Chapter 4
Intelligent Processes in Automated Production Involving Industry 4.0 Technologies and Artificial Intelligence

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ABSTRACT

The chapter presents different case studies involving technology upgrading involving Industry 4.0 technologies and artificial intelligence. The work analyzes four cases of study of industry projects related to manufacturing process of kitchen, tank production, pasta production, and electronic welding check. All the cases of study concern the analysis of engineered processes and the inline implementation of image vision techniques. The chapter discusses other topics involved in the production process such as augmented reality, quality prediction and predictive maintenance. The classic methodologies to map production processes are matched with innovative technologies of image segmentation and data mining predicting defects, machine failures, and product quality. The goal of the chapter is to prove how the combination of image processing techniques, data mining approaches, process simulation, chart process modeling, and process reengineering can constitute a scientific research project in industry research.

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INTRODUCTION

Industry 4.0 facilities are important about the upgrade of manufacturing processes (Rubmann et al., 2015). Automatism and image vision techniques can represent a good solution in order to improve quality control procedures (Massaro et al., 2018) according with ISO 9001:2015 standard, thus implementing Industry 4.0 control systems. Also traceability represent an important topic about process digitalization and process mapping. In this direction different technologies such as barcode, QR-code and RadioFrequency IDentification –RFID- can be adopted to trace and map production (Lotlikar et al., 2013). Traceability models should be integrated into management tools (Khabbazi et al., 2010) thus improving the knowedge base –KB-. Augmented reality – AR- can represent a further facility for monitoring manufacturing processes (Caudell et al., 1992), aided manufacturing (Novak-Marcincin et al., 2013), and quality check (Segovia et al., 2015). Specifically, by adopting marker-based approach in AR systems (Siltanen, 2012), it is possible to improve computer vision, image processing and computer graphics techniques. Image vision and image processing are suitable for automatic processes involving real time quality control of products. In this direction a study has been performed for welding monitoring of electronic boards by executing 2D and 3D image processing algorithms (Massaro & Vitti et al., 2018). In particular the 3D image processing could enhance and show hidden information (Cicala et al., 2014) thus contributing to view better possible defects and other construction details. Other sensors can be applied on production lines in order to achieve predictive maintenance (Massaro & Galiano et al., 2018). According with predictive calculus, data mining algorithms can be implemented into an information system in order to predict failures of single machines or of the whole production lines (Massaro & Maritati et al., 2018). In order to control the production during the time, can be adopted different charts mapping processes such as 4M charts (Favi et al., 2017), Plan Do Check Act -PDCA- (Chakraborty, 2016), Xm-R (Fouad et al., 2010), and *p* control charts able to check defect rate (Wang, 2009) and process quality (Acosta-Mejia, 1999). These charts can be joined with data mining and artificial intelligence –AI- algorithms to formulate a predictive maintenance scheduling model. In literature data mining has been implemented for multilevel alerting systems enabling predictive maintenance (Bastos et al., 2014), thus suggesting different industry research implementations and data flow architectures also in other application fields (Massaro, Maritati, Savino et al., 2018). Still remaining in the context of predictive maintenance, some authors applied artificial neural networks –ANNs- for the prediction of mechanical component failures and degradation prediction (Zhang, 2015), formulating innovative processes inherent in optimizing prediction and defining optimal training dataset (Krenek et al., 2016). These studies prove that different technologies can be applied in order to optimize