A Predictive Maintenance Planning System Implemented on a Web Platform

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ABSTRACT

Predictive maintenance predicts failures and determines the equipment’s remaining useful life, which provides maintenance time to plan their interventions, preventing breakdowns or reducing their impact. This paper presents a software application, implemented in a web platform, to support the implementation of a predictive maintenance plan. The developed system currently monitors certain parameters of a plastic injection molding machine. Furthermore, this system has real-time alerts that notify the maintenance team when the measured temperatures are outside the defined limits. Some extras were added, such as the report page, which calculates, automatically, performance indicators, the access management page, and a page that permits the realization of autonomous maintenance interventions, the verification of its fulfilment, and the visualization of the performed interventions’ results. After the system’s implementation, it was tested in real operating conditions. Following the test time, it was concluded that the desired parameters were measured correctly, which supported the work’s continuation.

KEYWORDS
Automation, Industry 4.0, Injection Molding, Predictive Maintenance, Software Application, Web Platform

INTRODUCTION

The ongoing globalization and the constant social, political, cultural and economic changes trigger rapid and continuous changes in the market. These constant changes force enterprises to look for new techniques and innovative technologies that allow them to increase productivity and profitability. Additionally, the evolving customer requirements for higher quality, shorter time deliveries, lower costs and highly customized products, force companies, to not only rethink their production systems, with the aim of making them more efficient and flexible, but also to eliminate any activities that, in the clients’ perspective, do not add value to the product (Alsyouf, 2007; Bastos, Lopes, Pires, & Pedrosa, 2009; Varela, Santos, Madureira, Putnik, & Cruz-Cunha, 2014).

It is in this scenario of great competitiveness and rapid changes that a new revolution, known as Industry 4.0, begins. This concept, allows organizations to increase their productivity and consequently increase their profits. However, for that, a higher level of automation is required, which makes them deeply dependent on technology and increasingly complex. All the above reasons enhance the importance of maintenance within the organizations, since a breakdown could result in the production’s interruption which has a significant impact on productivity and profitability (Alsyouf, 2007; Bastos et al., 2009; Bokrantz, Skoogh, Berlin, & Stahre, 2017; Ehinger, 1984; Lee, Chen, Atat, AbuAli,
& Lapira, 2009; Mobley, 2002). Thus, when rethinking maintenance strategies in light of the new technologies of industry 4.0, the concept of predictive maintenance arises. This type of maintenance consists on real-time monitoring to determine the ideal operating conditions of the equipment, on finding fault patterns and predict failures and the equipment’s remaining useful life (Bokrantz et al., 2017; Efthymiou, Papakostas, Mourtzis, & Chryssolouris, 2012; Mobley, 2002).

BACKGROUND

Maintenance

The automation’s growth, triggered by the new climate of excessive competitiveness, has made the industry dependent on technology, which highlights the need to implement efficient maintenance policies since, in this situation, a failure has severe consequence (Bastos et al., 2009; Ilonen et al., 2005; Lee et al., 2009).

There are two generic types of maintenance: reactive maintenance, which involves the equipment’s repair after the breakdown, and pro-active maintenance, in this case, the repair operation occurs before the failure.

The first type of maintenance is generally known as corrective maintenance. In this type of philosophy, the maintenance interventions only occur after the equipment stops working (Bastos et al., 2009).

Alternatively, the second type, pro-active maintenance, can be divided into two different maintenance philosophies’: Preventive and Predictive. The central objective of preventive maintenance is to prevent failures, which can be carried out by predetermined and constant time-based maintenance interventions (calculated according to the reliability of the equipment’s components and the production time), or through the monitoring of the equipment’s most important process variables.

Conversely, the main objective of predictive maintenance is to predict the equipment’s future “health” state and the remaining useful life until a failure occurs (Arno, Dowling, & Schuermann, 2015; Bastos et al., 2009; Efthymiou et al., 2012; Ilonen et al., 2005; Lee et al., 2009; Mobley, 2002).

In Bastos et al. (2009) an architecture for a predictive maintenance system is proposed. This system analyses several types of data through data mining algorithms, with the goal of predicting failures and increasing the equipment’s reliability. Similarly, Efthymiou et al. (2012) developed a related platform. However, this platform, in addition to doing everything the previous one does, also allows the user to obtain and visualize several performance indicators.

When analyzing the two previous platforms, it was detected that these involved the prior existence of a data history with the equipment’s failures, its causes, among others. In addition to this, and unlike the systems proposed in the previous works, the web platform presented in this paper goes beyond predictive maintenance, allowing companies to manage the access to the platform’s web pages and to implement an autonomous maintenance plan.

Availability, Mean Time Between Failures and Mean Time to Repair

To calculate the maintenance performance value Performance indicators are used. These are used to measure the maintenance performance in an organization and, depending on the results it could also be used to define objectives and implement new strategies.

- **Mean Time between Failures (MTBF)**: The mean time between failures corresponds to the mean time in which the equipment performs its assigned function between failures (Arno et al., 2015).

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MTBF = \frac{\sum \text{time between failures}}{N^o \text{of failures}}
\] (1)