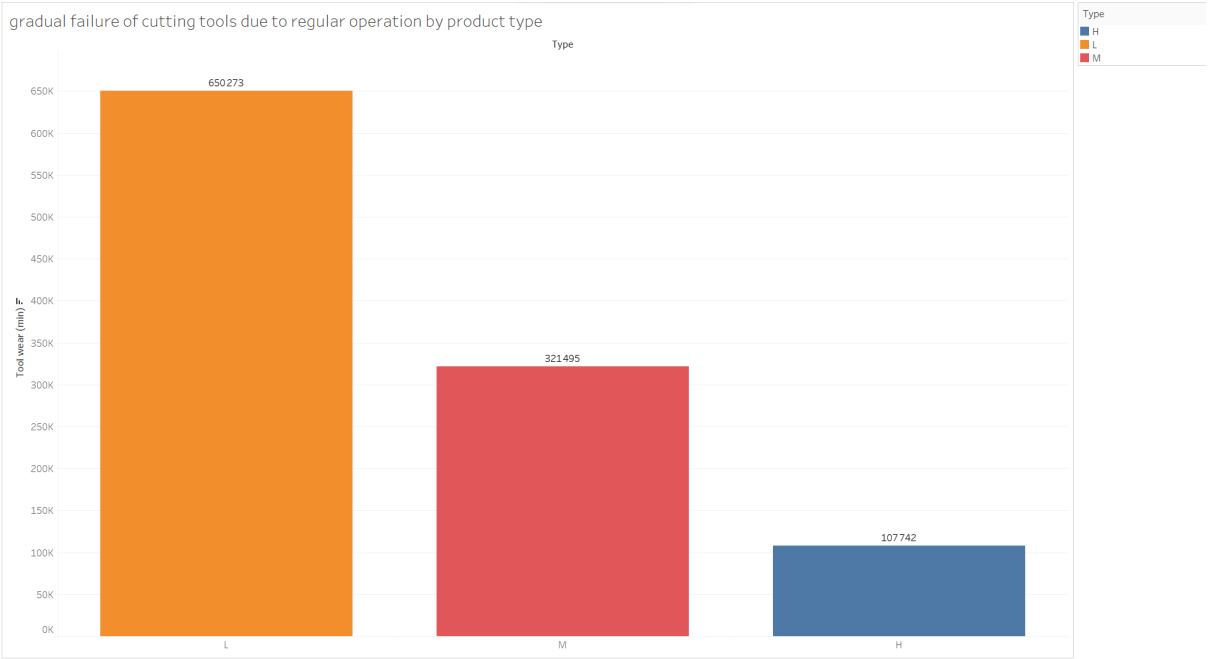

figure 1 : gradual failure of cutting tools due to regular operation by product type

the figure 2 visualize the healthy values of air temperature and process temperature

