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Performance analysis of the RFID system for optimal design of the intelligent assembly line in the learning factory

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Abstract

New industrial revolution, called Industry 4.0, is based on the evolution of information and communication technology. It creates new challenges for the scientific and industrial community, but it also creates a specific challenge to demonstrate this new industrial platform in the learning factory environment. A significant and interesting topic for a demonstration of Industry 4.0 is to track the manufacturing execution by using the RFID (radio-frequency identification) system. Thus, creating a system called RFID-enabled Manufacturing Execution System (MES). RFID technology is interesting, because it enables, not just identification of some product like barcode technology, but also writing the data on the RFID tag attached to the product (data about process times, ERP product data, or similar). This kind of live tracking of manufacturing execution can significantly improve production planning, especially for the small-lot and single-item production. Learning factories are, in the most cases, oriented to this type of production. However, RFID technology has its limitations. In this research, a performance of the industrial RFID system has been experimentally tested. Presented results give guidelines for the design of the intelligent assembly line in the learning factory at University of Split, regarding the limitations of the RFID systems.

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Keywords: Learning Factory; Industry 4.0; RFID

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1. Introduction

The introduction of the Information and Communication Technology with the Internet of Things and Services into the manufacturing environment has started the fourth industrial revolution, called Industry 4.0 [1]. This new type of industry is based on a Smart Factory model. The Smart Factory has a completely new approach to production based on Smart Products [2]. Furthermore, Smart Factories allow individual customer requirements to be met and make single-item production profitable.

Smart Products are unique (single-item), therefore they need to be identifiable, may be located any time and know their own history, current status and alternative routes to achieving customer [2]. The technology that can enable these requirements is radio-frequency identification (RFID) technology [3]. This technology is based on RFID tags for storing data into their memory, and RFID antennas to read data from the tag or write data to the tag [4]. RFID technology is already well-known technology, therefore it could be implemented into Manufacturing Execution System (MES) with ease, thus creating RFID-enabled Manufacturing Execution System [5]. This kind of live tracking of manufacturing execution [6] connected with Enterprise Resource Planning (ERP) system can significantly improve production planning [7], especially for the small-lot and single-item production, making them more profitable [1].

The main aim of RFID-enabled Manufacturing Execution System is to have real-time manufacturing execution data [8], i.e. to have Real-time MES [9]. The main layers of the Real-time MES that create MES framework are [8]: shop-floor layer with various hardware devices (RFID readers, RFID tags and other communication devices like Wi-Fi network, or similar); MES layer containing three core services (communication service, planning and scheduling service and visualization service); interface layer that aims at real-time intercommunicating with other enterprise systems (with ERP in general); and decision-making layer consisting of the information systems: ERP (Enterprise Resource Planning), PDM (Product Data Management) and CAPP (Computer-aided Process Planning).

However, it represents a significant challenge to demonstrate RFID-enabled MES in the Learning factory environment [10].

2. Design of the intelligent assembly line in the Learning Factory

As an answer on the challenges set by Industry 4.0, a new intelligent assembly line has been designed in the 'Lean Learning Factory @ FESB at the University of Split [11]. The main idea was to demonstrate all main aspects of the smart production, emphasizing vertical integration of production system. A special product, called 'Karet', was designed based on Design for Assembly. The industrial RFID system and Windows tablets have been installed on the workstations. The main aim was to connect MES and ERP, thus creating Pull-based production system (Figure 1).

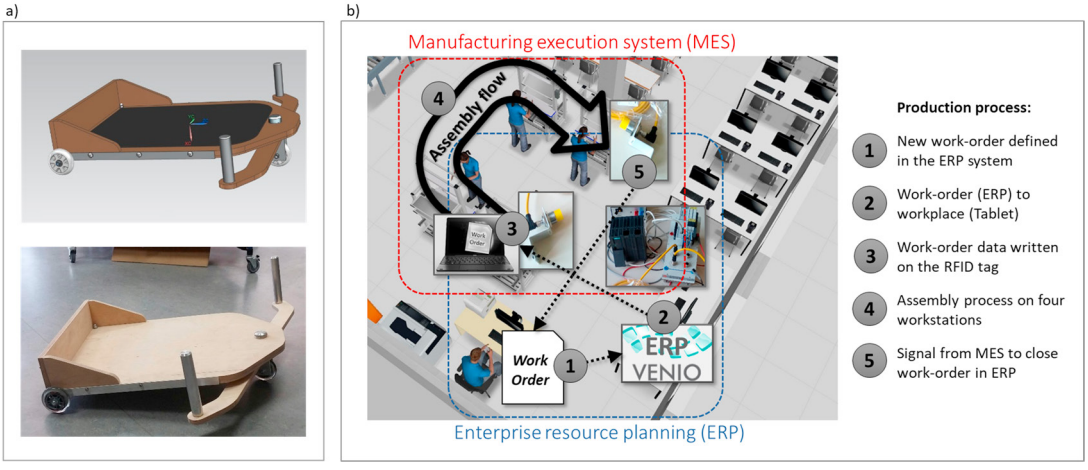

Fig. 1. Intelligent assembly line: a) Product ‘Karet’ for assembly; b) Production process with ERP and MES integration