*Article*

# A New RFID-Identification Strategy Applied to the Marble Extraction Industry

**Leonardo Andrade [1,2], João Figueiredo [3,\*] and Mouhaydine Tlemçani [1]**

[1] Mechatronics Department, University of Évora, R. Romão Ramalho 59, 7000-671 Évora, Portugal; andrade9653@gmail.com (L.A.); tlem@uevora.pt (M.T.)

[2] Metal Viçosa Lda, 7250-909 Alandroal, Portugal, and Marmetal-Marmores e Materiais de Construção, SA 7150-101 Borba, Portugal

[3] IDMEC, Mechatronics Department, ICT-University of Évora, R. Romão Ramalho, 59, 7000-671 Évora, Portugal

\* Correspondence: jfig@uevora.pt

**Abstract:** This paper aims to improve the marble industry production chain by proposing new technological approaches using the Radio Frequency Identification (RFID) systems. The dynamic capabilities of the RFID read-write tags allow the storage of physical characteristics of stone blocks, according to electrical, ultrasound and three-dimensional image characterization tests. These characterization non-destructive tests allow the evaluation of important parameters of the original stone blocks, by analyzing the internal structure of the rocks. Then, these parameters can be stored in databases through RFID-tags, in order to optimize their subsequent cutting and transformation processes. RFID identification technology when integrated into an ethernet communication network enables automatic communication with cutting and processing equipment, building an intelligent industrial platform, integrating PCs (Personal Computers) and PLCs (Programmable Logic Controllers) within an Industry 4.0 environment. Another huge advantage of RFID technology is that it allows full product traceability, namely by enabling the end consumer to reverse the production path. A laboratory prototype was implemented and a detailed analysis and discussion of the obtained functionalities is shown at the end of this paper.

**Keywords:** automatic identification; RFID systems; industry 4.0; marble industry

## 1. Introduction

According to European Parliament [1], the term "Industry 4.0" was created by the German Government describing and encapsulating the changes in manufacturing technologies. Numerous and detailed explanations involving Industry 4.0 can be found in the literature [2–4], but it basically focuses on the bellow summarized paradigms:

- **Horizontal Integration:** This integration spreads collaboration between value chain companies, directly linked to manufacturing and process planning. Using their information and communication technologies (ICT), efficient data exchange between service providers (materials and energy suppliers) and contractors (logistics, production, marketing), and other companies that are part of the value chain, increasing the added value;
- **End-to-End Digital Integration:** Proper use of information systems that enable digital support throughout the product life cycle. Tracking the product from the material line, manufacture, costumer use and end of life;
- **Vertical Integration:** It refers to the integration of the different business levels of the company (such as ERP, MES, and field equipment), allowing flexibility and reconfiguration of the manufacturing systems.