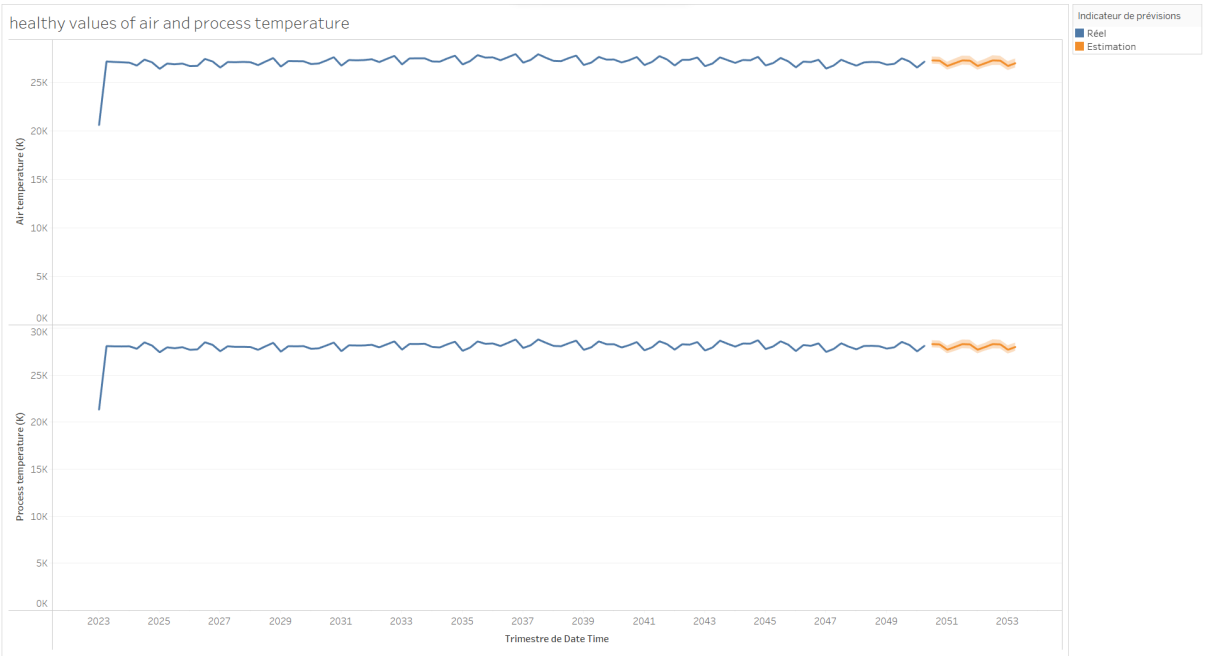

figure 2: healthy value of air and process temperature

here ,we can see the unhealthy value of air temperature and process temperature

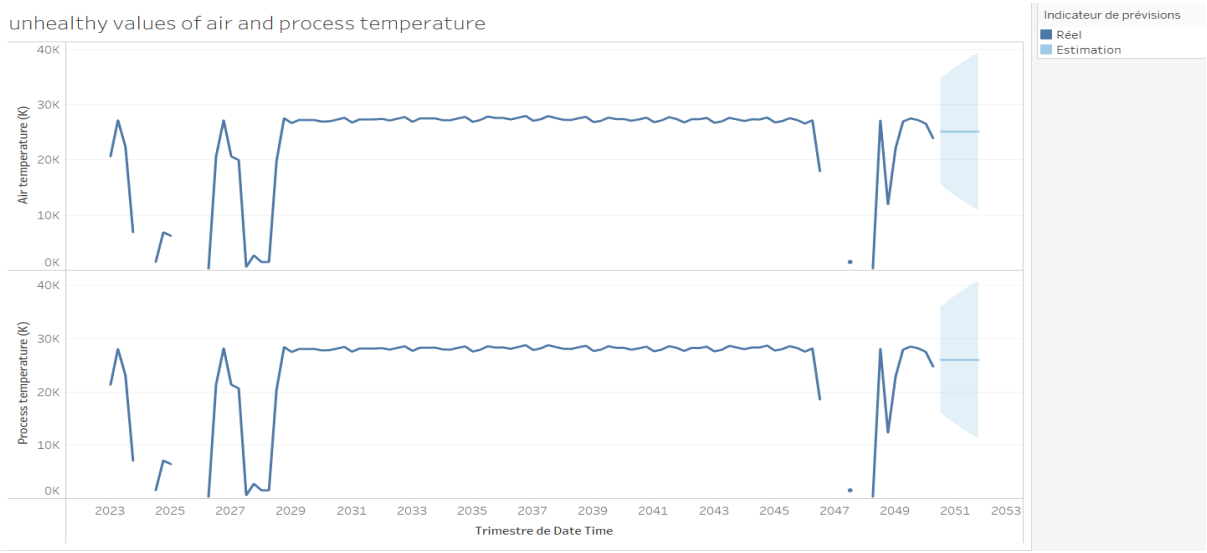

figure 3: unhealthy value of air and process temperature

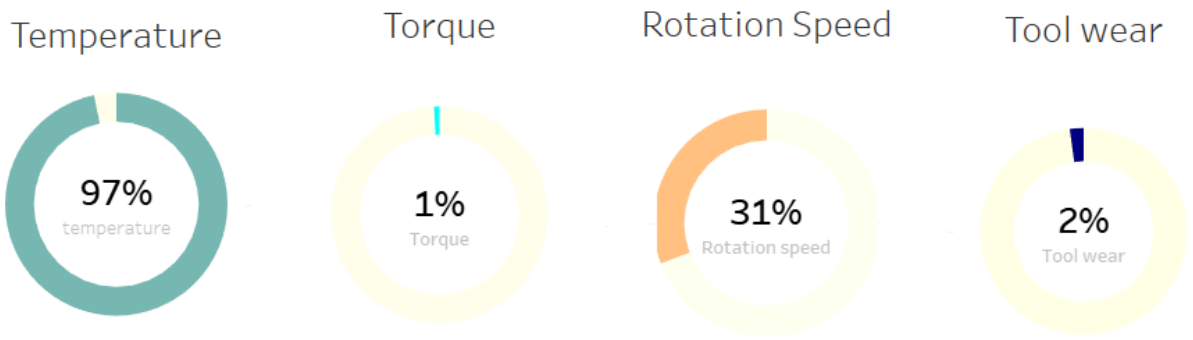

figure 4 : the mean value of Temperature, Torque,Rotation speed and Tool wear

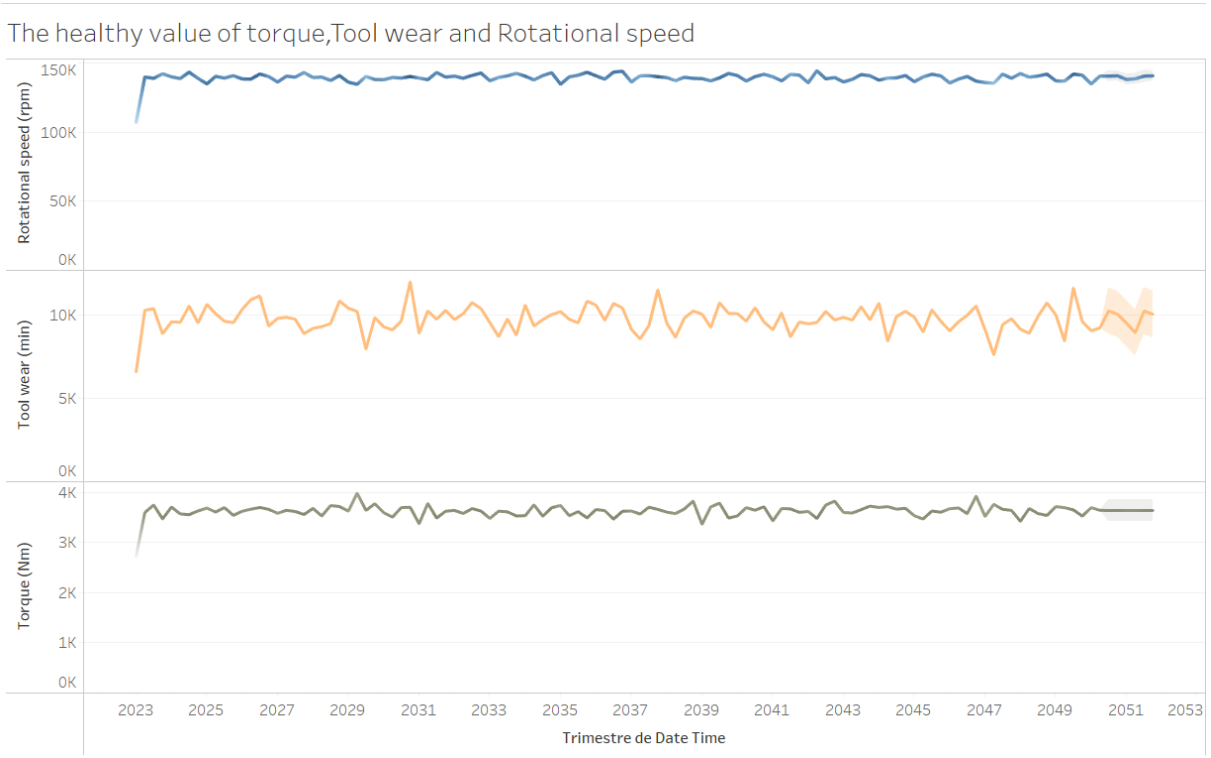

figure 5 : healthy value of torque,Tool wear and rotational speed

