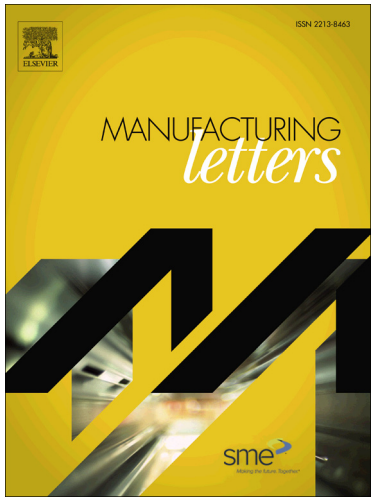

Letters

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Online Monitoring of a Micro-EDM Machine: Machining Diagnosis on the Cloud Based on Discharge Currents and Voltages

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Abstract

Currently, legacy machines (not designed to be connected to internet) are part of the manufacturing industry. This work presents a framework to incorporate legacy machines into cyber physical systems. A micro electrical discharge machine (µEDM) was equipped with sensors to monitor the machining energy. The data was uploaded to the internet. The data in the cloud determined if the machining was considered good, arcing or short circuit. This work contributes a cyber physical system that puts a µEDM online incorporating the real-time diagnosis of the machining quality, open architectures like MTConnect and compatibility with the goal of Industry 4.0.

Keywords: cloud, industry 4.0, cyber physical system, internet of things, micro electrical discharge

1. Introduction

Modern manufacturing requires access to data. Manufacturers make decisions based on real time information generated by the process. This is the core of the competitiveness and adaptability of companies in the present and near future [1]. While modern machines contain embedded technologies that prepare them for Industry 4.0, there are many legacy machines functioning today, understanding by legacy that the machines were not designed to be connected to the internet. Small and medium enterprises (SMEs) with custom made and old machines provide numerous quantities of products, yet suffer from lack of frameworks to monitor and predict behavior automatically [2].

One of the challenges for not-connected equipment is the integration into Cyber-Physical Systems (CPS). A CPS can be understood as not only the combination of physical assets and cybernetic components but also the data model that describe the physical assets and the services created using the data [3]. According to literature, the next characteristics are key for CPS in the manufacturing area:

- Internet bringing together humans and machines [4,5].
- Information exchange and control with intelligence and autonomy [6].

CPS are a prerequisite for cyber manufacturing and predictive manufacturing, in which the data pass through the next components: platform, predictive analytics, and visualization tools. These components are known as transformative agents [7,8]. The standard MTConnect is a step forward for the incorporation of data collection into the CPS. However, MTConnect is still evolving and is usually limited to machining centers [9]. For EDM machines, monitoring is key to perform analytics related to energy consumption[10,11], surface quality[12] and preventive maintenance for the goal of zero-defects [13].

This work studied the case of a micro electrical discharge machine (µEDM). The original scope of this particular µEDM was to improve machining performance [14]. The machine had no network capabilities built in. The objective of this work is the online monitoring of the operation of the µEDM by sensing the