Introduction

1. The Way to Predictive Maintenance

Today’s industrial machinery are usually capital-intensive. Hence, keeping such equipment in optimal operating condition with the highest availability, performance, and quality is viewed as a crucial part of ensuring the return on investment in the acquisition and operation. In this context, machine maintenance, a vital aspect of the Overall Equipment Effectiveness (OEE), ensures that a facility satisfies production schedules, minimizes machinery downtime, and prevents potential accidents in workplaces.

Different maintenance strategies are proposed as the complexity of machinery and their working environment increase over time. In general, they can be divided into:

1) reactive maintenance (performing maintenance when an issue is presented)

2) preventive maintenance (performing maintenance due to failure experience accumulated by machine producers and operators)

3) predictive maintenance (performing maintenance based on the evaluation of data collected from equipped sensors and other sources).

In comparison with reactive and preventive maintenance, predictive maintenance detours unnecessary maintenance stops and unscheduled machine downtime since the machine is constantly monitored, and the maintenance will solely be performed when failure is imminent.

1. Associated Challenges

Developing predictive maintenance concepts is encountered a wide range of challenges, such as cost, operational variability, and data privacy. First, as predictive maintenance is based on machine monitoring data collected from different sensors, the cost of the acquisition and installation of sensors is involved and can vary according to the complexity of the data model applied. Besides, individual machines produced as the same type might operate differently under different conditions. Hence, ensuring the general availability of the data-based model developed for a certain machine type evolves into another problem. Furthermore, accompanied by the increased complexity of methods and the quality of data flow, the requirements for hardware to process are restricted. Finally, data always implicates some sensitive information about production and business. Preventing data tampering and leakage is considered as well.

1. Industry 4.0 – Enabling Predictive Maintenance

In the current context of Industry 4.0, large amounts of devices are internetworked. The term Internet of Things (IoT) emerges as the amalgam of software techniques, communication technologies, and individual devices that constitute these networks which, despite the name, may or may not be connected to the internet.

The emerging chip technology facilitates the development of edge devices which, compared with cloud devices, provide the following advantages: 1) reduced latency, 2) improved security, 3) reduced infrastructure cost, 4) improved reliability, and 5) large autonomy for battery-powered devices. The combination of edge devices and predictive maintenance covers the challenges mentioned above.

1. Our Contribution

This paper illustrates an edge-based vibration monitoring system currently operating in a textile manufacturing machine and proposes a versatile anomaly-detection-based procedure for the analysis of real-world data and extraction of machine health status, considering the battery life of sensors.

The remaining part of the paper is structured as follows: Section II provides an overview of the related work regarding predictive maintenance concepts for vibration analysis. In Section III, we propose our concept for data analysis techniques. The implementation details are presented in Section IV. We highlight the results of the data analysis and indicate our discussion in Section V. Consequently, the paper is concluded in Section VI.