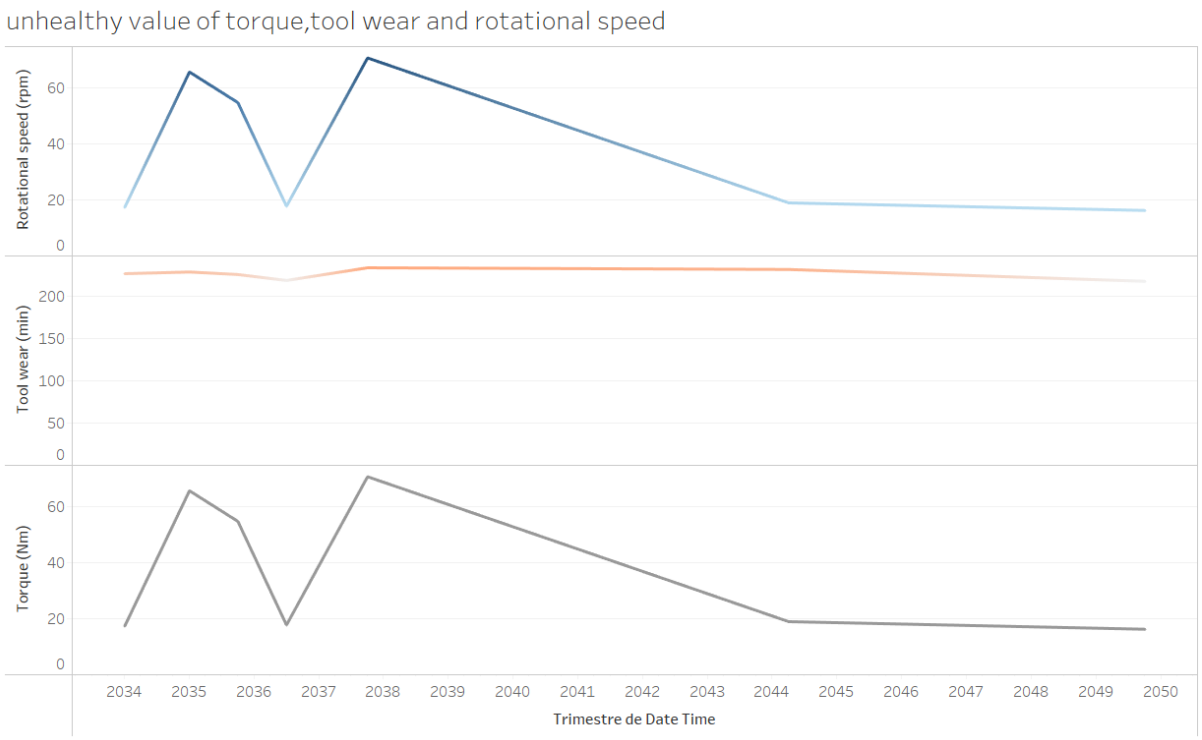

figure 6 : unhealthy value of torque , tool wear and rotational speed

The figure 4 tell the mean value of Temperature, Torque,Rotation speed and Tool wear and figure 5 et 6 shows healthy values and unhealthy values of the number of motors (torque) ,the tool wear and rotational speed.after showing these graphs we can help the users to ta kake a good decision to prevent equipment failure.

5.Conclusion

The Internet of Things is now constituting a viable data source in many domains of industry. Researches have been made to take advantage of big data technologies to handle the massive amount of data in many industry fields. In this work, we proposed an architecture to collect data from sensors and manage it using popular frameworks, then display it to users in a dashboard using meaningful graphs for decision-making.

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6. References

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