**Grâce**

**Publication**

**Papers published from Grace partners since project start**

**Towards the Integration of Process and Quality Control using Multi-Agent Technology**


IECON 11 - 37th Annual Conference of the IEEE Industrial Electronics Society

7th-10th Nov 2011 Melbourne, Australia

**Abstract**

“The paper introduces a vision on design of distributed manufacturing control systems for production using the multi-agent principles to enhance integration of the production control with the quality control processes. It is highlighted how agent technology may enforce interaction of manufacturing execution system and distributed control system, enhancing the exploitation of the available information at the quality control and process control levels. A specific focus is made on a suitable engineering methodology for the design and realization of such concept. Innovation is also presented at the level of adaptive process control and self-optimizing quality control, with examples related to a home appliance production line.”

**Multi-agent System for on-demand Production Integrating Production and Quality Control**

P. Leitão, N. Rodrigues

HoloMas-11 - 5th International Conference on Industrial Applications of Holonic and Multi-Agent Systems

29th-31st August 2011, Toulouse, France

**Abstract**

“Multi-agent systems is being pointed as particularly suited to design and engineer a new class of control systems to operate at the factory plants addressing the current requirements of modularity, flexibility and re-configurability. This paper introduces the main principles of a multi-agent system approach to support the integration of production and quality control processes in washing machines production lines that is being developed under the EU FP7 Grace project.”

**Simulation of Multi-agent Manufacturing Systems using Agent-based Modelling Platforms**

J. Barbosa, P. Leitão

INDIN-11 - 9th IEEE International Conference on Industrial Informatics

26th-29th July 2011 Lisbon, Portugal

**Abstract**

“Multi-agent systems (MAS) are driving the way to design and engineer control solutions that exhibit flexibility, adaptation and reconfigurability, which are important advantages over traditional centralized systems. The understanding, design and testing of such distributed agent-based approaches, and particularly those exhibiting self-* properties, are usually a hard task. Simulation assumes a crucial role to analyse the behaviour of MAS solutions during the design phase and before its deployment into the real operation. Particularly, Agent-Based Modelling (ABM) tools are well suited to simulate MAS systems that exhibit complex phenomena, like emergent behaviour and self-organization. This paper discusses the simulation of agent-based manufacturing systems and introduces the advantages of using ABM tools. The NetLogo platform is used to illustrate the benefits of such tools in the manufacturing world on the specification of a MAS system for a washing machine production line.”

**Development of a method to analyze the impact of manufacturing systems engineering on product quality**

M. Foehr, A. Lüder, T. Jäger, A. Fay

EFTA-11 - 16th IEEE International Conference on Emerging Technologies and Factory Automation

5th-9th September 2011, Toulouse, France

**Abstract**

“Product quality is one key performance indicator for manufacturing systems with growing importance. Among others it depends strongly on manufacturing properties and parameters defined within the engineering process of the manufacturing system creating these products. Thus, manufacturing systems engineering quality directly influences product quality. To control the reachable product quality within the engineering process, the dependencies between engineering process, manufacturing

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system, and product have to be known and used within the engineering process as guidance. Within this paper a method is described which can be used to analyze the dependency of product properties and, thereby, product quality from engineering activities.”

**Vision system based on a conic mirror for dimensional measurements inside near-cylindrical cavities**
L. Stroppa, A. Bastari, N. Paone
Optimess-12 - 5th International Conference on Optical Measurement Techniques for Structures and Systems 4th-5th April 2012, Antwerp, Belgium

**Abstract**
This paper presents an omnidirectional vision system to perform dimensional measurements for quality control applications on the internal surfaces of cylindrical objects; the system is based on a standard camera and catadioptric optics with a conic mirror mounted in axis with the lens. Such a vision system performs a geometric transformation that maps a cylindrical surface, whose axis coincides with the camera objective optical axis, into a circular annulus in the image plane domain. From the image analysis, through calibration, it is possible to perform dimensional measurements in real world units.

In this paper results of system calibration are shown and discussed. Two approaches are presented. In the first approach system uncertainty is assessed according to ISO-Guideline to the Expression of Uncertainty in measurement, using a grid pattern calibration target and it is proven that the system can be effectively used as a measurement instrument in the field of quality control inspections. In the second approach a brief overview of the possibility of implementing an auto-calibration algorithm is given if a known pattern can be found on the image and only measurements on the axial direction are needed.

This system has been integrated in an automatic test bench for in-line quality control of axis dimensions and the achieved results show that the vision system with conic mirror and auto-calibration algorithm can be effectively applied to dimensional measurements, being faster than alternative techniques, such as scanning profilometry for full field measurements.”

**Papers already accepted for publication**

**Quality control agent: self-adaptive laser vibrometry for on-line diagnostics**
S.Serfani, N.Paone, P.Castellini
AIVELA 2012 - 10th International Conference on Vibration Measurements by Laser and Noncontact Techniques 26th-29th June 2012, Ancona, Italy

**Abstract**
It is presented the development of a self-adaptive diagnostic system based on laser vibrometry for production line quality control. The vibration measurement system consists of a laser Doppler vibrometer, equipped with scanning mirrors and a smart camera, which implements self-adaptivity for compensating target mis-positioning under guidance by a vision system and for the achievement of the best condition for measurement by optimizing the Doppler signal level. This system is designed as a Quality Control Agent (QCA) and it is part of a Multi Agent System (MAS) that supervises all the production line. The QCA behavior is defined so to perform a minimization of measurement uncertainty during the on-line tests; for this purpose the QCA exhibits a self-adaptive behavior. Best measurement conditions are defined in terms of amplitude of the optical Doppler beat signal (signal quality - SQ). In this paper, the optimization strategy for measurement enhancement achieved by the down-hill algorithm (Nelder-Mead algorithm) and its effect on signal quality improvement is discussed... Tests on a washing machine in controlled operating conditions allow to evaluate the efficacy of the method; significant reduction of noise on vibration velocity spectra is observed.”

**Modelling and Validating the Multi-agent System Behaviour for a Washing Machine Production Line**
P.Leitão, N.Rodrigues
ISIE-12 – 21st IEEE international Symposium on Industrial Electronics 28th-31st May 2012, Hangzhou, China

**Abstract**
This paper describes the formal modelling and validation of the behaviour of a multi-agent system that integrates the production and quality control processes in a washing machine production line. The modelling, analysis and validation process uses the Petri nets formalism that provides a rigorous and formal language based on its powerful mathematical foundation, supporting the complete verification of the system correctness during the design phase and before to proceed to the deployment phase. The behaviour models of each agent belonging to the system architecture is edited, analysed and simulated in the PnDK framework.”

**List of Deliverables**

**D1.1** “Report with the requirements of multi-agent architecture for line production system and production on-demand” November 2010 | Public

**D1.2** “Specification of the multi-agent architecture for line production system, integrating process and quality control” October 2011 | Public

**D1.3** “Document defining the ontology for line production system, integrating process and quality control” March 2012 | Public

**D2.1** “Specification for self-adaptation and self-optimization mechanisms in WM production” February 2011 | Confidential

**D2.2** “Implementation of adaptive control algorithms and self-optimization mechanisms at local level” February 2012 | Confidential

**D3.1** “Specification for testing and quality control functions in the WM production” January 2011 | Confidential

**D3.2** “Self-optimizing/self-adapting quality control agents” December 2011 | Public

**D4.1** “Document defining the engineering process reference model” March 2011 | Public

**D4.2** “Definition of the engineering methodology” April 2012 | Public

**D6.1** “Project presentation” December 2010 | Public

**D6.2** “Rolling Dissemination and Exploitation Report” January 2012 | Public

Deliverables available at grace-project.org